THURSDAY, AUGUST 5, 1909.

WHAT THE ELECTRICIAN WANTS.

Modern Electric Practice. Edited by Prof. Magnus Maclean. New edition. In six volumes. Vol. i., pp. xii+302. Vol. ii., pp. vii+351. Vol. iii., pp. viii+340. Vol. iv., pp. vii+314. Vol. v., pp. vi+293. Vol. vi., pp. vii+362. (London: The Gresham Publishing Co., 1909.) Price, the six volumes, 54*s*.

A PUBLICATION of so ambitious a character as that which now lies before us courts severe criticism. Six handsomely bound volumes, which would adorn any bookshelf, beautifully printed on excellent paper, and copiously illustrated with still more excellent illustrations, should be, like Cæsar's wife, above suspicion. The indolent reviewer may well feel aghast when confronted with "a comprehensive treatise" which "no single writer could hope to issue," and which has consequently been compiled by "the cooperation of contributors, each of whom is an expert in his own department of study and practice"; and the editor may well comfort himself against the possibility of adverse criticism by the reflection that what no one man can write no one man can review—a comforting reflection and a true one; but therein lies the paramount necessity for being above suspicion; for, unable to criticise all, the reviewer must perforce base his judgment on selections, and if, perchance, those selections are unfavourable, good work runs the danger of being condemned merely on the strength of its association with bad, and the "experts" as a body stand or fall according as some amongst them have or have not proved worthy of their trust.

Let us, however, in the first place venture some criticism of the work as a whole. A publication such as this challenges comparison with a number of independent treatises, and in one respect at least it should be superior. Careful editorship should secure, not only no unnecessary overlapping, but also uniformity of treatment. When reviewing the first three volumes on their original appearance five years ago, the writer pointed out that the statement in the preface that the contributors had all been allowed to use their own units amounted simply to an admission of slipshod editing. We regret to find that statement still standing. But in our former review we directed attention to a more serious error, namely, that at different places different values were given to the same quantities. We have turned again to the two tables to which we referred, and find them unchanged, the editor being still apparently unable to make up his mind whether the conductivity of platinum is greater or less than that of iron. We pity the student or the engineer who consults such data as these for trustworthy information. It is a well-known rule of conduct when a number of people agree to disseminate incorrect information that the precise nature of the information is of less importance than that all should be agreed upon it; we think this rule should be borne in mind when the third edition is issued, if it is not found possible to obtain a correct table of conductivities.

Discrepancies such as these once discovered, suspicion is aroused, and one turns to individual articles to consider each on its merits. Here, as is naturally to be expected, one encounters varying degrees of merit. Some of the articles are well written, sound, and comprehensive monographs; others are exceedingly weak. We do not profess to have carefully read all, but can only judge the bulk by the average of those we have studied carefully, and it must be confessed the average is low.

Take, for example, the subject of primary batteries; the references in the index raised considerable hopes, but after they were traced we came to the reluctant conclusion that the index conveyed almost as much information as the articles. Primary cells are dealt with in section i., part i., chapter viii. Their treatment occupies five pages, about one-third beng woodcuts (Figs. 58 and 59, by the way, being crossed). The particulars given are most meagre; neither the E.M.F. nor the internal resistances are given, and one has no idea whether the Leclanché cell, for example, gives 1 volt or 100; no particulars of life or output are given, and there is no comparison between the efficiency of different types. Dry cells are referred to in half a line, which conveys no impression whatsoever as to what they are like. Primary batteries are, it is true, again referred to in vol. vi., in the article on electromedical appliances, but only incidentally, and though the E.M.F.'s are mentioned here in one or two cases, this is about the only additional information given. The most elementary five-shilling textbook with the same ground to cover gives more valuable information on this subject than this comprehensive treatise written by experts; and it cannot be claimed that the primary battery is of no importance, as it is still enormously used for telegraph and telephone work, the consumption in England running into several millions a year.

Or, turn again to wireless telegraphy: this is not quite so easy as it sounds, for the entries under this heading in the index are of no use. There are two, of which one draws a blank, and the other leads to a casual reference to the subject in the article on secondary batteries. Under telegraphy we fare no better, but the recollection of the somewhat unfamiliar name of radiotelegraphy eventually leads us on the right track, only to find a bare five and a-half pages allotted to the subject. It is needless to say that no adequate treatment can be given in this space, even though one-half of it is occupied by diagrams. It is difficult to reconcile this with the allocation of four-and-forty pages to the description of electric fittings.

There is one respect in which a publication such as this is liable to compare unfavourably with the individual treatise—it is more difficult to keep up to date. If one branch of electrical engineering shows specially rapid development, it is easy for a treatise which deals with that branch alone to be revised or rewritten; but a production such as this is not likely to be revised when only one or two of its sections call

loudly for revision. This is the always recurrent objection to the encyclopædia, which applies with special force to an encyclopædia of so progressive an industry as the electrical. If any real attempt is to be made to maintain such a publication in the front rank, it can only be done by very frequent and thorough revision. We have certainly no ground for complaint in the present instance on the score of frequency of revision—a new edition within four years of the original issue is as much or even more than could be expected—but some of the contributors do not appear to have taken the duty of revision with sufficient seriousness, and thus, whereas some of the articles have been entirely rewritten, others in which progress has certainly been no less marked appear to have been scarcely altered.

We need make no apology in this connection for referring to the articles on electric lamps. Probably in no other branch of the electrical industry has there been more startling progress during the past three or four years. Often though the expression is abused, it is true in this instance to say that both arc lighting and incandescent lighting are being revolutionised. The article on incandescent lamps has been brought well up to date, and the information given on metallic filament lamps, if not so full as some could hope, is as full as could be expected in relation to an industry still carried on with more or less secrecy; but the article on arc lamps appears to be untouched. We have the gravest suspicion that the author does not realise what the flame arc really is; if he does, he signally fails to convey a correct impression to his readers, and, at the best, his treatment of the flame lamp is grossly inadequate.

In reviewing one of the volumes on its first appearance we ventured to suggest that, in view of the generally inferior standard of the letterpress as compared with the illustrations, the latter should be published without the former. The publishers appear to have adopted this suggestion to the extent of attaching to the inside of the back covers of some of the volumes ingenious little folding paper models of electrical apparatus to which we have been unable to trace any reference in the text. Many a pleasant half-hour may be spent by the student of electrical engineering, unable to obtain access to real electrical apparatus, in unfolding these models and trying to fold them up again in the correct order.

We are at a loss what to say in conclusion; we suppose that, so long as there is a large number of engineers anxious to write, and several willing to read, there will be an output of treatises, good, bad, and indifferent; but, personally, we have a strong disposition against buying in bulk, taking the good with the bad, "as they come," in the phrase of the market.

The beneficent uncle anxious to make a suitable gift to a budding electrical engineer may find in these volumes a useful outlet for surplus wealth, but the discriminating student will be well advised to make other investments. We can well imagine that there will be many, when confronted with so imposing an array of information in so handsome a guise, who will be unable to believe that the matter can be less good than the manner; but we are loth to think that it is a comprehensive treatise such as this which really represents what the electrician wants.

MAURICE SOLOMON.

THE THERMODYNAMICS OF THE EARTH.

Radio-activity and Geology. By Prof. J. Joly, F.R.S. Pp. xi+287. (London: A. Constable and Co., Ltd., 1909.) Price 7*s.* 6*d.* net.

THOSE who are acquainted with Prof. Joly's presidential address to Section C at Dublin last year will not be surprised at the appearance of this volume from his pen. One of the most remarkable chapters the scientific historian has yet to write is the story of the rapid progress of research into the phenomena of atomic instability. In the spontaneous disruption of atoms, showing itself in the phenomena of radio-activity, we have learned of a store of energy of immense magnitude hitherto undreamt of. The fact alone that atoms are unstable systems has enlarged immeasurably the scope of our speculations regarding all inorganic evolution, while the knowledge of the forces locked up in them has still more directly affected almost every department of science. It is impossible that the geologist should long remain indifferent to this new phase of scientific inquiry, and it is Prof. Joly's endeavour to show him that already he must give heed to its teachings, and to point out where attention must be given. As being himself an active investigator, able both as physicist and geologist, no one better qualified for the task could be found, and his work must be carefully considered by every thoughtful geologist, however much any of his conclusions may be controverted.

The volume is wisely opened with a couple of chapters in which the fundamental principles and methods of radio-active inquiry are simply but accurately explained. These we would especially commend to the reader who may be inclined to a not unnatural scepticism as to the trustworthiness of conclusions based on the investigations of quantities of material habitually measured in billionths of a gram. It is of the utmost importance, too, for the geologist to realise to what degree the intra-atomic changes are independent of physical conditions, and that such changes do not affect the atoms of radium alone, but in varying degrees those of many substances.

In the chapter on radium in the earth's surface materials we are supplied with fairly ample data on which to judge of the general distribution of this element and its associates in the rocks. It is a significant fact that the rarer an element the more uniformly it appears to be distributed in nature. In spite of the natural variation of the quantities in different rock-specimens, and of considerable divergence among the averages of different investigators, we are still left with the conviction that the almost uniform presence of radium in fairly well ascertained quantity throughout the earth's crust is assured, and may be safely assumed as a basis of speculation. The

demonstration at the end of the chapter, that the well-known pleochroic halos in certain minerals are due to the radio-active discharges from the minute inclusions forming their centres, will specially interest petrologists.

Thus assured of the general prevalence of radium, Prof. Joly proceeds to trace its effects as a factor in terrestrial thermodynamics. The variations in the temperature gradient below the surface naturally suggest investigation, and an attempt is made to connect the high temperatures met with in the Simplon tunnel, and that near one end of the St. Gothard, with local variations in the radium content of the rocks. In the succeeding chapter is worked out a very ingenious theory to account for the well-known fact that mountain chains arise on the sites where sedimentation has been most extensive, *i.e.* from the great geosynclines. Having shown that the rocks cannot retain the comparative richness in radium, which they possess normally at the surface, to a depth of more than ten or fifteen miles, and that detrital rocks contain almost the whole of the radium which was in their parent rocks, it is then pointed out that denudation results in the thinning of this radium-rich surface-layer in one locality and the piling up of such material in the area of sedimentation—it leads to "a convection of energy." Not only is a much larger quantity of radio-active material accumulated in the sedimental area, but—and this is still more important—the *thickness* of the radio-active layer is there greatly increased. As a result, the heating effect is there emphasised, and the area of sedimentation becomes an area of weakness; the geosyncline becomes a mountain chain.

In natural sequence comes an inquiry whether the same cause of instability may in any degree account for the more general movements of the ocean bed which were first referred to by Darwin. This involves a preliminary discussion of the probable depth of oceanic deposits. The radium content of globigerina ooze is found by numerous determinations to be four or five times that of normal sediments, but its efficacy will depend much more on its thickness. Such meagre data as are available in the few examples of upraised oceanic sediments are carefully discussed, and a thickness of 4 kilometres is assumed as probably not excessive. This is estimated to lead to local weakening to the extent of bringing the 800° C. isotherm 10 per cent. nearer the surface, even assuming the radio-activity of the ooze no greater than that of ordinary sediments. It is, therefore, concluded that the accumulations of ooze which surround all the great coral areas may well account for some at least of their instability.

Returning again to the mountains, some of their more specialised problems are dealt with—the great overfolds and the extensive metamorphism which appears in some cases to have been effected at depths of only a few kilometres.

Finally, the larger problems of earth-heat in general are considered. Kelvin's estimate of the comparatively short interval since the attainment of the *consistentior status*, on the assumption of the simple cooling earth, is taken as evidence against the truth of that assumption. It is well maintained that the known radio-activity of the surface rocks, even if continued to only very moderate depths, is sufficient to account for all the present heat loss; and, in view of the fact that some of the loss must be due to interior heat and to decay of the radio-active supply, a limiting depth of 10 to 15 kilometres is obtained for the rich surface layer. At the same time, it is shown that the low conductivity of the rocks allows the assumption of considerable quantities of interior radium, as the interior might rise in temperature for many millions of years without the surface being affected. The determination of the age of minerals by measurement of the quantity of helium evolved from their contained uranium concludes the work. The results of Strutt are strongly criticised on the ground of their disagreement with the ages determined from the rate of accumulation of sediments and of oceanic sodium, though hope is entertained that the method may yet give accurate results.

As a kind of appendix, a useful chapter is added, explaining in detail the methods of investigating the radio-activity of the rocks.

It is necessarily easy to criticise a work of this character. Almost all its conclusions are involved in assumptions. Yet the fundamental position is sound. The radium is there, and in such quantities that its energy must be a primary factor in the evolution of the earth. Its distribution within the globe is perhaps the most crucial point awaiting settlement. On the existence of the rich surface layer of very small depth, much of Prof. Joly's argument rests. The very unsatisfactory state of our knowledge of underground temperature-gradients seriously interferes with the estimate of this depth, while the average radium content of the surface rocks can scarcely be considered as settled. Should Eve's average be anywhere near the mark, the story would be considerably altered. When Prof. Joly adduces Alpine metamorphism as evidence of radio-active heating, we think he scarcely allows sufficiently for hydrothermal action. The assumed depths of 20 to 40 kilometres, below which the rocks are supposed to yield hydrostatically, are much greater than those indicated by earthquakes and the formation of thrust-planes for the attainment of that condition. The explanation of the great overfolds of the Alps as due to the pushing of the rigid crust over these hydrostatically yielding layers might apply in that case, assuming that such folds in fact exist, but the same phenomenon may be observed on very much smaller scales, and there the theory fails. It appears to us that the estimates of the "geological age" from sedimentation and sodium accumulation are rather overweighted. The former method probably fails because the thickness of sediments is usually governed by the rate of subsidence rather than by the supply of sediment, while the data for the latter are very uncertain.

Some of the speculations may be considered rash, but the treatment of the subject is intentionally light; and it is well so. The book is full of suggestion and new lines of thought. It will compel interest, and should do much to encourage and direct investigation into what cannot fail to be a richly fruitful field.

ARCHÆOLOGY AT AVEBURY.

A Guide to Avebury and Neighbourhood. By R. H. Cox. Pp. 68. (London: E. Stanford, 1909.) Price 2*s.* net.

"A GUIDE to Avebury"—a fascinating title, giving hope of a learned speculation as to the uses of this, the most stupendous work of ancient times in this island. Was it within the circle of this great earthwork that the astronomer-priests conducted their observations, and was the great bank thrown up to form an artificial horizon to mark the lapse of time and change of season by the movements of the sun and stars, or was it simply to veil the mysteries and maintain the secrecy of the rites of a dominant priesthood, on whom the people, in those days before almanacs were thought of, were dependent for instructions when to sow and when to carry out any other of the operations of agriculture or of life that are subject to the seasons for their accomplishment? But no! there is little upon these questions to be found in this "Guide," which gives, indeed, a sort of general introduction to the study of the ancient remains in and around Avebury, and catalogues the camps, the tumuli and the trackways to be found in a long excursion from Barbury Castle round by Oldbury Castle, Oliver's Camp, St. Ann's Hill, Rybury, and Martinsell to Marlborough, but we look in vain for any real conception of the grandeur and mystery of the place.

The maps are a feature of the book, but they are difficult to understand; on p. 22, for instance, there is nothing to show what the red lines mean, and the red spots marking tumuli and camps cannot be distinguished, and do not by their size in any way indicate which are the more important; then there are only two indications of sarsen stones, the northern labelled "Grey wethers," and we wonder if the author has ever seen the vast sea of sarsen stones near "Glory Ann" and "Totterdown."

On p. 44 we are informed that near Urchfont is the watershed between the head-waters of the Wiltshire Avon and the "Stour," an extraordinary statement, as the Stour rises some thirty miles away to the south-west, and the waters from Urchfont (Hart's fount) flow into the Bristol Avon.

On p. 53 we have the statement that the West Kennet Long Barrow is now taken over by H.M.'s Board of Works, and on the same page the author writes of it as "the Government's long barrow," all of which is pure imagination, as the barrow is no more the property of the Government than is Silbury Hill or Avebury. These inaccuracies make us chary of accepting the author's statements, but they are insignificant compared with Lord Avebury's statement on p. 6 that the earth and chalk from the ditch have been thrown up on the *inner* side, whereas, of course, the curious fact at Avebury is that the bank is on the outside of the ditch.

As the author makes no mention of the late Rev. A. C. Smith's "British and Roman Antiquities of North Wiltshire," we presume he does not know the book or the elaborate maps contained in it, showing every road and trackway, every camp, tumulus, or sarsen stone that exists, or of which there is tradition, in the 100 square miles round Avebury, and we venture to think a careful study of it would have been useful to the author.

We hoped, when the delving archæologists were collected at Avebury this summer, that something might be done to protect the most interesting relic of all—the two remaining stones of the "cove" of the northern circle—but apparently the use of these stones as protection for a hayrick was deemed quite appropriate.

R. H. C.

VENOMS AND ANTI-VENOMS.

Venoms, Venomous Animals, and Anti-venomous Serum-therapeutics. By Dr A. Calmette. Translated by E. E. Austen. Pp. xvi+403. (London: John Bale, Sons, and Danielsson, Ltd., 1908.) Price 15*s.* net.

WHATEVER may be thought of their reputed powers in other directions, there is no question of the peculiar fascination exercised by snakes upon the popular imagination, so that a translation of a work by Prof. Calmette, whose name in all that relates to snake-venoms and antivenoms is familiar in men's mouths as household words, is certain to command attention.

The volume consists of five rather unequal parts, dealing respectively with the classification, habits, and geographical distribution of poisonous snakes; the chemistry and physiology of snake-venom; immunisation, and the preparation of antivenoms; the venoms of various classes of animals other than Ophidia; and records and results of numerous cases of snake-bite treated with the author's antivenin.

The book is addressed particularly to medical men, naturalists, travellers, and explorers, and the author believes that physiologists also may read it with profit. Its value to the physiologist is diminished by the fact that, as a summary of our knowledge, its design is hardly catholic enough; but that it will prove of very great service to the medical man, and particularly to the medical officer stationed in the tropics, there can be no two opinions. For just those things that the medical man wants to know, and the medical officer is expected to know, about snakes—what venomous species he is likely to encounter in his own province, how those species may be recognised, how their various venoms manifest their action and to what degree they are dangerous, and on what rational principles the treatment of snake-bite is based—are here to his hand in a single volume of convenient size and of moderate price.

The first part of the book, which deals with poisonous snakes from the systematic and geographical points of view, may be described as a condensed extract of the British Museum Catalogue, leavened with remarks on habits, and finely flavoured with well-chosen figures. The British Museum Catalogue, which itself is a marvel of conciseness, does not lend itself to condensation of this sort, but the figures in this instance make it good. What one

misses, in a book meant for medical men and travellers, are good, plain descriptions and diagrams giving the names and explaining the relations of all those parts of the snake's skeleton and integument that are of applied value in classification. Here there are descriptions and figures, but they do not explain *all* the terms employed in the specific and generic diagnoses; moreover, some of the terms used are not those commonly current, and some do not correspond in text and figure. Thus the well-known quadrate bone is referred to as the tympanic; and the shields which in the text are called, in accordance with the authorised British version, internasal, prefrontal, frontal, and parietal, appear in the figure under other names. Seeing that the differentiation of species, and even of genera, largely depends upon scale-characters, this is hardly a matter of little moment.

The second part, which treats of snake-venoms, describes the methods of collecting venom and the chemical composition of the secretion, and gives an account of the way in which in the laboratory the various constituents of the venom act upon the blood and tissues. The gross effects of cobra-bite and viper-bite are also contrasted. The author naturally draws largely on his own experiments, but the work of other investigators is duly considered. It is rather surprising, however, not to find any mention whatever of D. D. Cunningham, who for many years was in India the observed of all observers in this field.

The third part brings us to the cream of the subject, namely, the acquisition of immunity against snake-venom and the use of the serum of immunised animals as a cure for snake-bite. This subject is so largely the author's own that criticism can only be offered with deference. But, considering merely the way in which the matter is represented in the book under review, the author appears to rely rather too much on his own large experience with cobra-venom, and also to be hardly consistent; for although he seems to adhere to the untenable opinion that neurotoxin is the essential toxic constituent of *all* venoms, whether colubrine or viperine, he allows that cobra-antivenin is of no avail against what, by a strain of language, he calls the "local" effects of viperine venom, and he concedes the practical point that an antivenin of general efficacy can only be obtained from an animal that has been immunised against *both* kinds of venom, colubrine and viperine.

The only other part of the book that requires notice is that concerned with the venoms of animals other than snakes. Here we find many interesting fragments of information about the venom of polyps, sea-urchins, arthropods, molluscs, fishes, and amphibia. The venomous Mexican lizard, Heloderma, and the spur and femoral gland of Ornithorhynchus are also remembered, but, strange to tell, the dreadful sting-rays, the notorious jelly-fishes, and the molluscan Toxiglossa are quite forgotten.

As to Mr. Austen's translation, it is as near as possible perfect, being wonderfully faithful to the original, and yet, so far as technical terms do not interfere, good English. In the case of some of the technical terms, however, Mr. Austen's unflinching fidelity sometimes goes near to make the reader wince. There are expressions, such as "gingival fold," "ergastoplasmic venogen," "sanguinolent serosity," "laccate," "chloridate," "asporogenous," to which even the hardest-mouthed jargonmonger will object.

THE SCOTTISH LAKE SURVEY.

Bathymetrical Survey of the Fresh-water Lochs of Scotland. Under the Direction of Sir John Murray, K.C.B., F.R.S., and Laurence Pullar. Pp. viii+288; maps and plates. (London: Royal Geographical Society, and Edward Stanford, 1908.)

IN some countries it appears so natural that the national surveys should present a complete delineation of the solid surface of the land that the accident of certain hollows being filled with water does not excuse the surveyor from continuing his contour lines across the submerged slopes. With us, however, until the Survey Department was supplied with the necessary data by private investigators, no sub-lacustrine contour lines appeared even on maps of the largest scale, and large surfaces of paper remained blank save for the artistically graduated lines which indicated the difference between a water and a land surface. Most of the English lakes were surveyed in 1893 and 1894, and the contour lines appear on the later editions of the six-inch maps, with due acknowledgment of the source whence they were derived.

The volume now before us completes the preliminary publication of the survey of the lakes of Scotland undertaken by Sir John Murray and Mr. Pullar in 1896, and now brought very near completion. It represents an immense amount of work of national importance carried out at the personal cost of the authors, and its very magnitude makes it impossible to give any serviceable summary here of the additions to limnology it contains. Eighteen papers appeared in the *Geographical Journal* between 1900 and 1908, illustrated by bathymetrical maps of 213 fresh-water lochs, and this volume, published separately by the Royal Geographical Society, gives particulars and bathymetrical maps of a further series of 349 lochs, making a total of 562 surveyed and described. The number is so great that we cannot help regretting that it has not been made complete, but the rule appears to have been that no steps were taken to survey those lochs on which a boat was not available. In this way some sheets of water of considerable size and great interest have been left unsounded, a fact the more regrettable because difficulties due to sporting rights in some of the nearly inaccessible valleys in the heart of the great deer forests may prove insuperable to less known investigators in the future, while the high distinction of Sir John Murray's name might possibly have smoothed a way in the course of his great survey.

Apart from this, the record of the Loch Survey is one that Sir John Murray, Mr. Pullar and their numerous assistants may well be proud of. How great a body of work it represents may in part be gathered from the complete index, which includes all lakes described here and in the articles which have appeared in the *Geographical Journal*; but a mass of additional

material bearing on the physics and biology of the waters has still to be published.

The bathymetry of the lake-basins was determined by series of close soundings in lines transverse to the long axis, and the scale of the maps is sufficiently large (3 inches to 1 mile) to allow of all the soundings being represented in figures as well as by contour lines. We think that a longitudinal line of soundings along the axis of maximum depth would have been a useful addition in all cases, and a valuable check on the transverse series. Supplementary soundings would also have been useful in many places where the exceptional run of the contours suggests some unusual configuration. Such additional lines have been run on some of the lochs, and the maps of these inspire a more complete confidence as to detail than do the others. We should have liked to see some larger-scale surveys of such individual features as the sub-lacustrine slopes of delta fans, screes, steep rocky shores, and the transition belt between the steep sides and flat floors of many of the basins.

The sounding of the large area of fresh water which fell between the two stools of the Admiralty and the Ordnance surveys is a splendid example of public-spirited private enterprise undertaking and carrying through work which should have been included in the routine of a Government department. It is, happily, not the only case in which the collective shortcomings of the nation in matters affecting the advancement of scientific knowledge have been made good by individual effort and at private expense. When the right men are at the head of such an investigation, and their labours are not trammelled by the want of means, we are of opinion that better work can be done at a smaller outlay than if the operations were conducted by an official department or under the auspices of a committee of many specialists on different subjects; but when the right men are not to be found the lack of Government interest in the completion of our knowledge of our own land and its resources may lead to unhappy consequences. It is fortunate, indeed, that Sir John Murray and Mr. Pullar have had both the will and the power to carry out the work, which, when completed by the publication of the additional material already collected, will form a noble monument to the memory of the late Mr. Fred Pullar, to whose energetic assistance the early stages of the research were so much indebted.

H. R. M.

THE OLD AND THE NEW MECHANICS.

(1) *A First Dynamics.* By C. S. Jackson and W. M. Roberts. Edited by W. J. Greenstreet. Pp. viii+412. (London: J. M. Dent and Co., 1909.) Price 5*s*.

(2) *Elementary Mechanics.* By Prof. C. M. Jessop and Dr. T. H. Havelock. Pp. viii+277. (London: George Bell and Sons, 1909.) Price 4*s*. 6*d*.

(1) SO many new series of mathematical school-books have appeared during the last few years that the present series has remained almost unnoticed. This is the more remarkable in view of the wide reputation of the editor, Mr. Greenstreet, and also of the fact that the contributors are also mostly well-known authorities in the mathematical teaching world. Messrs. Jackson and Roberts have fully justified the existence of their book by the amount of freshness and originality they have put into it, and particularly by the extent they have treated the subject from a common-sense, practical point of view. As the authors point out in the preface, there have been in the past two classes of book in which the relations between force, matter, and motion are dealt with. There has been, first, the book on applied mechanics, in which the principal object has perhaps been to describe machines, and there has next been the "academic" book, in which dynamics might perhaps better be described as "dogmatics," the most prominent feature of which has been a collection of exercises in algebra.

It has been the object of the present authors to make the principles of dynamics the prominent feature of their book, and to illustrate them by applications to phenomena of everyday life rather than by algebraic drill. In this they have been very successful, so far as can be judged without an extended trial of the book in the class-room.

The main crux in writing a book on dynamics is the question of units. Shall the author use poundals and please one class of teachers, or shall he use slugs and be commended by another section? It seems to have been generally forgotten that there is a third alternative which still allows those who wish to do so to replace Newton's "proportional" by "equal" in the laws of motion. That alternative is to take the gee (g) as unit of acceleration, and write force in lbs. wt. = mass in pounds and acceleration in gees; and if any writer chose to champion the claims of the gee, he could point to the fact that the foot, if defined by the length of the seconds pendulum, is really a gravitation unit of length.

Messrs. Jackson and Roberts, while discussing the two generally recognised systems, adopt the more rational plan of basing their treatment on the proportion:—

$$\frac{\text{force}}{\text{weight}} = \frac{\text{acceleration}}{g}.$$

It has been popularly supposed that this plan is theoretically good, but how would the equations of motion of complicated systems be written? Now in Mr. Jackson's hands the equations all look delightfully simple; not only is there no more difficulty than occurs somewhere in every system, but *it is very easy to see if the results written down are correct in their dimensions.* The suppression of constant multipliers in physical equations does not always conduce to simplicity; it more often causes confusion, especially in connection with electrostatic and electromagnetic units, and also in hydrodynamics, where problems of discontinuous motion are solved for jets of one particular breadth (generally π) with one particular velocity, and the solution appears inapplicable to other jets differing in size and velocity. A little doubt may occur as to whether momentum should be defined as Wv/g, as Mr. Jackson does, or simply as Wv; but this is a matter in which experience will indicate the wisest choice.

The subject-matter treated includes such applications as the instantaneous centre of a connecting rod, two-speed gears, and the elements of dynamics of rotation. There are many reasons why the latter subject should be included in an elementary treatise; indeed, the authors claim that, "frankly, unless a student means to know, in broad outline, about as much of the principles of mechanics as we have given, he may with advantage allot more time to some other subject."

In certain details the book leaves something to be desired. It would surely be better, for example, to give the rule for composition of relative velocities after, instead of before, the construction for the relative displacement and velocity of two moving bodies. The present order is a survival of the old idea that because the parallelogram of forces is the fundamental proposition in statics, the parallelogram of velocities ought to be the fundamental proposition in kinematics. In the proof of the relations between angular and linear velocity, a 60 is introduced unnecessarily and then cancelled by considering the space described in a minute instead of in the unit of time (a second) assumed in the definitions. In several places where uncertainty exists as to how much should be included in the text and what should be omitted, the final result suggests that the authors were not given sufficient facilities for making alterations when the proofs were in type. The paragraphs are unnumbered, and this is a great drawback, but the worst feature is the illustrations, which are badly reproduced, with coarse, unsightly lettering. In one of them, on p. 177, a capital V looks like a Greek γ. If books of this class are to hold their own in the field of competition, not only should the figures be above reproach, but a large amount of time and thought must be devoted to minor alterations and emendations such as only suggest themselves when the text has been seen in print.

(2) If novelty and originality is one of Mr. Jackson's strong points, this cannot be said of Prof. Jessop and Dr. Havelock's book. It brings back to memory days of long ago, with its "forces of 1, $\sqrt{2}$, and $\sqrt{3}$ lbs.," its Roman and Danish steelyard, its three classes of lever, the oar being included in the second regardless of the man's thrust on the rowlock, its mechanical advantage instead of the more modern velocity ratio and efficiency, its systems of pulleys which only lift a weight a small fraction of the height of the supporting beam—and perhaps do not lift it at all if the ropes are extensible, and its Attwood's machine neglecting inertia of pulley, in the first instance, although this is now taken into account at the end of the book. But Jessop's "Elements of Applied Mathematics" was an excellent book when it was written, and it is not the book which has gone backward in its present revised edition, only other people have moved forward. Moreover, the present reviewer can ill afford to find fault with an author who is prevented by his professorial duties from completely rewriting his text-books when his opinions on certain points have changed. At the same time, in view of the fact that revision has been undertaken by Prof. Jessop's lecturer, we think something more might have been done. The separate formulæ for the resultant at angles of 30°, 45°, and 60° might surely be struck out *now*, although the present reviewer pleads guilty of having perpetrated the same barbarisms (under protest) when he was younger and was informed that certain classes of students required them. On the other hand, the addition of sections on harmonic motion, bending moment, and shearing force (under graphical statics), and the chapter on energy of rotating bodies are valuable additions. In the latter chapter the moments of inertia of simple figures are stated without proof. Perhaps this is the best way, in view of the fact that integral calculus is now usually taught at an early stage; had this not been the case, the use of the geometric progression formula for making the necessary summations would have been recommended.

A student might do worse than use Prof. Jessop's book for algebraical drill, supplementing it by a course of experimental mechanics, or by Mr. Jackson's book; and whatever else may be said, no exception can be taken to the general appearance of the book, or the diagrams, which fully maintain the high standard that characterises Messrs. Bell's text-books.

OUR BOOK SHELF.

The State and the Farmer. By Prof. L. H. Bailey. Pp. xii+177. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1908.) Price 5*s*.

LESS than a generation ago farming and farmers made very small figures in the public eye; men of affairs, when they gave the subject a thought, regarded British agriculture as a dying craft, something that had ceased to pay and might be left to extinguish itself quietly, leaving the country for the recreation of the town-dweller, to provide sport for the rich industrial, health and the gratification of his æsthetic tastes for the employee. Business men paused sometimes to make pharisaical remarks about the wastefulness of the farmer; men of science scolded him for sticking to his old ways, not adventuring his substance on the crude generalisations which were put forward to represent the infinitely complex life of animals and plants; the politician had no use for the agriculturist, whose vote he knew was safe in the landlords' pockets; and the journalist saw little but comic copy to be got out of Hodge and its ways. As Sir Horace Plunkett said in his British Association address, modern civilisation has joined the rural exodus.

But latterly there have been signs of change; the triumphal march of industrial progress, with its concomitants of vaster factories and ever extending suburbs of mean streets, has proved less satisfying than its prophets had promised; the nation has begun to awake to the essential instability of such a system, and to the need of keeping up agriculture as the soundest basis of the State and the only means of creating wealth, whether of men or things.

To some men the necessity of drawing men back to country life seems little less than a holy cause into the service of which they are ready to put their whole strength, and among such men Prof. L. H. Bailey, of Cornell, is perhaps most prominent on the other side of the Atlantic. In the little book before us Prof. Bailey pleads for the better organisation of rural life with eloquence and conviction; rural life, not merely because it pays, but because it is the life best worth living, most calculated to raise a sober and

strenuous race of men. The author's particular text is the function of the State in fostering agriculture; left to himself, the farmer is normally a strong individualist, who readily becomes isolated and hidebound. His sole chance of success in modern life is collective action, and Prof. Bailey discusses in successive chapters the extent to which the State can profitably intervene in the organisation of rural life by education and by starting various forms of cooperative work which will lead the farming community to act together. Different as the agricultural conditions are in this country and in America, the problems are the same in both places, and Prof. Bailey's discussion of the subject gains a special interest for us at this moment, when the Chancellor of the Exchequer has just set aside a "development grant" to be devoted to the promotion of all agencies for encouraging rural life.

The Problem of the Feeble-minded. An Abstract of the Report of the Royal Commission on the Care and Control of the Feeble-minded. With an introduction by Sir Edward Fry, G.C.B. Pp. x+113. (London: P. S. King and Son, 1909.) Price 1*s.* net.

THE appearance of this abstract is most opportune. The small committee of persons interested in social problems which is responsible for its publication is anxious to bring before as large a section of the public as possible the urgency of the matters in question, and points out in the preface of the book that the Poor Law Commissioners have given it as their opinion that if the recommendations of the Commission on the Care of the Feeble-minded were carried into effect, a system of control over the feeble-minded would be initiated which would free the Poor Law administration from one of its greatest difficulties and, we may add, the country from a cause of enormous expenditure. In his introduction Sir Edward Fry quotes Bagehot's sad reflections upon the undue haste and benevolent thoughtlessness with which so much philanthropic effort is attended, and the terrible question which he poses as to whether the benevolence of mankind does not do more harm than good. Sir Edward Fry can, however, recommend the work of the Commission on the Feeble-minded as one done with deliberation and not with "a wild passion for instant action." The various problems which came before the Commission, such as mental defect and drink, mental defect and crime, and mental defect and illegitimacy, are adequately epitomised, and the far-reaching recommendations of the Commission duly considered as to the essential points. The book also contains some special articles, of which that upon segregation, by Mr. Galton, we can especially recommend to our readers.

The Economy and Training of Memory. By Henry J. Watt. Pp. viii+128. (London: Edward Arnold, 1909.) Price 1*s.* 6*d.* net.

THE training of the memory is undoubtedly a part of any good education, and it has hitherto been too much the peculiar field of the faddist and of ingenious but ignorant *a priori* system-makers. This little book, which aims at making of practical value to student and teacher the results of scientific experiment into the subject, is therefore to be welcomed. It is true that some of its precepts appear obvious, but where there are so many conflicting truisms the selection of the right obvious is not unimportant; and much definite information is given on particular points where the merely empirical adviser is quite at a loss, *e.g.* the advantages and disadvantages of specific types of mental imagery, and the variations of method corresponding to differences in the material to be memorised. Moreover, if the book did no more than free the ordinary adult from that excessive distrust of his memory, which is so bad in effect, and is, perhaps, too optimistically believed by Mr. Watt to be quite ungrounded in fact, it would be abundantly justified.

Mr. Watt considers the mechanical memory of association to be, in a sense, more fundamental than the intelligent memory based on connection of thought, since the association between word and "meaning" is in itself mechanical. It seems doubtful if that ultimate "association" of meaning and imagery can be expressed so simply; but the point, though of great interest, is of minor importance in a confessedly practical book.

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.*]

Rate of Helium Production from the Complete Series of Uranium Products.

A KNOWLEDGE of this constant is essential to the estimation of the ages of minerals from their helium content. In a paper published in Proc. Roy. Soc., July 28, 1908, I gave the ages of some minerals provisionally on the assumption that the rate was $9{\cdot}13\times10^{-8}$ c.c. per gram U_3O_8 per annum. This rate was calculated from Rutherford's indirect data. It has received much support from Sir J. Dewar's determination of the rate of production by radium with its immediate products. I am now in a position to confirm it further by an experiment on the rate of growth of helium in a solution of pitchblende; I speak of *a* solution, but it has been found impracticable to take up all the constituents by one solvent. Two solutions were necessary.

The pitchblende solutions contained 115 grams of U_3O_8, and yielded in sixty-one days a quantity of helium which was measured as 2×10^{-6} c.c. in the capillary of a McLeod gauge. This gives the rate as $10{\cdot}4\times10^{-8}$ c.c. per gram U_3O_8 per annum. No stress can be laid on the close agreement with Rutherford's estimate in view of the very small gas volume measured. The experiment proves, however, that that estimate is of the right order of magnitude. Larger scale experiments are in progress, and these, in conjunction with similar experiments on thorianite, will, it is hoped, enable data on the quantity of helium in minerals to be translated into estimates of time with full confidence.

R. J. STRUTT.

Imperial College of Science, South Kensington, July 27.

A Kinematic Illusion.

PEOPLE are sometimes amazed by noticing that in a motor-car seen through railings the wheels appear to revolve the wrong way. As the eye follows the moving objects it is convenient to imagine that the car, which may be actually running to the right, is stationary, while a vertical rail is moving past it to the left with an equal velocity. The apparent intersection of this rail with the upper edge of the wheel is a point running round in a contrary direction to that of the rotation of the wheel. This moving point suggests rotation of the wheel. When oblique lines swing in front of vertical lines the movement of the intersections is curious to watch. It is true that the lower half of the wheel goes against our theory, but at a given moment its effect may be less noticeable, either from being hidden in dust or because the eye has a very small range of close attention. I have seen the appearance, and have had reports of it from others, but cannot speak with precision as to the condition of seeing it effectively.

It is common to rotate vacuum tubes while a discontinuous spark illumines them. A spark may pass at the instant of starting one revolution, and the illumination

may recur slightly before or after the beginning of a second round; in either case there is a false suggestion as to the rotation. The railings would make discontinuous vision of the spokes of the motor wheels, and a spoke might be seen upright in one gap but at slightly different angles at other gaps. I do not feel that the solution of the problem lies in this direction.

Winchester College. W. B. CROFT.

Natural Selection and Plant Evolution.

MANY readers of NATURE must have been browsing with delight in the goodly volume on "Darwin and Modern Science" which Prof. Seward, of Cambridge, has taken such admirable pains to collect. Of all its many chapters few are more significant than that on the palæontological plant record by Dr. D. H. Scott, because there, perhaps for the first time, the evidence of the fossils with regard to the influence of natural selection has been fairly tackled by competent hands.

Dr. D. H. Scott does not attempt to maintain that the record to-day is nearly so imperfect as it was when Darwin wrote his famous chapter thereanent, fifty years ago. Dr. Scott's namesake and collaborator from Princeton speaks even of the record as, in some parts, "crowded with embarrassing wealth of material"; and yet what about evidence of natural selection? The present writer ventured to say (*Contemp. Rev.*, July, 1902, p. 83):—"Modern palæobotanists furnish us with next to no evidence at all of the work of Natural Selection in evolving new species." Prof. Seward vehemently challenged my statements next month; yet, seven years later, Dr. Scott feels constrained to tell us:—"As regards direct evidence for the derivation of one species from another there has probably been little advance since Darwin wrote."

To put it more plainly, Dr. Scott is forced to admit that he can adduce absolutely no satisfactory evidence at all. All he does is to affirm his own firm conviction (as it is Prof. Seward's too) that natural selection must have been the chief agent; and he instances two cases where he thinks the possible inference extremely plausible, viz. (1) the case of the pollen tube, quite absent in the Palæozoic seed-plants, found very short and imperfect in the living cycads and ginkgos, and fully developed in the angiosperms, but fossil proof of linking forms there seems none; (2) the embryo in the angiospermous seeds, whilst Palæozoic seeds contain none. It may, as he says, be "impossible" to some "to resist the conclusion" that the nursing of the embryo by the seed was a process of adaptation. But, at any rate, there is no fossil proof thereof; and yet, as Dr. Scott will scarcely deny, there surely ought to have been some hint and trace thereof, the record being so comparatively rich and full as it is. In the case of the Tertiary mammals the action of natural selection can be very clearly demonstrated in numberless cases. If natural selection was *the* factor in plant evolution too, why is the record so obstinately silent?

Dr. Scott, like Prof. Seward, takes refuge in the thought that our plant record, for many purposes, begins far too late. "An immense proportion of the evolutionary history lies behind the lowest fossiliferous rocks." My chief object in writing this letter is to ask, Is there any valid proof of this in regard to *land plants*, the matter specially in hand? Their record begins, actually, in the Upper Silurian, and though it is very, very meagre and imperfect, the traces are too widespread to be denied. To deny the existence of known Upper Silurian plants is rankest scepticism, though Dr. Scott avoids all reference to them whatsoever. Why, even so very cautious an investigator as Mr. Robert Kidston tells us of "a plant showing woody structure," a plant so high as that, in the Lanarkshire Ludlow beds (Summary of Progress of Geol. Survey for 1897, p. 74). The most important Upper Silurian plant-remains are probably those from the Tanne Greywacke of the Harz, a fairly numerous and well-developed series, of age a good deal lower than Wenlock. Drs. Scott and Seward ("Encyclop. Brit.," Supplement) wish to pronounce all these fern-like and other plants Devonian, because of their facies; but Sir Archibald Geikie ("Text-book of Geology," ii., p. 976) tells us that these Tanne plants are found a long way below shales with graptolites, which surely is proof enough of Silurian age.

We have, then, fair evidence of land plants in the Upper Silurian. Our very first air-breather or land animal, a cockroach, comes from the top of the Lower Silurian; and the fossil record of the whole Silurian is rich, varied, widespread, without gap. Yet it yields no hint of conditions favourable to land life below the top of the Lower Silurian. Is it, then, scientific to postulate dogmatically land plants earlier than the Silurian, simply because a theory requires it? Dr. Scott admits quite freely that the known facts go the other way.

He tells us not only of the opposition of the mighty like Nägeli, he also tells us that, as regards the succession of species, there are no greater living authorities than Grand'Eury and Zeiller, and that, in their opinion, "the evidence from continuous deposits favours a somewhat sudden change from one specific form to another." This is most certainly true of the palæontological record as a whole. The evidence is overwhelming here, if only our men of science would be brave enough to forget their theories for a little while. Why insist on exalting the *a priori* methods of the schoolmen on the fair field of modern science? Why insist on refusing all evidence that does not suit? Why? Surely it is not, and cannot be, to enjoy the pleasure of barring out all design from the world in which we dwell.

JAMES B. JOHNSTON.

St. Andrew's Manse, Falkirk.

Musical Sands.

I CANNOT call to mind the occasion upon which Dr. Irving suggested that grains of hyaline quartz might produce the notes from musical sands, but, as a matter of fact, the grains do not "ring," or vibrate individually as sonorous bodies, and there is no apparent resonance or sensible continuance of the note after the plunger is withdrawn. I do not think any particular variety of silica is essential, because coral-sand is often musical, and my artificial musical sands are made up almost entirely of silicate of iron.

I have already shown that the natural sorting action of winds and waves is a requisite condition for the formation of musical patches on sea-beaches.

Mr. M. S. Gray's letter in NATURE of July 29 giving interesting particulars of his visit to the musical sand-hill near Copiapo, in Chile, confirms the statements made by the inhabitants to Darwin in 1835. In his "Journal during the Voyage of H.M.S. *Beagle*" Darwin referred to this hill of sand as "El Bramador"—"the roarer or bellower," but he did not personally visit the spot.

The extraordinary sensations experienced by Mr. Gray were probably similar to those which have been described by the various writers who, from time to time, visited Rig-i-Rawán and Jebel Nakous, both of which were referred to at length in my paper on musical sands in 1888. Particulars of the artificial production of notes from certain sands were also given by me in NATURE of August 6, 1891.

CECIL CARUS-WILSON.

A Question of Percentages.

IF a student obtains 37 out of 50 in one paper, 50 or full marks in a second, and 71 out of 100 in another, what is his percentage on the three taken together? If we add the marks as they stand we get 158 out of 200, or 79 per cent. If, on the other hand, we double the marks on the first two papers, we have 74 per cent., 100 per cent., and 71 per cent. If we add these we get 245 out of 300, or 81⅔ per cent. Will any of your mathematical readers kindly tell me which of these two different results is the true percentage for the three papers taken together? The answer may be very obvious; I can see that the two results must be different, but I cannot see which is the more correct method to use.

J. T. CUNNINGHAM.

60 Milton Park, Highgate, N., July 24.

THE UPPER CRETACEOUS IGUANODONT DINOSAURS.

DISCOVERIES of the last few years in Wyoming and Montana have thrown a flood of light upon the great herbivorous dinosaurs of the Upper Cretaceous which Joseph Leidy named Trachodon, so that now they are by far the most completely understood group of the dinosaurs, not excepting the famous iguanodonts of the Wealden or Lower Cretaceous of Bernissart.

It has long been known that Trachodon is readily distinguished by the elaborate and compound nature of its multiple grinding teeth, which present as great an advance upon those of Iguanodon as the teeth of Equus do upon those of the Eocene Orohippus; but there prove to be other characters indicative of the fact that Trachodon followed a fundamentally different line of evolution from that initiated by Iguanodon, or by the nearly contemporary, closely related Camptosaurus of America. These true Lower Cretaceous iguanodons are probably typical terrestrial forms, as shown in the familiar restorations of the Bernissart specimens, possessing a short manus with the first digit set well apart, as if adapted to grasping the branches of trees or shrubs, or to supporting the animal while browsing.

Trachodon also has been represented as a terrestrial animal. One of the skeletons mounted under the direction of Mr. F. A. Lucas in the United States National Museum, and another mounted under the direction of the late Prof. Charles E. Beecher in the Yale Museum, represent the animal in a walking or running position, using the tail as a balancing organ. On the other hand, Mr. Barnum Brown, who has been the leader of the American Museum expeditions, under the writer's direction, to the Laramie or Upper Cretaceous of northern Montana since 1902, is convinced that these animals were principally aquatic or swimming forms, which used the tail chiefly for propulsion through the water, a view shared by Mr. Charles H. Sternberg, another field explorer. It may be added parenthetically that observation in the field often affords the most important indications as to mode of life.

It will be interesting to discuss the question of the appearance and habits of these animals from materials in the American Museum, which are being very thoroughly studied by Mr. Brown in preparation for a memoir. Of the two skeletons represented in the accompanying photograph (Fig. 1), this museum has acquired three skeletons. The one mounted in the quadrupedal pose (Fig. 1) was discovered in South Dakota, north-east of the Black Hills, by Dr. J. L. Wortman, in 1882, while collecting for Prof. Cope. It had been complete, and the skeleton was surrounded by impressions of the skin, most of which were destroyed during excavation. Some epidermal parts were preserved on the broad bill, showing an interlocking, tooth-like series of points on the horny sheath. As the skeleton lay in the rocks a stream had cut through it, carrying away both femora, most of the pelvis, and twelve presacral vertebræ. The erect specimen (Fig. 1) was found in central Montana by Mr. Oscar Hunter in 1904, and originally "swapped" for a "six-shooter" revolver. In 1906 it was purchased by the American Museum and excavated by Mr. Brown. An important feature of this skeleton was that the vertebral column was connected throughout, and all the bones which the Cope specimen lacked were preserved, together with both lower jaws and two bones of the skull; the rest of the skull is restored after the Cope specimen. In both specimens the tip of the tail is missing.

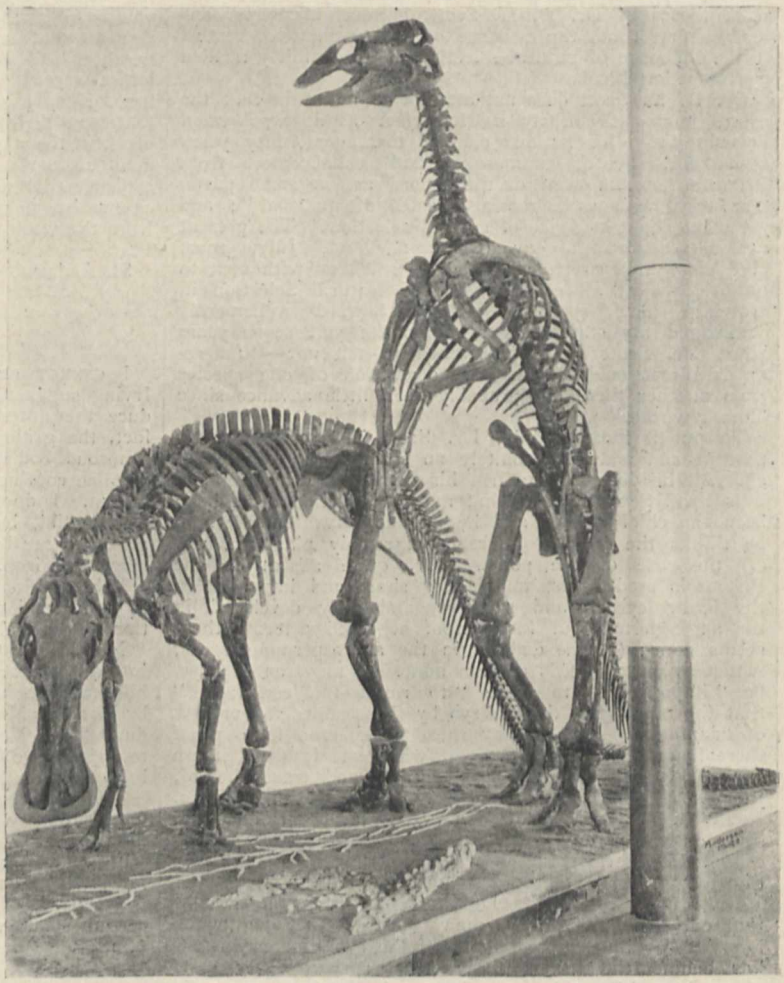


FIG. 1.—Oblique front view of two specimens of *Trachodon mirabilis* as mounted in the American Museum of Natural History.

The difference in the preservation of these two animals partly controlled the design which has been adopted for the mounting; the animal with the perfect head, well known through the descriptions and figures of Cope as *Diclonius mirabilis*, is represented in a feeding posture, which brings the head where it can readily be examined, while the imperfect skull of the second skeleton is "skied" where it cannot be seen. The conception of this group takes us back to the close of the Cretaceous period, when trachodons were among the most numerous of dinosaurs; as two of

them are feeding along the marshes, one is startled by the approach of a carnivorous enemy, Tyrannosaurus, and stands on tip-toe better to overlook the foliage; the other, unaware of danger, continues browsing. On the base of the group are shown impressions of leaves, fruit, wood, and shells, replicas of fossils actually associated with the bones of Trachodon. The leaves of the ginkgos, natives of China, were mingled with the cones of Sequoia, or big tree of California. Horsetail (Equisetum) rushes were abundant and luxuriant in growth, an imperfect specimen here represented measuring sixteen feet in length. Fruit and leaves of the fig are also abundant, and with the leaves of a species of banana and numerous palms attest a warm climate in the northern United States during the period.

Hardly was this carefully studied group completed late in 1907 when the fortunate discovery was made in Converse County, Wyoming, in August, 1908, by Messrs. Charles and George Sternberg, father and son, of another specimen of Trachodon with the epidermal impressions very extensively preserved. This completes our knowledge of the animal. Among many other new features it especially brings out the very important difference between the fore feet of Trachodon and of Iguanodon. As noted above, the manus of

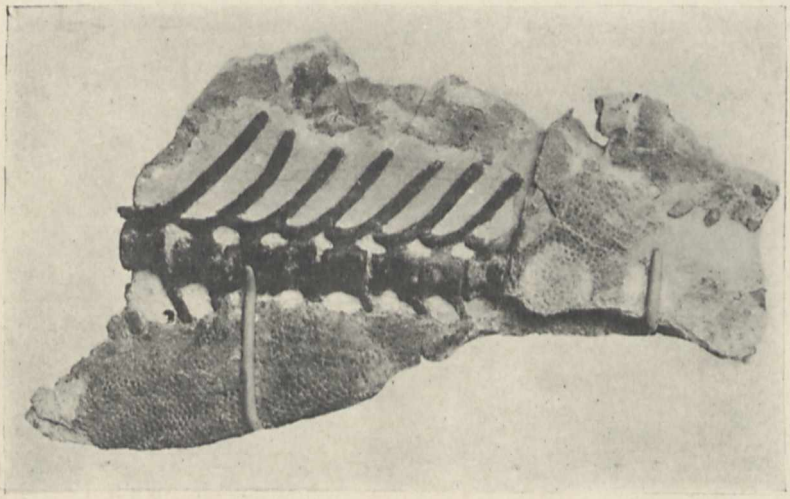


FIG. 2.—A portion of the tail of *Trachodon mirabilis* preserving the pavement epidermal scales.

Iguanodon is a short organ with grasping function. In Trachodon the manus is long and very slender; the thumb, or first digit, is not free, but closely appressed to the side, and still more remarkable is the fact that the entire hand was encased in an epidermal web, so that the digits are not freely movable, but closely united, and thus strongly indicative of a paddle function while moving in the water. This bears directly on the question whether these animals were aquatic, amphibious, or terrestrial. The terrestrial theory may apply to Iguanodon, but certainly not to these animals. The littoral or amphibious theory was that held by Prof. Cope. The familiar restoration by Charles R. Knight, which was made under his personal direction, represents one Trachodon on the shore in a sitting position, a second wading and feeding in shallow water. The enormously powerful hind limbs, provided with three large digits incased in hoofs, together with the long lines of osseous tendons connecting the vertebræ of the back with the vertebræ of the tail, both point to capacity for land progression on the hind limbs, with the use of the tail as a balancing organ. No habitually swimming animal would retain such limbs or acquire such inflexibility of a large region of the backbone as is suggested by the ossification of the tendons. On the other hand, river-frequenting or littoral habits are indicated first by the webbed nature of the epidermis on the fore feet, as well as by the observation of Mr. Brown that of all Upper Cretaceous dinosaurs these are the only ones the remains of which are found in off-shore marine deposits. This fact may be cited as a proof, either that they frequented shallow- and still-water bays of the sea, or that their remains were carried seaward in rivers.

The position selected for the group accordingly represents these animals as on a ripple-marked shore; one, the Cope specimen, in the quadrupedal position, with the tips of the digits of the manus lightly resting on the ground rather as balancers than as supporters. This is the first time an iguanodont has ever been mounted or represented in this position, and the justification for it is found in the fact that the fore limbs do readily reach the ground and terminate in expanded phalanges, which indicates the retention and occasional use of hoofs. If the trachodons in this phylum had never assumed a quadrupedal position, or used the fore limbs in this way, it is safe to infer that the limbs would have been either still more reduced and degenerate, or else the digits would have spread or expanded into true swimming paddles.

This method of mounting two or more specimens together, but in different poses to illustrate the supposed habits of feeding and of locomotion, is one which is being generally adopted. In the present case it brings out in side and rear views every important feature in the osteology of these animals. By an accident the tail in both these specimens terminates at the same point, but in other specimens in the Yale and National Museums smaller terminal vertebræ have been found which would add about five feet to the tail beyond the parts preserved in these specimens.

The actual height of the head above the ground in the standing Trachodon is seventeen feet; the total length of the body is thirty feet. Remains of still larger individuals of this species have been found which indicate greater height and length.

It is first of all evident from these skeletons and models that these Trachodons, like all the iguanodons, were full-chested and slim-wasted, to use the terms of fashion; while the longitudinal diameter of the pelvic region is enormous, the vertical diameter is very slight. Thus the proportions of the abdominal girdle directly reverse those of the Sauropoda and carnivorous dinosaurs, in which the vertical diameter is the greatest. The shape of the chest is exactly preserved in the new Sternberg specimen, as well as in the indications of the muscular outlines of the limbs and of the presence of a dermal frill on the neck and anterior part of the back. The neck and chest regions are relatively short. The gape of the mouth is placed exactly at the front of the great rows of grinding teeth, as in the mammals. There is evidence that the skin was thrown into loose folds at the junction of the arms and legs with the body, as well as on the sides of the chest.

The Trachodon with the epidermal impressions was

found in the region of Converse County, Wyoming, made famous by the explorations of Hatcher for remains of the great horned dinosaurs or Ceratopsia. The entire animal lay in a normal position on its back. The left fore limb was outstretched at right angles to the body, while the right fore limb lay stretched over the under surface of the head. The hind limbs were drawn up and doubled on themselves. The hinder portion of the pelvis and the entire tail had been removed by erosion. The epidermal impressions are best shown on the throat and anterior part of the neck, on the arms and fore limbs, the entire right side of the body, including the axillary region, and especially over the abdomen. The skin is inflected like a curtain over the entire abdominal region without a single break, with brilliant impressions of the scale pattern. This abdominal infolding, the close appression of the skin to the surface of the bones, and the sharp transverse folds all indicate that after death the body was exposed for a long time to the sun, and the muscles and viscera became completely dehydrated; in other words, the body became thoroughly dried and mummified, while the epidermis became hardened and leathery under the action of the sun. In this condition the dinosaur mummy was caught in a freshet, and rapidly buried in fine river sand, which took a perfect cast of the epidermal markings before the tissues disintegrated under the solvent action of the water.

There is no evidence in any part of the epidermis either of coarse tubercles or of overlapping scales; on the contrary, the epidermis is extremely thin, and the markings are very fine for an animal of such large dimensions. In all parts of the body observed, the epidermis is covered with scales of two kinds—namely, smaller tubercular scales and larger pavement or non-imbricating scales. The latter are perfectly smooth, and, as grouped in clusters or rosettes, assume a rounded or irregularly polygonal form. Over the throat, neck, sides, and ventral surface these clusters are regularly disposed in different patterns, separated by rows of finer tubercular scales, but in the tail, as indicated in the specimen of *Trachodon mirabilis* (Fig. 2), it is probable that the cluster arrangement disappears, and that the entire tail is covered with the tesselated or pavement scales. The vigorous use of the tail among Iguanodontia as a balancing, and perhaps partly as a swimming, organ would lead us to expect this strong development of the scales in the tail region. This disposition of the scales into larger pavement groups and smaller tubercular rows is unlike that observed by the writer in any Lacertilia; it appears to be unique. H. F. O.

A Marten moving along a Bough. Photo. by Mr. Douglas English. From "The Nature Book."

NATURE STUDIES IN NEW ZEALAND AND AT HOME.[1]

(1) MR. THOMSON is well known among zoologists by his discovery of Anaspides, a very interesting genus of Crustacea, on Mount Wellington, Tasmania. In this volume he has collected observations made in the neighbourhood of Dunedin during the last thirty years. The articles appeared originally in the New Zealand Press, and were obviously written without any intention of subsequent issue in volume form. They are necessarily somewhat slight, and touch upon a great variety of topics without systematic treatment. Yet they possess a value which often attaches to first-hand observation written down at the time, for the animals and plants of the island are undergoing a rapid change. Destruction of the bush and the importation of a European element has transformed the neighbourhood, not only of Dunedin, but of other parts of New Zealand. The indigenous plants, insects, and birds are, in many places, becoming scarce, or have disappeared, and only a few more tenacious or more resistent have survived the process of change which has accompanied the development of the South Island. Hence these notes of garden and field life will be of interest to all who are anxious to preserve records of older societies, whether of animals or plants. It would be of the greatest interest to discover how rapidly and completely the introduced flora and fauna acquire the new periodicity of the seasons in New Zealand, and Mr. Thomson's notes may give the requisite stimulus to observers for further investigation on the indigenous and alien organisms of that country.

(2) This work has already appeared in serial form, and will prove a welcome gift-book to many a budding naturalist. The illustrations are excellent, and bring

[1] (1) "A New Zealand Naturalist's Calendar." Notes by the Wayside. By Geo. M. Thomson. Pp. 224. (Dunedin: R. J. Stark and Co., 1909.)
(2) "The Nature Book." A Popular Description by Pen and Camera of the Delights and Beauties of the Open Air. Vol. ii. Pp. iv+373–752. (London: Cassell and Co., Ltd., 1909.) Price 12*s.* net.
(3) "The Book of Nature Study." Vol. iii. Edited by Prof. J. Bretland Farmer. Pp. 228. (London: Caxton Publishing Co., n.d.) Price 7*s.* 6*d.*

out the characteristic features of the subject with the utmost faithfulness; the topics range from thunderstorms to valley formations, and through a great variety of field and garden forms of life. Amongst such a feast of good things it is invidious to select, but we may mention the articles on British carnivores and rodents, on the grasses and sedges, on the "cryptozoic" fauna, and on certain British trees, as among the most attractive. The physiographical papers by Dr. Lockyer, Mr. M. Duncan, and the late Mr. Lomas are of great interest. No more fascinating work could be easily suggested that would appeal to the eye with such success as this volume does, and though the text is of unequal merit, it has throughout the advantage of being the work of trained observers in the field.

(3) By this new volume of Prof. Farmer's "Book of Nature Study" the student is introduced to plant life. The headings of the first four chapters seem to us remarkably chosen. They may be summarised thus:—Seeds and seedlings, the bud and its growth, vegetative methods of reproduction, the importance of hairs. Surely this is a very inadequate and unequal manner of treating the subject. Miss Laurie has, however, described the objects under discussion well, and the illustrations are good. May we point out that two of the experiments could not be got to work as described and figured? An incompletely described experiment is worse than useless in an elementary book. On p. 40 (Fig. 29) carbon dioxide would enter by the lower edge of the bell-jar, and thus vitiate the experiment. One inch of water is, of course, needed. Fig. 30 (p. 50) represents an experiment which even the author would find physically impossible to set up in the manner described. Sufficient stress, furthermore, is not laid on the fact that all parts of the plant breathe. On p. 56 the storing function of the stem is not referred to. We must, in fact, state that the four chapters give one an inadequate idea of plant life. Prof. Lang's chapters on some flowering plants require no comment. We have here a few flowers, or, rather, complete plants carefully described. The types chosen are readily obtained, and thus every student can have a living plant by his side when working through the descriptions in the book.

RESEARCHES AT THE NATIONAL PHYSICAL LABORATORY.

VOL. V. of the Collected Researches of the National Physical Laboratory, which has recently appeared, consists of reprints of thirteen memoirs emanating from the laboratory, and extends to 266 pages. Engineering subjects are answerable for about eighty of these pages, while the rest are about equally divided between electricity, metallurgy, and cosmical physics.

Of the engineering memoirs that dealing with wind pressures is of great importance. By experiments on plates and on lattice-work structures, both in natural winds and in pipes within which a uniform flow of air was maintained, it is shown that the pressure is proportional to the square of the velocity, and further, that the actual pressure on a lattice-work structure when exposed to the wind may be found by observations taken on a small model placed in a pipe through which a uniform current of air is flowing.

A second memoir of interest to engineers is that on a new fatigue test for metals. The material tested is in the form of a ring, which is kept rotating about its own axis under pressure by means of three rollers which bear on its outer surface. Under a test of this kind the superiority of nickel steel rails for railway work is well brought out.

In the electrical section, one of the most important memoirs deals with the history of the standards of electrical resistance kept at the laboratory. The ultimate standards are of mercury in glass, and were first set up in 1902. They show no change in the interval, but many of the secondary standards have increased in resistance by a few parts in 10,000 since they were constructed, some ten, others twenty, years ago. Some of the secondary standards have, however, proved more satisfactory, those of platinum, some of those of platinum-silver, and some of the manganin ones, appearing to be unchanged.

As the result of a comparison of the new electric current balance of the laboratory with the standard ampere balance of the Board of Trade set up fourteen years ago, it appears that the two agree to within 1/100th part of 1 per cent.

In the metallurgical department the alloys of lead and tin have been investigated in considerable detail, both thermally and microscopically, and the eutectic found to be 37 per cent. lead, 63 per cent. tin. A new method of determining the phosphorus in phosphor tin has been also worked out, and promises to be both shorter and much more convenient than the older methods.

Only a portion of the work of the department which deals with cosmical physics is recorded in this volume. This portion consists of a discussion of the magnetic declination as recorded at Kew during the years 1890–1900 in the light of, or, rather, the obscurity provided by, the multitude of theories of terrestrial magnetism now in the field. It is shown that the records are incompatible with any theory which regards magnetic disturbances as directly dependent on the area of the sunspots visible at the time. From the report of this department we note that at Kew the mean declination during 1908 was 16° 16′ W., the mean dip 67° 1′ N., and the mean horizontal force 0·1852 c.g.s. units. By the end of the present year it is hoped that the new observatory at Eskdalemuir will be in full working order, many of the recording instruments being already installed.

From this short summary it will be seen that vol. v. is well worthy to rank with its predecessors, as a contribution to science of which the nation may feel proud. C. H. L.

JOHN REID, 1809–1849.

UNDOUBTEDLY 1809 was an *annus mirabilis*. Nineteen hundred and nine is, therefore, the hundredth anniversary of the birth of certain great ones in letters, in politics, and in science. Several epoch-makers have their statues in the intellectual Valhalla of the nation, but it would not be well if we allowed the statues on their pedestals to make us overlook the busts in the smaller niches. One of the busts in the Hall of Shades is that of the Scotsman, John Reid, born April 9, 1809, the son of a cattle-dealer, dying July 30, 1849, Chandos professor of anatomy and medicine in the United College of St. Salvator and St. Leonard in the University of St. Andrews. Forty-nine years only intervened—they were filled with the activities of a strenuous Scottish character.

John Reid, the sixth child of Henry Reid and Jean Orr, his wife, was born in the little town of Bathgate in Linlithgowshire, the same in which two years later James Young Simpson, the epoch-maker, first saw the light.

From his native parish school, Reid passed, at

the age of fourteen, to the University of Edinburgh. In 1824 he entered for the classes of humanity and Greek; in that year "Richard Owen, Lancaster," was a fellow-student. In 1825 Reid "signed on" for the class of chemistry, and thus entered the faculty of medicine; two years later, "James Simpson, Linlithgowshire," did the same thing. In 1825 the third Munro was in the chair of anatomy, which he was to occupy for forty-eight years, and William Pulteney Alison in that of the "Institutes of Medicine," a subject he taught from 1821–42. From the former, Reid got the least, from the latter the most, inspiration which as a student he received from his teachers.

Early in his studies, Reid showed a preference for anatomy and physiology, and as these formed part of the one and "final" examination for the degree of M.D. (there being no M.B.), Reid dissected from the beginning to the end of his student days. He graduated on August 7, 1830, his Latin thesis being "De aneurismate."

Reid was, therefore, dissecting during 1827 and 1828, the very years in which the Burke and Hare murders were committed. It is believed that "the rooms" both at the University and at Dr. Knox's (Surgeons' Hall) were supplied by the miscreants just named.

His parents had hoped that Reid would study for the Church of Scotland; after having graduated, he himself thought of a surgeonship in the Royal Navy; but neither the Church nor the Navy was to have him whom Science had marked for her own.

Early in 1833 Reid received an invitation from Dr. Knox to become his assistant at Surgeons' Hall, so large had the classes there become. Prof. Monro's dullness had driven the majority of the students over to Knox's rooms. For three years Reid demonstrated for Knox, and so laid for his subsequent physiological researches that surest of all foundations—a sound knowledge of human anatomy. For the session 1835–36, John Reid was one, and J. Y. Simpson was the other, of the presidents of the Royal Medical Society, which presidentship has always been regarded as the "blue ribbon" of the Edinburgh Medical Societies.

Towards the end of 1836, Reid received a most gratifying invitation to succeed Dr. Fletcher, lately deceased, as extra-academical lecturer in physiology. The requisition was signed by no fewer than eighty-six persons, one of them being later the well-known writer on physiology, Dr. W. B. Carpenter, of London University. They asked him to accept the lectureship, for, by so doing, they said, he would "increase the reputation of this city as a school of medicine." "The zeal and success with which you have hitherto prosecuted physiological investigations being already well known to the public." Reid replied to this flattering invitation in the most modest way, and immediately consulted Prof. Alison. Alison not only advised him to take the step suggested to him, which virtually transformed Reid into Alison's own rival, but he proposed him for the Fellowship of the Royal College of Physicians of Edinburgh, into which learned body he was admitted on October 4, 1836.

During 1835 and 1836 Dr. Reid published papers upon obliteration of the vena cava superior at its entrance into the heart; phlebolites; peculiarities of the fœtal circulation; monsters; mesenteric glands in the whale; transposition of abdominal viscera; venisection relieving the heart; and the anatomy and physiology of the heart.

During the next two years Reid carried out the most important of his experimental researches—namely, that into the functions of the ninth, tenth, and eleventh pairs of nerves. Hughes Bennett tells us in his "Memoir" that between 1836 and 1838 he performed upwards of one hundred experiments on animals in order to unravel the functions of the so-called "eighth pair of nerves." A copy of this paper lies before me; it extends to sixty-two octavo pages, and consists of a thorough investigation into the activities of the glossopharyngeal, the pneumogastric, and the spinal accessory nerves. After giving a full account of the French, German, and Italian literature accessible to him, he details the experimental procedures employed to arrive at an understanding of the functions of the many branches of these three great nerve-systems. When we consider the technical difficulties under which he worked, having no stimulus more satisfactory than the galvanic current or chemical or mechanical irritation, no anæsthetics other than prussic acid and morphia, and the knowledge of no procedures known as antiseptic, we are amazed that he discovered so much and of so elusive a character. This work on the nerves was his *magnum opus*, probably the last important piece of work in physiology anterior to the introduction of the stimulus of the "interrupted current" from the laboratories of Germany. It is curious to notice the absence of tracings in the paper; Reid was the last pre-graphic physiologist in Scotland. Amongst other things long since fully corroborated, Reid showed that the heart had the double innervation through the vagi and the sympathetic. He came within a very little of discovering the cardio-inhibitory functions of the vagus. The memoir was published in full in the *Edinburgh Medical and Surgical Journal* (No. 139), but an *epitomé* of it had been read at the Liverpool meeting of the B.A. in 1837.

One or two paragraphs from this admirable paper are worth quoting in the light of to-day:—"It may appear to some that I have repeated many of these experiments with unnecessary frequency and a wanton sacrifice of animals, but I naturally felt diffidence and distrust in the accuracy of the results I obtained when opposed to those of more experienced observers, and it was only after repeated and careful examination of the phenomena that I could feel myself justified in calling these in question. It is also sufficiently obvious that nothing is more injurious to the progress of science than hasty and partial observations, and I was anxious to avoid . . . adding to that mass of conflicting evidence which there is already so much reason to deplore."

"It is obvious that, without the aid of active and intelligent assistants, it would have been perfectly impossible to have proceeded with such an investigation."

It is interesting to us to be told that one of these assistants was Sharpey.

Had Reid lived only a little longer, so as to have used the DuBois' Inductorium, he would unquestionably have discovered much more; the pity was, he had to cease working "in the rich dawn," physiologically speaking, "of an ampler day."

In 1838 he was appointed pathologist to the Edinburgh Royal Infirmary, and a year later superintendent of the Pathological Department. As the result of his observations at this time, he compiled "Tables of the Weights of some of the most important Organs of the Body at different Periods of Life" (published 1843). In 1839 he brought out a paper, "On the Effect of Lesion of the Trunk of the Ganglionic System of Nerves in the Neck on the Eyeball."

Dr. Reid had unsuccessfully contested first the chair of medicine, and later the chair of anatomy in the

University of Aberdeen, but in 1841 he was unanimously elected to the Chandos chair in St. Andrew's. In the same year he published his important paper, "On the Relation between Muscular Contraction and the Nervous System," whereby he made a contribution to a controversy then already quite a century old—as to whether the irritability of muscle was or was not "inherent." The great Haller had taught it *was* inherent (the "vis insita"). Robert Whytt, professor of medicine at Edinburgh just a hundred years before Reid's time, had been a strenuous opponent of the doctrine of inherent irritability. Follow-Boerhaave, the leader of the Batavian school, who had trained so many of the professors of Edinburgh, Whytt considered that his experiments confuted the opinions of Haller. When Reid took up the subject in 1834, it was still a controversy.

Reid, using frogs, demonstrated :—

(1) That the muscle of a nerve-muscle preparation, fatigued by stimulation through its nerve, could still contract when it was stimulated directly.

(2) That a muscle, the nerve of which had been cut, would not waste away, provided it was "daily exercised by galvanism."

He even then pointed out the now obvious therapeutic application of this latter fact. His position was: irritability is indeed inherent, but the muscle must be constantly in use in order not to suffer from "dis-use atrophy."

Amongst his collected papers we find one "On Sensational and Emotional Reflex Actions," from which we may conclude that Reid had grasped the essence of the conception of reflex action in such a way as to see that the presence of consciousness need not make the action any the less truly "reflex."

After going to St. Andrews, Prof. Reid published two long papers on the epidemic of fever in Edinburgh in 1836. He began to study the marine biology of the bay, and papers on polyps, molluscs, and medusæ were, between 1844 and 1847, communicated to the "Philosophical Society of St. Andrews," a society still existing.

In 1844 John Reid was married to Miss Ann Blyth, of Edinburgh. Their two sons died in infancy; their two daughters died before their twenty-fifth year; his widow, who was married to a Mr. Foster, survived him more than forty years.

Prof. Wilson, his biographer, describes Reid's appearance in these words :—"Tall, with a strong figure, diminished in height by a stoop acquired by so much bending over books, dissections, and microscopes, his complexion fresh and even ruddy, his forehead expansive, his eyes small, but of a bright black; his hair, which matched his eyes, was worn long."

By August, 1848, it had become evident that Reid was suffering from cancer of the tongue and throat. On August 31, at Prof. Simpson's, 52 Queen Street, Edinburgh, John Reid underwent an operation at the hands of his friend, Mr. (later Sir) William Fergusson; Goodsir, James Duncan, and Hughes Bennett (his old pupil) assisting. On November 29 a second operation was considered necessary; this was carried out at Prof. Goodsir's, 55 George Square, by Duncan, Spence, and Goodsir. For a third time (January 1, 1849) did poor Reid submit to the knife; he warned them about admitting air into the veins of the neck; they could not have forgotten that he had written on "Death by Admission of Air into the Venous System." Doomed at forty, Prof. Reid, after visiting Keswick and Innerleithen, returned for the last time to his house in North Bell Street, St. Andrews (now re-named Greyfriars Garden). On his death-bed he collected all his published papers in a large octavo of 659 pages. He had the courage to review a work by Hughes Bennett on "Cancer." His sufferings were extreme: morphia and the newly-discovered chloroform alone could assuage them. The end came none too soon on July 30, 1849.

In the "Life of John Reid" (Edinburgh, 1857) Prof. Wilson tells us that he attended the funeral on a "singularly bright and beautiful day."

We who know the old city have seen such days, rare indeed, but memorable in their rare beauty when they come. We can so well picture the sad, slow procession from the Town Kirk to its goal within the ruins of the noblest of Scottish cathedrals; there, amongst green graves, they laid John Reid to rest where the murmur of the everlasting sea makes moaning music through the roofless fanes.

Scotland has produced greater anatomists, pathologists, zoologists, and physicians than was John Reid, but I question whether, having regard to the limitations of his scientific environment and to the imperfections of the methods and of the technique with which he worked, anyone would undertake to deny his right to be considered one of the most original and prescient physiologists of purely Scottish birth and training.

I venture to believe that in this year of centenary commemorations no man of science will grudge John Reid his own. D. FRASER HARRIS.

NOTES.

THE collection of fossil Brachiopoda formed by the late Mr. J. F. Walker, of York, has been presented to the British Museum (Natural History) by his executors, Mrs. Walker and Mr. Gelson Walker. It consists of several thousand specimens arranged in groups to illustrate the variations of species and the gradation of several so-called species into each other. It therefore supplements the Davidson collection, which was bequeathed to the museum in 1885. It is especially rich in material from the English Jurassic and Cretaceous formations, to which Mr. Walker devoted much attention; but it also contains important series of specimens from other English strata, besides several small collections for comparison from the European continent. The greater part of the collection will be kept for reference in the original cabinets, but more than a hundred important specimens, described and figured in Davidson's "Monograph of the British Fossil Brachiopoda," will be placed in the exhibition cases of the public gallery.

MR. W. R. BOELTER writes to urge the institution of a people's "Arbour Day" in October for the purpose of planting fruit trees along roadsides as they are in some parts of Germany. From a report issued by the Minister of Agriculture of Saxony it appears that the department in charge of these trees made a profit of 12,000*l.* during 1908 from a countryside corresponding to our Black Country. As, however, the system of road maintenance in Germany differs completely from that followed in England, similar success can scarcely be anticipated here, where the roads are controlled by numerous district and county authorities. Farmers object to trees on the roadside near arable land, and road surveyors in general dislike trees, because the highway does not dry up well under them after rain. Even when permission has been obtained to plant fruit trees along roadside waste in some districts, it will be necessary to appoint officers whose duty it is to protect the trees and promote their satisfactory growth. We are afraid that few local authorities are likely to add to their responsibilities by undertaking the care of young trees along the roadside, much as we are in sympathy with Mr. Boelter's suggestion.

THE *British Medical Journal* announces the death of Prof. A. Fraser, occupant of the chair of anatomy in the Royal College of Surgeons, Dublin.

FROM an obituary notice by Herr von Konkoly, appearing in the *Astronomische Nachrichten*, we learn with regret of the death of Herr Eugen von Gothard, known throughout the astronomical world for his brilliant researches on the spectra of comets, nebulæ, novæ, and other celestial objects at his private observatory at Herény, Steinamanger, Hungary. In 1892 von Gothard photographed the spectrum of Swift's comet on the same plate as the spectrum of the base of a Bunsen flame, and thereby showed the two spectra to be identical so far as the fourth band. He also obtained illuminating spectra of Nova Persei in 1901, and did a great deal of experimental work on the construction of various astronomical instruments. At the time of his death, May 29, von Gothard was only fifty-two years of age, a fact which makes the loss of a devoted worker, possessing exceptional abilities, more keenly felt by all those interested in the progress of astrophysical science.

PROF. F. H. SEARES has resigned the directorship of the Laws Observatory, of the University of Missouri, to become superintendent of the computing division at the Mount Wilson Solar Observatory. This post he assumed on August 1, and asks that all correspondence, pamphlets, &c., shall be addressed to him at the Solar Observatory, Pasadena, California.

THE Baly medal, awarded by the Royal College of Physicians of London every alternate year to the person who shall be deemed to have most distinguished himself in the science of physiology, has been awarded to Dr. Emil Fischer, professor of chemistry in the University of Berlin; and the Moxon medal, awarded every third year to the person who shall be deemed to have most distinguished himself by observation and research in clinical medicine, has been awarded to Sir W. R. Gowers, F.R.S.

THE recorder of the Engineering Section of the British Association has sent us a copy of the provisional programme of the proceedings at Winnipeg, in which the following papers appear in addition to those mentioned in the article on July 15:—the National Transcontinental Railway, Duncan MacPherson; improvements in the navigation of the St. Lawrence, Lieut.-Colonel William P. Anderson; great engineering works on the Canadian Pacific Railway, J. E. Schwitzer; losses from high-tension overhead lines due to brush discharge, E. A. Watson; on the calculation of the charging currents in three-core cables and overhead transmission lines supplied with three-phase currents, E. W. Marchant.

REUTER messages state that two severe earthquake shocks were experienced in Mexico City at 4.20 a.m. and 4.25 a.m. on July 30. Half the city is said to have been destroyed by the earthquake. Chilpanzingo and Chilapa are reported to have been destroyed. Earthquakes are also reported as having occurred at intervals for fourteen hours at Iguala and Guerrero. At Acapulco not a single building escaped some damage; in this locality the most disastrous shock occurred during the afternoon of July 31, when the water in the harbour is said to have receded 33 feet and then to have risen with great force, causing much damage. Seventy-three shocks were felt during the three days July 30 to August 1.

THE second International Congress for the Repression of Adulteration in Food, Chemical Products, Drugs, Essential Oils, Aromatic Substances, Mineral Waters, &c., is to be held in Paris on October 17–24. There are likely to be representatives present from every civilised country, and official delegates have been appointed by many Governments. The particular object of the congress is to define what operations are permissible in the handling of food, and follow upon the definitions accepted at the congress held in Geneva last year. The Society of the White Cross of Geneva originated the idea of holding these international congresses, and four congresses have been arranged; the third will be held probably at The Hague in 1910, and the fourth in London in 1911. The work of this year's congress will be held in three sections:—the first, on alimentary technology, will be presided over by Prof. Muntz, director of the chemical laboratories of the National Agronomic Institute, Paris; the second section, dealing with hygiene, will be presided over by Prof. Landouzy, of the faculty of medicine in the Paris University; and M. Guignard, director of the School of Pharmacy, Paris, is the president of the third section, which will be concerned with crude drugs, essential oils, chemical products, and mineral waters. Prof. Bordas is the president of the executive board, and M. Maurice Rivière, 16 Place Vendôme, Paris, the treasurer. Mr. Loudon M. Douglas, 3 Lauder Road, Edinburgh, is the honorary secretary for the United Kingdom, and men of science and others in this country proposing to attend the congress are asked to send an intimation of their intention to him. Subscriptions, which vary in amount according to the character of the membership, should be sent direct to the treasurer.

NO. 1 of vol. xvii. of the Proceedings of the Royal Physical Society, Edinburgh, is devoted to the presidential address of Mr. William Evans, in which our present knowledge of the fauna of the Forth area is discussed at considerable length.

WE have been favoured with a copy of the report of the Colombo Museum for 1908, in which the director, Dr. H. Willey, emphasises the fact that the scope of that institution is restricted to the products, natural and artificial, of the island of Ceylon. Special attention is directed to a collection of bronzes and stone implements, several of which are figured, found by the Archæological Survey in 1907, and deposited in the museum last year.

WE have received from the author, Dr. E. Balducci, a copy of a paper, issued in the *Pubblicazoni de R. Istituto di Studii Superiori Practici e di Perfezionamento in Firenze*, on a forest-hog from the Upper Congo, for which the new name *Hylochoerus gigliolii* is proposed. No mention is made of *H. ituriensis* from the same region, named in 1906 by Dr. P. Matschie in the Annals of the Congo Museum, but there can be no reasonable doubt that the supposed new species is identical with that form.

To vol. v., part vii., of the Annals of the South African Museum, Dr. R. Broom communicates further particulars with regard to the milk dentition of the aard-vark. The full dental formula he believes to be $i.\frac{3}{3}$, $c.\frac{1}{1}$, $p.+m.\frac{8}{8}$. Dr. Broom accepts, provisionally, the opinion that Orycteropus is not an edentate; but there is at present insufficient evidence to determine its true affinities. It is suggested that the above-mentioned dental formula is inherited from an early ancestor, and that the genus may consequently be allied to the Mesozoic mammals, a number of which, he states, may probably have had a similar formula.

AT the conclusion of an article on the sense of direction in man, published in the July number of the *Revue des*

Idées, Mr. V. Carnetz, who bases his opinion on observations made on natives of the Tunisian Sahara between the years 1891 and 1894, denies that the power of orientation is due to the possession of a sixth "sense." We have to deal rather, it would seem, with an instinct, if it may be so called, acting as an intermediate innate agent between the external medium and the sense of vision, of which it forms a kind of offshoot. It cannot act without vision, but the latter alone is insufficient for the purpose of finding the direction.

IN the summer number (vol. iii., No. 6) of *Bird Notes and News*, attention is directed to the transference of the offices of the Royal Society for the Protection of Birds from No. 3, Hanover Square, to 23, Queen Anne's Gate, Westminster, this transference having become necessary owing to the impending removal of the Zoological Society's offices from the former address. The summer number is accompanied by a pamphlet giving a summary of the arguments in favour of bird-protection and of the efforts which the society has made in this direction, together with an appeal for further assistance in carrying out and developing the society's work.

THE July number of the *Zoologist* contains an article by Dr. E. Menegaux, of the Paris Museum, translated by the author from *La Nature*, on American egrets as victims of fashion. According to statements made by the well-known traveller and naturalist, Mr. Geay, large quantities of "ospreys" are collected as shed feathers by the natives of Venezuela and Colombia, and also that when the plume-hunters kill the birds themselves, they always spare the young birds, which yield no ornamental feathers; while it is further stated that when the parents of nestling egrets have been slain, the latter are fed by other birds, so that deaths from starvation do not take place. As an appendix the editor reprints a document published by the Royal Society for the Protection of Birds as a kind of counterblast to Mr. Geay's assertions.

THE degeneration of armour in animals forms the subject of an article by Dr. Felix Oswald in the July number of *Science Progress*. As instances of this disappearance the author refers, among many other examples, to labyrinthodonts as contrasted with modern amphibians, to the disappearance of the solidly armoured glyptodonts and the survival of the less immovably shielded armadillos, the disappearance of the Palæozoic ostracoderms and placoderms and the emancipation from armour of modern fishes, and very specially to the numerous independent instances where the shell has been more or less completely discarded by gastropod molluscs. He might also have referred to whales and dolphins as contrasted with the zeuglodonts, and to the evidence recently quoted in NATURE as to the presence of vestiges of a dermal armour in the fox.

TO *Naturwissenschaftliche Wochenschrift* for July 18, Prof. H. Kolbe communicates an interesting article on the theory of a former extension of the Antarctic continent, with remarks on the distribution of animal life in the southern hemisphere. Commencing with a reference to the hypothesis that the Arctic region formerly enjoyed a mild climate and a large continental area which served to a great extent as a centre of dispersal and radiation for animals in the northern hemisphere, the author proceeds to adduce evidence in favour of the former existence of very similar conditions at the opposite pole. Reference is made to recent discoveries indicating the large area still occupied by the Antarctic continent, and to the occurrence of a fossil flora in high southern latitudes which must have required a comparatively warm climate for its development. Ortmann's work on the Lower Miocene marine deposits of Patagonia, New Zealand, and Australia, which are certainly of littoral origin, is next cited as evidence of an inter-continental connection in later Tertiary times in high southern latitudes. Further testimony to the same effect is adduced from the present faunas of the great southern continents, more especially from beetles and other insects. The idea that such resemblances as exist between the different southern faunas may be explained by "convergence" is shown to be untenable, as convergence consists in resemblances between different groups, not the likeness of allied forms. A South Polar union of the southern continents in later Tertiary times is considered by the author to be now demonstrated.

THE anatomical structure of the Holothurians is described and discussed in an elaborate manner by Dr. Siegfried Becker in the third part of vol. i. of Dr. Spengel's "Ergebnisse und Fortschritte der Zoologie" from the point of view of the phylogenetic relationships of the various members of the class. In the opinion of the author, considerable modification of the generally accepted phylogeny of the group, as given, for instance, in the "Cambridge Natural History," is necessary. The Synaptida, for example, are regarded as a very ancient group, which, with certain other forms, are widely distinct from the modern types. The Dendrochirota and the Molpadiida, again, in place of being, in common with the Synapta, derived from a hypothetical common stock, are regarded as of independent development. The remainder of the part last quoted is devoted to a memoir, by Dr. Max Rauther, on the morphology and mutual relationships of the nematode worms.

THE *Journal of Comparative Neurology and Psychology* for June (vol. xix., No. 3) contains an interesting paper by Mr. R. E. Sheldon on the sensitiveness of the general body surface of the smooth dogfish to those chemical stimuli which in man provoke sensations of taste and smell. Both normal and "spinal" dogfish were under observation; in other dogfish the spinal cord had been destroyed, in others, again, the olfactory crura or the four branches of the trigeminal nerve had been divided. The author finds that the dogfish reacts to chemical stimuli applied to any spot on the body surface or to the mouth or nostrils, that acids and alkalis, even when very dilute, are potent stimuli, that salt and bitter substances are less powerful, and that no reaction occurs towards sugars. The results of experimental interference indicate that the extreme sensitiveness of the nostrils of the fish is due to the trigeminal rather than to the olfactory nerve. The nerves of the lateral line appear not to be concerned in these "chemical" sensations, as no reactions occur after destruction of the spinal cord, the fish being viable for some weeks in this state. Cocaine is found to abolish tactile sensibility before response to chemical stimulation is affected. The author concludes that the sensitiveness to chemical stimuli is due almost exclusively to the nerves of general sensation, not at all to the olfactory and very little to the gustatory nerves, and that a special nervous mechanism, distinct from that for touch, constituting the apparatus of a distinct "chemical" sense, exists alike in the vertebrate and in the invertebrate world.

AN essay by Miss B. Freire-Marreco on the hair- and eye-colour of school children in Surrey appears in the July number of *Man*. The essay was prepared for the diploma examination at the Oxford School of Anthropology—a

welcome indication of the progress being made in this department. The observations, which extended to 591 subjects, have been tabulated on the plan recommended by Dr. John Beddoe, and have been examined by the aid of the index of nigrescence adopted by the same authority, and also by the index of M. Collignon. According to the former, the people of these Surrey parishes turn out to be four times as fair as the fairest people of Scotland; according to the latter the result is inconclusive, the reason being that the outstanding feature of the record is the predominance of medium eyes and the comparatively high percentage of brown hair. On the whole, girls are slightly darker than boys, and as the difference lies mainly in eye-colour, this is possibly a sex characteristic; and there seems to be some connection between red hair and medium eyes. The author suggests a third method of examination in addition to those of Beddoe and Collignon. The paper, on the whole, shows a decided aptitude on the part of the author for statistical work of this kind, and it may be hoped that she will follow up the subject, largely increasing the area of her inquiry and the number of subjects.

ONE of the most interesting of the numerous writings to which the recent Darwin anniversaries have given occasion is the first article in the current number of the *Quarterly Review*. The article, which is by Prof. Poulton, discusses the various criticisms that have been directed against the Darwinian theory both in early and in recent times. The author passes in review the work of Weismann, of Mendel, and of de Vries, showing the relation of the results obtained by each of these investigators to the conclusions reached by Darwin. He demonstrates by an ample series of quotations that the idea of "mutations" was constantly present to Darwin's mind, and that he only rejected the supposition that they might be concerned in the production of new species after giving the fullest consideration to the whole question. Prof. Poulton concludes, on several lines of evidence, including that of palæontology, that the mutationist theory of evolution is untenable, and that the only explanation of the course of evolution which really accounts for the facts is the principle of the accumulation of small differences by natural selection, as maintained by Darwin and Wallace. He is inclined to attach weight to de Vries's distinction between "elementary species" and varieties, as exemplified by their different behaviour in relation to Mendel's law, but he considers that the only fundamental change in the original Darwinian doctrine which is actually valid is that brought about by Weismann's denial of the transmissibility of acquired characters.

A FIRST volume of Transactions has been issued by the Liverpool Botanical Society, in which are published several papers read before the society, and a biographical list of deceased Lancashire botanists, prepared by the secretary, Mr. A. A. Dallman. A communication by Prof. R. J. Harvey-Gibson on the problem of photosynthesis concludes with a reference to experiments supporting the hypothesis that formaldehyde is produced in the leaf from carbon dioxide by electric currents generated by the chlorophyll. Messrs. J. A. Wheldon and W. G. Travis contribute a list of hepatics for South Lancashire.

IN the course of an article in the *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften*, Vienna (vol. cxvii., part viii.), describing certain fungi collected in Java, Prof. F. von Höhnel adduces convincing evidence to show that there has been indiscriminate naming of tropical fungi, due partly to great variation in the species, partly to the examination of insufficient or dried material. Thus, with regard to fungi growing in the nests of white ants, all the portions of agaric material collected were referable to a single species, which the author assigns to *Volvaria eurhiza*; two species of Xylaria were also found in the nests, and a species of the nature of a Hypocrea. Another variable species is determined as an Oudemansiella. Among the new species identified are a Sphærocreas and a Corditubera.

WE have received a copy of the schedule and rules of the International Agricultural Exhibition to be held at Palermo (Buenos Aires) by the Sociedad Rural Argentina from June 3 to July 31, 1910, under the auspices of the Government of the Argentine Republic, in celebration of the emancipation of the Argentine, May 25, 1810. The conditions of entry of live-stock, implements, &c., are clearly set forth, and full information is given for intending exhibitors.

THE education committee of the Durham County Council has issued a report on further experiments on the feeding of dairy cows at Offerton Hall, by Messrs. F. P. Walker and S. H. Collins. The effect of brewers' grains has been again tested, both on the quantity of milk produced and on the percentage of butter-fat present. Mr. Collins also shows, in another experiment, that boric acid can get into milk if the cows are fed on food which, like Indian cotton cake, contains much of that substance.

THE reports on experiments with crops and stock carried out during the past year at the Midland Agricultural and Dairy College, Kingston-on-Soar, and in the contributing counties, have just been published, and they show a very commendable zeal and activity on the part of the staff. The experiments deal with varieties of mangolds, potatoes, swedes, and oats, and also with the manuring of swedes and oats, and are designed to assist the farmers in selecting varieties of crop and the combinations of manure likely to prove profitable.

AN interesting series of papers by Dr. Juritz has been appearing in recent issues of the *Agricultural Journal of the Cape of Good Hope*, discussing the soils of Cape Colony. Large numbers of chemical analyses and a certain number of mechanical analyses are quoted, and references are made to the special agricultural characteristics of some of the soils. Whilst the work in question forms by no means a complete soil survey, it marks a beginning, and shows that the Cape agricultural authorities are fully alive to the necessity of making systematic examinations of their soils.

A NUMBER of bulletins have reached us from the United States Department of Agriculture Bureau of Entomology, including papers on the codling moth in the Ozarks (E. L. Jenne), the striped cucumber beetle, *Diabrotica vittata*, Fab. (F. H. Chittenden), the hop flea-beetle, *Psylliodes punctulata*, Melsh. (F. H. Chittenden), the spring grain-aphis, *Toxoptera graminum*, Rond. (F. M. Webster), and the wheat-straw worm, *Isosoma grande*, Riley (F. M. Webster and G. I. Reeves). A very useful pamphlet gives a list of all the publications issued from the Bureau since it was established in 1863.

THE *Journal of Agriculture for South Australia* for June publishes the report of the experiments made at the Roseworthy College for the seasons 1907–9. The most important experiments are naturally those on wheat. Land values in many parts of South Australia are rising, and the old plan of growing wheat as the main crop with frequent fallows is no longer so profitable as before. The experiments show that the fallow is not necessary, but can be displaced by another crop; a rotation system has therefore to be evolved. The average rainfall is 17·4 inches.

FUMIGATION under tents with hydrocyanic acid gas has been the principal means of controlling scale-insects on citrus fruit trees in California for many years. Most of the commercial orchards in the State are fumigated at intervals of one or two years, at a cost ranging from 25 cents to 1·50 dollars a tree. The results of the work of different manipulators, and against different scale pests, show considerable discrepancy, and a good deal still remains to be done to put the whole method on a sound basis. Mr. Woglum has recently published the results of investigations made in California with the view of clearing up some of the discrepancies; the paper, which is well illustrated, forms Bulletin No. 79 of the United States Department of Agriculture Bureau of Entomology.

THE summary of the weather for the week ending July 31 shows that the period was again cold for the time of year over the whole country. The highest maximum shade temperature for the week over the United Kingdom was 73° in the east of England and in the Midland counties, whilst in the north and east of Scotland and in the north of Ireland the thermometer did not exceed 68°; the rainfall over England was everywhere largely in excess of the average. The summary for the eight weeks of summer, as yet expired, shows that the thermometer has not exceeded 77° in any part of the kingdom, and in the north-east of England the highest temperature is 73°. The excess of rainfall for the eight weeks amounts to 1·6 inches in the west of Scotland and in the north-west of England, and to 1·3 inches in the Midland counties. At Greenwich the excess of rain for June and July amounts to 2·4 inches, the aggregate measurement being 6·85 inches. The duration of bright sunshine for the summer, so far, is largely deficient of the average, the deficiency exceeding eighty hours in the north-east and south-east of England.

IN the *Archiv for Mathematik og Naturvidenskab* (vol. xxix., No. 12), Mr. A. S. Steen discusses the mean temperature of the sea surface on the Norwegian coast, "reduced" for the thirty-year period 1874–1903. With one exception the observations were made at light-stations between Torungen in the south-east and Gjesvær in the extreme north (lat. 71° 6′). The lowest mean values occur in February and March, and the highest in August. Selecting two stations on the Atlantic coast, we find at Utsire (lat. 59° 18′) those values to be 39·2° F. and 58·5°, and at Andenes (lat. 69° 20′) 33·3° and 51·1° respectively; up to lat. 63° the mean annual temperature of the 30-year period does not fall below 46·4° F. The tables also include departures of the monthly means from the normal value for each of the separate years 1874–1903.

AMONG several useful papers on the climatology of Italy recently received from Dr. Eredia, we may refer to two of special interest, relating to torrential rains in Sicily (1879–1907), and to the disastrous floods, especially in the provinces of Syracusa and Catania, caused by severe thunderstorms in November last. The heaviest rains occur on the eastern slope of the island between September and April; at Riposto a fall of 7·64 inches within twenty-four hours occurred in November, 1889, and one of 8·12 inches at Catania in September, 1902. In the thunderstorms of November 17 and 18, Riposto recorded daily falls of 18·29 inches and 8·11 inches; 5·91 inches fell in twenty-five minutes. At Sant' Alfio the falls were 8·68 inches on November 17, and 14·39 inches on November 18. This remarkable downpour was caused by a shallow barometric depression passing from the south of Spain to Algeria, with high barometric pressure existing at the time over the Balkans and Upper Italy.

AFTER the Kangra earthquake of April 4, 1905, Prof. Omori, who had been sent by the Japanese Government to India, lent to the Indian Meteorological Department a portable seismograph of his design. This instrument was set up in Simla, and in vol. xx., part iii., of the Memoirs of the Indian Meteorological Department a list is given of the seismographic records obtained with it between June, 1905, and November, 1908. The instrument is of the pattern which records by the movement of a tracing point on a travelling sheet of smoked paper, and has a heavy mass of about 10 kg. at the end of a boom 75 cm. in length. Experience has shown that instruments of this type seldom give satisfactory records of the preliminary tremors unless the heavy mass is at least 25 kg., and the seismograms, reproduced in the memoir, show that the Simla instrument is no exception to this rule.

IN a recent number of *Globus* (xcvi., 1), Mr. W. Reinhard gives a short description, with facsimile, of a MS. map of the British Isles preserved in the British Museum, which does not seem to have hitherto met with the attention it deserves. It is of interest as occupying an intermediate position between early productions such as those of Matthew Paris, and the more precise work of Christopher Saxton, or even of Mercator and Ortelius. It is without date or author's name, but may be assigned with some confidence to the middle of the sixteenth century, being thus about contemporary with (Mr. Reinhard says *earlier* than) the map of George Lily (1546), stated by Gough to be the first exact map of Great Britain. While not quite so correct as this as regards the outlines, especially of Scotland, it is perhaps superior as regards the amount of detail supplied, at least for England. Besides most of the principal towns and villages, it names a number of physical features. Among islands, we find Holy and Farne islands (Northumberland); Mersea and Foulness (Essex); Mt. St. Michael (Cornwall); Priestholm or Puffin island, near Anglesey. The name Portland appears on the mainland, while Corfe and Selsea are both shown as islands. Of towns and villages swept away by the sea, we find Dunwich, Orwell (misplaced), and others, but not Ravenspur, though this had been destroyed only about 1530. A large island seems indicated within the mouth of the Humber, though it would probably be risky to argue changes of coastline from such evidence. There is still much room for research as regards the data on which such maps were based.

THE June number of *Terrestrial Magnetism and Atmospheric Electricity* contains a frontispiece showing the magnetic survey yacht *Carnegie* under full sail, and an article describing her construction and the work she is intended to do. She has a displacement, when fully equipped, of 568 tons, and is built almost without iron, her bolts and metal fittings being of bronze, copper, or gun-metal. The observation rooms are amidships. The yacht is to make a magnetic survey of the oceans during the next fifteen years, with the object of correcting the magnetic charts and compass data at present available. Her first voyage will be to Hudson Bay and the North Atlantic Ocean.

THE *Electrician* for July 16 contains an article, by Mr. L. W. Wild, on the comparative merits of photometers of the Bunsen type, of the Lummer type, and of the flicker type, for testing the brightness of lights of different colours. Mr. Wild has used two or three photometers of each type in the comparison of a carbon with a tungsten filament lamp, and comes to the conclusion that for accurate work

photometers of the Bunsen type are to be preferred to those of the flicker type. He considers the latter, although more sensitive than the former, give readings for the comparative brightness of the two lamps about 6 per cent. from the true value. He finds photometers of the Lummer type come short of the Bunsen in sensitiveness, and he thinks that in time the Bunsen will displace the other photometers at present in use.

BULLETIN No. 30 of the University of Illinois consists of an important paper, by Mr. J. K. Clement, on the rate of formation of carbon monoxide in gas producers. The numerous theoretical works on the processes taking place in the fuel bed of the producer have been built up on a rather slender experimental basis, and the present communication fills a decided gap in our knowledge. The experiments deal more especially with the rate of formation of CO in the reaction $CO_2+C=2CO$, previous researches having been rather directed to the study of the final equilibrium than to the rate at which the reaction takes place. Three authors contribute to this memoir, J. K. Clement, L. H. Adams, and C. N. Haskins, dealing with the subject from the physical, chemical, and mathematical point of view respectively. The result of this collaboration is a valuable monograph, which cannot be neglected by anyone interested in gas producers.

MR. W. B. CLIVE has published a second edition of Mr. William Hall's "Modern Navigation." The text-book deals also with nautical astronomy, and is intended to meet the needs of cadets of the Royal Navy and the syllabus of the Board of Education. The scope of the volume is limited to instruction in navigation so far as, and including, the problem of fixing position by one position line derived from sights of the sun and another derived from a bearing of land. The book has been entirely re-cast. Its price is *7s. 6d.*

AN abstract of Dr. John Morrow's contribution to part iii. of the third volume of the Proceedings of the University of Durham Philosophical Society was published in NATURE of July 29 (vol. lxxxi., p. 128). The volume contains, in addition, other articles of interest, among which the following may be mentioned:—Prof. Thornton describes a new method of measuring *v*; Prof. G. H. Stanley contributes a note on an artificial formation of zincite; Dr. D. Woolacott writes on borings at Derwenthaugh and Dunston; Mr. A. S. Horne describes observations on protoplasmic structure and streaming in potato; Messrs. Harold Crofts, H. Tiplady, and A. Forster discuss certain chemical experiments; and Messrs. T. Herdman and E. Merrick record observations in local geology. The third report of the Boulders Committee is also included in the volume.

OUR ASTRONOMICAL COLUMN.

MOVEMENTS IN THE SUN'S UPPER ATMOSPHERE.—In continuation of his previous papers, giving the results of the solar researches carried on at Meudon, M. Deslandres has a paper in No. 3 of the *Comptes rendus* (p. 179, July 19) wherein he describes and discusses more recent results dealing with the question of motion in the upper layers of the solar atmosphere. First he mentions the connections previously shown to exist between spots, "filaments," and "alignements," and points out that owing to the greater size, frequency, and distribution of the latter, they afford much more trustworthy and continuous data on which to base any researches or theories dealing with solar changes than does the study of spots alone; but for any exhaustive study of these phenomena the velocities of the solar vapours in the line of sight must be determined, and it is to this determination that M. Deslandres has in the more recent work returned. As Meudon is the only observatory employing the *spectro-enrigistreur des vitesses radiales*, the results are of great interest.

To measure the radial velocities all over the disc would take much more time than the Meudon staff are able to devote to the work, so, for the present, only those in the neighbourhood of filaments near the centre of the disc have been measured. A diagram of a typical radial-velocity curve shows that in the filament, shown on the "K_3" image, the vapours are moving towards the observer, the displacement of the line being towards the violet. At first glance this appears to contradict M. Deslandres's previous conclusions, and the fact that whilst, in May and June, when spots were scarce, or small, the filaments were well developed, yet further suggests that the two phenomena are not physically connected; but M. Deslandres thinks it necessary only to modify and enlarge these conclusions, and shows how solar convection currents, analogous to Benard's cellular liquid *tourbillons*, would account for the apparent discrepancy of the results, and, at the same time, afford an explanation of Evershed's radial motions observed in the penumbræ of spots.

SEARCH-EPHEMERIDES FOR COMET 1896 VII. (PERRINE).—In No. 4342 of the *Astronomische Nachrichten* Herr F. W. Ristenpart publishes a set of elements, brought up to the equinox of 1910, for the comet discovered by Perrine in 1896; the time of the next perihelion passage is given as 1909 November 4·12 (M.T. Berlin). Three search-ephemerides, computed from the elements by Messrs. R. Castro and A. Repenning, are also given, T being taken as October 27·5, November 4·5, and November 12·5 respectively. According to the second ephemeris, the comet is at present in Pegasus (August 6, 12h. M.T. Berlin, $\alpha=23$h. 44·2m., $\delta=+31°$ 40·2′), and will apparently travel, in a north-easterly direction, through Andromeda towards Perseus; on August 24 its position should be $\alpha=$oh. 11·4m., $\delta=+40°$ 12·4′, and the comet should appear about as bright as when discovered. The computed brightnesses at perihelion are 6, 13, and 20·5 respectively, according to the date of perihelion passage.

OBSERVATIONS OF JUPITER.—Some incidental measures of the positions of Jupiter's belts and of the polar diameter of the planet are given by Prof. Barnard in No. 4339 of the *Astronomische Nachrichten* (pp. 307–10). For each recognisable feature he gives the distances from the south and north limbs and the apparent latitude; the observation on February 19 8h. 0m. (central standard time), 1907, gave the apparent polar diameter as 40·78″, and, reducing this to $\Delta=5·20$, the polar diameter therefore becomes 36·11″.

On this date a narrow south belt, 2″ wide, in apparent latitude −9·88″, showed several ill-defined white spots, and on May 26, 1908, the north equatorial belt was double for part of its length.

THE ORBIT OF X SAGITTARII, A CEPHEID VARIABLE.—The variability of the star X Sagittarii was discovered by Schmidt in 1886, and the radial velocity detected by Slipher in 1904. In No. 157 of the Lick Observatory Bulletins Mr. J. H. Moore discusses a series of one-prism and three-prism spectrograms taken at Mount Hamilton during the period 1904–8. Plotting the velocity- and the light-curves for the same epoch, it is shown that the times of light-maximum and of greatest velocity of approach agree very closely, this being a fundamental characteristic, as Mr. Albrecht has shown, of all variables of the δ Cephei type. No such close agreement is shown, however, between the epochs of light-minima and maximum recession.

THE LEEDS ASTRONOMICAL SOCIETY.—The energy and activity of the Leeds Astronomical Society in popularising the study of astronomy is well illustrated in the Journal and Transactions for 1908. This journal contains abstracts of the papers read before the society, and a large number of astronomical notes contributed to various periodicals by Messrs. Elgie and Whitmell, members of the committee. Among the former there appear papers on sundials (Mr. T. Wright), variable stars (Mr. Ivo Gregg), and "other inhabited worlds" (Mr. T. Benton), while an interesting popular paper dealing with the fancied figures in the moon is contributed by Mr. Elgie.

THE SOLAR ECLIPSE OF JUNE 17, 1909.—Observations of the contacts, during the solar eclipse of June 17, were made by Father Rigge, at the Creighton University Observatory, Omaha, and showed that the phenomena actually occurred a second or two earlier than the computed times. At first contact the difference was 2·02s., and is trustworthy, but at the last contact a difference of 18·4s. was observed, and may largely be due to the extremely bad conditions under which the observation was made, the sun being within fourteen minutes of setting (*Astronomische Nachrichten*, No. 4340).

RECENT IMPROVEMENTS IN THE INTERNAL-COMBUSTION ENGINE.

I.

A SURVEY of the progress made during the last twenty-five years in almost any field of engineering work would show an immense advance. Even during the past ten years very considerable progress has been made in certain branches of applied science, and in none of them to a greater extent than in the internal-combustion engine. We need not in this comparison claim the gun as a form of internal-combustion engine, though we are naturally entitled to do so. We may leave lethal weapons aside, and think only of the remarkable development of the reciprocating internal-combustion engine, and of the many changes it has brought about in our times. It has revolutionised cross-country transit. It has given us the long-deferred, but now actually achieved, victory called the "conquest of the air." It is extraordinary to think of the numbers of men who have spent ingenious years in seeking a solution of the problem of flight. The solution has come in the unexpected form of a pair of long, sail-like arms, driven forward by a small high-speed internal-combustion engine. This simple form of design, which, owing to the relation between centre of pressure and angle of tilt, seems to be naturally stable, bids fair to be adopted in a great output of flying machines shortly to be constructed. The hardly less novel, but less interesting, dirigible balloon owes the whole of its dirigibility, whatever that may amount to, to the internal-combustion engine.

Less startling, but of considerable material importance, is the utilisation of "waste heat" in our coal- and iron-producing areas. Our coal supply is admitted to be limited, and there seems to be at least an indication that at the present rate of consumption mankind would, in a few centuries, have to be prepared to turn its attention to the unlocking of some other form of stored-up energy, perhaps a radio-active one. It is not too much to say, however, that if the power available from the waste gases of blast-furnaces and coke-ovens in this country—and the amount can hardly be less in the aggregate than 1,000,000 h.p.—were put to use, the saving in the coal consumption might perhaps give us another half-century or two in which to look about for some substitute for coal.

In writing of what has been already achieved, we have to remember that we are only yet at an intermediate stage in the development of the internal-combustion engine. The internal-combustion engine gives us a bigger return for heat put in than any other known form of engine. We cannot imagine the development of the future "going back," so to speak, on such an advance as that. The internal-combustion engine must come, and existing steam engines be replaced. This means the supersession of the steam turbine, and may therefore seem to suggest a retrograde step, since the rotary engine is mechanically an improvement on the reciprocating one. We have to remember, however, that evolutionary processes sometimes take a step backwards to an earlier form in bringing forward the latest and most developed creation. No one would look on any reciprocating engine as a final improvement on a rotary one, even although, as is now the case, large gas engines are capable of so uniform a rotary motion that alternators are easily driven by them in parallel—the standard test of excellence in this respect. The day of the gas-engine turbine must come. Numbers of men are working at the problem which it presents; but little has as yet been published as to the result of their labours—an indication that the many difficulties are not yet mastered.

The present stage in the development of the internal-combustion engine is a convenient one at which to summarise briefly what has been done in regard to its improvement. We therefore propose in this and the succeeding articles of the series to state the problem and the lines on which, with such a striking measure of success, its solution has been attempted.

The problem can be stated in a very simple form. Given one pound of carbon of, say, 12,000,000 ft. lb. calorific value, which is a normal estimate, find how to obtain the largest possible amount of useful power. So far this energy has always been liberated in the form of heat. This heat has been given to some body which, by its subsequent cooling, can give out mechanical energy—such a body is a mass of gas or vapour. Let us assume that a mass of gas is chosen as the working medium. It is obviously desirable that the heat liberated should be absorbed as completely as possible by the gas, but in investigating whether this has been effected one at once meets with a check. To tell whether the whole of the 12,000,000 ft. lb. of heat energy has reached the gas, we may either look out for possible chances of heat leakage or may measure the amount of energy in the gas at the end of the operation. But to do the latter is practically impossible, for we do not know the specific heat at high temperature of any gas, and to do the former is extremely difficult, owing to the very short time the heat transference usually takes, and owing also to our lack of knowledge as to the temperature of metal or other surfaces in contact with, and enclosing, the gas. Many attempts have been made to ascertain what happens to the heat liberated, and much has been written on such topics as "dissociation," "after-burning," and "increasing specific heats." There would be no difficulty in filling the whole of the allotted space with a discussion of the various experiments that have been made and theories that have been built on this subject, but as many other matters have also to be dealt with, and as the author has already written on this topic elsewhere,[1] he does not now propose to go into the matter at length.

Briefly summarised, the result of gas-engine experiment is to establish that only about 50 to 55 per cent. of the heat energy known to be liberated is accounted for by multiplying the measured rise of temperature by the commonly accepted figure for the specific heat at constant volume. The same ratio of 50 to 55 per cent. was found for all sizes and shapes of containing vessel, and for all mixtures of gas. This constancy at once disposed of the theory that the "suppression of heat" was due to dissociation, as such an effect would naturally be dependent upon, and increase with, the increasing temperatures due to the richer mixtures. Equally it showed that the cooling of the gas by convection currents, radiation, and conduction to the walls of the containing vessel was an inadequate explanation. The suggestion of the French physicists, MM. Mallard and Le Chatelier, that the effect must be due to increase of specific heat with temperature was open to precisely the same objection as that of dissociation, and involved values of the instantaneous specific heat much in advance of what was then thought likely. It is now generally recognised that the real explanation of the apparent suppression of energy is due to a combined cooling effect and rise of specific heat. "After-burning" is now generally believed, as a result of many tests, not to occur in normal circumstances. With a weak mixture the time of explosion, and therefore of cooling, is a long one, so that the cooling loss has time to become considerable, and this compensates for the lesser degree to which the theory of increasing specific heats is effective for these weak mixtures and low temperatures.

The constancy of this apparent "loss" made it clear that no great improvement in the internal-combustion engine could be looked for in any increase of pressure and temperature in a gaseous mixture of given strength. We cannot alter the specific heat law of a substance. We might, perhaps, alter our working medium, which now for the most part is nitrogen, but no other gas is so cheap or so easily obtained; but we may vary the part of the temperature scale over which we work, and, within limits, we may affect the cooling loss by altering the shape of the containing vessel or cylinder. Experiments have shown

[1] "The Internal-combustion Engine" (Constable and Co.)

that the less the ratio of cooling surface to volume the less the proportionate cooling loss, and therefore the greater the amount of thermal energy converted into work.

Engines that have "pockets," that is, cavities in their walls, in which to contain ignition plugs or valves, are known to be less efficient than those that have not. On the other hand, it must not be forgotten that although this loss of efficiency exists, it is at any rate partly compensated for by the greater flexibility of the engine. It has been found, particularly in motor-car engines, that "pockets" have a very useful effect in enabling very variable mixtures to fire. The ignition plug is placed in a pocket so that, even when the mixture is a very poor one, there will be sufficient local "richness" in its neighbourhood to start an explosion which, once started, proceeds throughout the mass of the gas. Another fact which may have the result of increasing "pocketing" is the recently measured temperature limit for pre-ignition. Prof. Hopkinson has found that surfaces below 700° C. will not cause pre-ignition, whilst those above may do so—if above 750° C. they are pretty sure to do so. Now the surfaces most likely to rise to such temperatures are those remote from the cooling water in the jacket. The projecting end of an ignition plug is such a surface, and when exposed to the full heat of the explosion, as it is when the plug is not pocketed, pre-ignition may well occur. Prof. Hopkinson has shown also that when once a point of metal gets hot enough to cause pre-ignition, the very ignition of the flame in its neighbourhood will tend to cause the temperature to rise still higher, so that the phenomenon grows on itself and persists. It is not everyone who is moved, however, by such considerations, and we have lately seen in the design of the new Daimler engine a clearly expressed intention to avoid pocketing and its consequent loss of efficiency without any apparent fear of introducing other features much less desirable. It is only fair to say, however, that this engine is still on its trial. The ideal plan would appear to be to pocket the ignition plug but not the valves, and so combine the good features of both systems.

This frank abandonment of the highest possible efficiency by those who use pocketed engines brings us naturally to the consideration of thermal efficiency and the laws that regulate it. One may say at once that the theory of the internal-combustion engine has, until lately, been in a chaotic condition. The standard of efficiency for gas engines laid down by an influential committee had been found subsequently to be unsatisfactory as giving an impossibly ideal figure. That such remarkable progress in invention and mechanical perfection should have gone on side by side with this uncertainty as to the true standard of performance has often struck observers with astonishment. The considerable scale of the practical side of gas-engine development is illustrated by the fact that of one well-known make of double-acting gas engines alone, no fewer than 247 engines of an aggregate output of 308,000 b.h.p. have been built or ordered during the last six years. This corresponds to the large figure of more than 50,000 b.h.p. per year for only one of the many firms engaged on the work. At the moment the total capacity of gas engines in use must be well over 2,000,000 h.p., and of petrol engines much more than 1,000,000 h.p., making a total of more than 3,000,000 h.p. in internal-combustion engines. These are striking figures. Some of these engines and plants work with solid fuel and some with liquid. It would not be possible, even were it considered desirable, to use liquid fuel to the entire exclusion of any other. The present output of petroleum over the whole world is only 20,000,000 tons, a very small figure compared with the yearly consumption of 800,000,000 tons of coal. Unless, therefore, fresh supplies of oil are discovered, there can be no development of the internal-combustion engine which would lead to liquid fuel replacing solid fuel altogether.

In the articles that will follow, the author intends to deal with the problem of efficiency, taking into account the now established increase of specific heat with temperature, its effect on rating, and the recent practical improvements in the design and operation of gas engines and gas-producing plant.

H. E. WIMPERIS.

CONTINUATION SCHOOLS AND NATIONAL EFFICIENCY.[1]

AMONG the numerous problems now confronting English educational administrators, probably the most urgent is that discussed in the valuable and exhaustive report on attendance at continuation schools recently issued by the Consultative Committee of the Board of Education. To some extent the report covers similar ground to that traversed in the educational sections of the Majority and Minority Reports of the Poor Law Commissioners, arriving at almost identical conclusions.

The essential features of the problem are as follows:—Under the existing Education Acts, children must attend school from their fifth to their fourteenth birthdays, subject to certain exemptions (prescribed by local bye-laws) during the last three years of the school period. Local education authorities may grant (*a*) total exemption from school attendance at eleven years of age to children engaged in agriculture, (*b*) full-time or half-time exemption, or both, to children between twelve and fourteen. The "leaving age" is generally twelve or thirteen. Full-time attendance at a day school until fourteen is now compulsory over areas comprising about 22 per cent. of the population of England and Wales. The committee estimates that in the year 1907, the latest year for which full statistics were available, there were about 211,000 children under fourteen years of age who had obtained full-time exemption from day-school attendance. Of these, only 40,500 were attending evening schools in the year 1906–7, leaving 170,500 children between the ages mentioned not attending any form of week-day instruction. Further, the estimated population of England and Wales between the ages of fourteen and seventeen is 2,022,300. After deducting from this the number attending elementary, secondary, technical, or evening schools, it is estimated that nearly 1,498,000 (or approximately 74 per cent.) boys and girls between the ages of fourteen and seventeen are not receiving any form of scholastic instruction. We have therefore, about 1,668,500 boys and girls from twelve to seventeen years of age whose formal education has entirely ceased for the time being. Recent inquiries in London and Glasgow render it highly probable that a very large proportion, if not the majority, of these boys and girls, if in wage-earning occupations, are employed in purely mechanical work of a monotonous, uneducational character, of no industrial value when the child becomes an adult.

Under these conditions the education, such as it is, given in the elementary school is being rapidly forgotten. The boys and girls are almost entirely exempt from parental control; they are falling victims to the prevailing passion for cheap amusements and to the attractions of the streets. Any slight gleam of intellectual aspiration which may have been aroused in the elementary school is rapidly being extinguished. The enormous sums spent by the State upon the elementary education of these young people are almost entirely wasted. All that remains is a certain facility in reading, writing, and very elementary arithmetic. Even if the boys are definitely apprenticed to a trade, matters are not much better. Under the present industrial conditions, involving the minutest possible specialisation in the works, the employer cannot possibly afford, even if he wishes, to give the boy the all-round training which was given by apprenticeship under the older industrial *régime*. Industry now requires, in addition to manual dexterity, a general industrial knowledge and a trained intelligence which will enable the worker to adapt himself to ever-changing industrial conditions; but this knowledge and training are not now given by apprenticeship. Hence, an education outside, but concurrent with, the workshop is essential. A further important factor is that even if a boy be apprenticed to a skilled trade, he is generally not taken on until about sixteen years of age. The intermediate years, between leaving school at thirteen and commencing apprenticeship at sixteen, are usually spent in "blind alley," uneducational occupations such as that of errand boy, van boy, messenger, &c.

For many years to come the formal education given to

[1] Report of the Consultative Committee of the Board of Education on Attendance, compulsory or otherwise, at Continuation Schools. Board of Education, White Paper. Cd. 4757. (London: Wyman and Sons.) Price 1*s.* 6*d.*

the bulk of the population of this country will be that imparted in the elementary school, the continuation evening school, and the evening technical (including by this term commercial, or art or craft) school. The nation, at enormous expense, has instituted a system of national education which is almost entirely confined to children under fourteen years of age. In addition to this, an elaborate system of evening technical education has been established, mainly for those above the age of seventeen; but no adequate national system of evening continuation schools, for the boys or girls between the ages of fourteen and seventeen, linking on the elementary school to the evening technical institution, has yet been developed. The boy or girl leaves the elementary school at the age of thirteen. At seventeen or eighteen the youth may realise the necessity of attending evening classes for technical instruction relating to his special industry, assuming he is engaged in some skilled occupation or other. At the technical school he finds that he is unable to profit by the instruction given. During the years between thirteen and seventeen his powers of assimilation have declined through disuse, he has lost the habit of study, and most of his previous small stock of knowledge, *e.g.* mathematics and English, has vanished. He speedily becomes disheartened and ceases to attend. As a result, the greater portion of such chances as he possesses of rising in his trade, or of even keeping his position in a few years' time, vanishes. Not only is the worker thus damaged in an industrial sense, but the community loses, first by his diminished efficiency as an industrial unit, and secondly by the lessening in the sum total of sustained intellectual effort made by its citizens. Every workman, who by systematic instruction passes from the level of the ordinary artisan to that of the trained, intelligent worker, becomes an asset of increased value to the nation.

The problem now is, What can be done to (*a*) carry on the education of the wage-earning youth of this country during the years from thirteen to seventeen, (*b*) bridge over the present gap between the elementary school and the centres of higher evening instruction, such as the technical school? The solution lies in the development and the increased efficiency of the evening continuation school. The following statistics for 1906–7 from the report are not without interest as showing to some extent the measure of success which has been obtained :—

	Number of evening schools	Number of scholars on register in evening schools	Average attendance in public elementary schools (from five years upwards)	Percentage of evening scholars to day scholars
Lancashire ...	436	49,833	230,584	21·6
Yorkshire (West Riding)	308	29,447	211,281	13·9
Surrey	132	10,788	70,047	15·4
Birmingham ...	31	12,544	77,540	16·2
Bradford	34	8,361	35,372	23·6
Halifax	15	3,578	11,334	31·6
London	438	175,482	590,800	29·3
Manchester ...	92	26,838	88,887	30·2
Total for all counties in England and Wales	4,506	315,522	2,846,653	11·1
Total for all county boroughs in England and Wales	1,427	420,990	2,063,569	20·4

In recent years special attempts have been made in some districts to persuade boys and girls on leaving the elementary schools to join the continuation schools without delay. Some striking results have been obtained. In Widnes about 80 per cent. of the boys leaving the elementary schools commence attendance at evening schools without a break. Halifax has secured 66 per cent. The Lancashire County Education Committee reported in January that in the larger boroughs 37 per cent., and in the smaller boroughs 22 per cent., of the boys and girls leaving school during the year ending October 30, 1908, to secure employment, joined the evening schools immediately.

The principal recommendations of the Consultative Committee are the following :—

(1) The leaving age should be raised to thirteen years, and after a short period to fourteen years.

(2) Full-time exemption from the day school should only be given to boys and girls under sixteen when the parents or guardians can show that the children in question are suitably employed.

(3) It should be the statutory duty of each local education authority to make suitable provision of continuation classes for the further education of young persons up to the age of seventeen.

(4) Local education authorities should be empowered to make bye-laws compelling attendance at continuation classes for young persons up to the age of seventeen, and employers should be compelled to make provision enabling such young persons to attend the continuation classes.

(5) Employers should be forbidden under penalty to employ any young person under seventeen years of age who fails to attend the evening continuation classes regularly.

(6) The curricula of the continuation schools should be such as to continue the general education given in the primary school. It should have reference to the crafts and industries in the district, and prominence should be given to practical and manual instruction.

Most educationists will heartily support the above recommendations. Numbers (3) and (4) of the above are taken from the Scotch Education Act of 1908. The committee points out that in Germany attendance at continuation schools is compulsory in portions of twenty-two out of twenty-six of the constituent States of the Empire, and in Switzerland in portions of nineteen out of the twenty-five cantons of the Republic. The committee is of opinion that there is now a strong and rapidly increasing body of public opinion ready to support its recommendations. The committee estimates that the total cost (imperial and local) of "maintenance" which would follow from raising the leaving age to fourteen would be about 490,000*l.* per annum. The corresponding cost of compulsory continuation classes (exclusive of new buildings) would be about 2,600,000*l.* per annum.

The proposals of the committee, if adopted, would have important educational and sociological results. Thus for example, one of the main causes of unemployment would be eliminated. Educationally the proposals would have a far-reaching effect upon the development of a complete national system of education. As has been before indicated, the continuation schools would take the boys and girls from the elementary schools, continuing without a break their general education, while specialising to a limited extent in either commercial, agricultural, technical, or domestic work, depending upon the requirements of the pupils. At the age of seventeen the boys and girls, after this preliminary training, could then be drafted on to technical, or commercial or art schools. The continuation schools would thus link on directly, and coordinate with, the elementary schools on the one hand and the technical institutions on the other.

The direct and indirect gain to the community from (*a*) the improvement of the general education of the masses, (*b*) the increased technical efficiency of the workers, would be incalculable. In this connection the following extracts from the report may be given :—

"An increasing stock of practical ability in a nation enlarges the range of its economic abilities and rapidly adds, through all the gradations of directive responsibility, to the number of well-remunerated posts which could never have existed if men had not been forthcoming to fill them."

"A rising level of education among the mass of workers increases the real level of their wages, though this may not be accompanied by a rise in their nominal amount. It conduces to wise expenditure of income and to the avoidance of thoughtless or harmful waste."

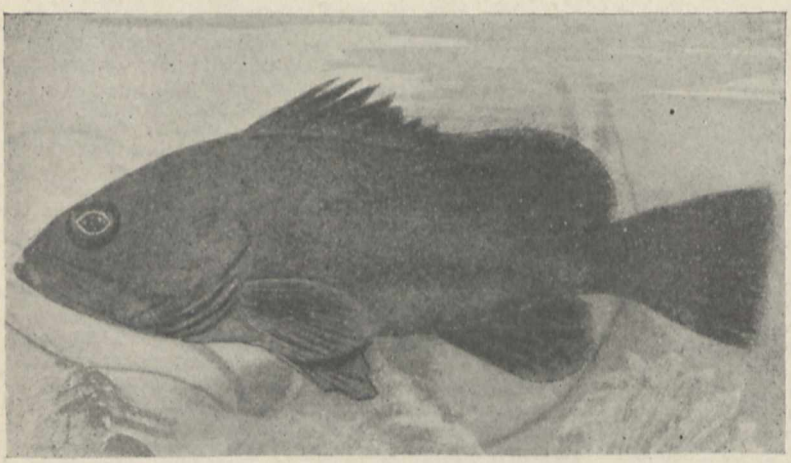
"Improvements in educational opportunity make possible

forms of government which give to the working class in the community an effective voice in policy and administration."

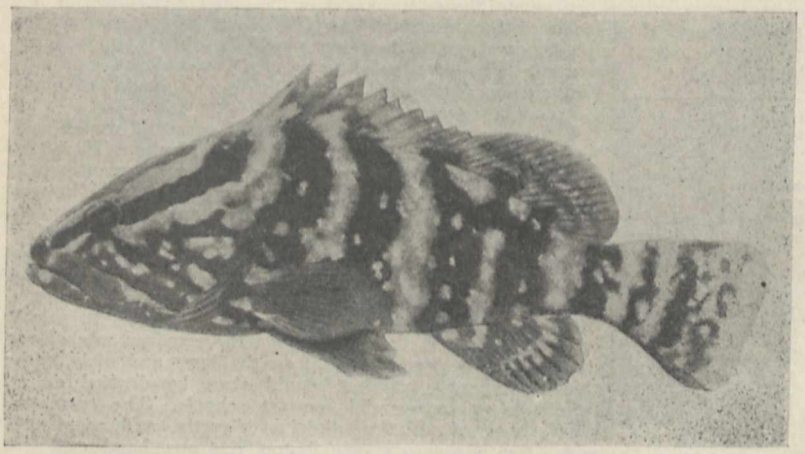
"The temper, the outlook, the recreations, and the ideals of a nation may be so refined and raised by the right kind of training as to secure for the mass of the people a more choiceworthy life." J. WILSON.

CHANGES IN COLOUR AMONG TROPICAL FISHES.

THE Zoological Society of New York recently issued a very interesting paper written by Mr. C. H. Townsend on the instantaneous changes of colour among tropical fishes (thirteenth annual report, 1909). The specimens came from the Bermudas, and are kept under favourable conditions in the aquarium of the society. The changes of coloration "begin to be in evidence within an hour of the arrival of new specimens, or as soon as they recover from the alarm produced by handling, and are produced as long as the fishes live in the tanks, which, in some cases, may be several years."



Dark Phase.



Banded Phase.

Two Colour-phases of the Nassau Grouper (*Epinephelus striatus*).

The phases of coloration are illustrated by a striking series of photographs, two of which are reproduced. From these it will be seen that the fish can pass from a uniformly dark (plumbeous) colour to a banded phase with white markings. Four other phases can also be assumed, including a uniformly creamy-white one. This plasticity of coloration is characteristic of most of the fish dealt with, which include Serranidæ, Scaridæ, Teuthididæ, and Scorpænidæ. There is frequently a pale and a dark monochrome phase when the fish is at rest. Under any excitement, such as the presence of visitors, the fish assumes a parti-coloured aspect. This paper clearly shows how inadequate and misleading are many of the descriptions of colour hitherto accepted, and is a very suggestive and attractive piece of work. An error occurs on p. 3, where it is said that "their different colours result from muscular action upon one or more kinds of cells." The mechanism of colour-change is not muscular, but nervous.

MINERAL OUTPUT OF THE UNITED STATES.[1]

THE well-known publication referred to below now appears in a form slightly different from the one to which we have hitherto been accustomed, being issued in two volumes, the first devoted to the Metallic products and the second to the Non-metallic products; this is done in consequence of a recent legislative enactment (Act of May 27, 1908), and presents some advantages, though it might be well to submit, with all respect, to the Government of the United States, that these (and sundry other) publications of the United States Geological Survey stand in far greater need of condensation than they do of expansion. When a work becomes unwieldy, there are two obvious remedies, either to issue it in two volumes or to compress the information it conveys into smaller compass; the latter is no doubt the more difficult proceeding, though the one that best serves the interests of the readers, and it is a matter of regret that, in this case, the line of least resistance has been followed. In the present instance it leads also to a few anomalies, as, for instance, the inclusion of crushed steel (as an abrasive) and of certain other metalliferous materials, such as arsenic, manganese, chromite, &c., in the volume devoted to non-metallic products.

It is greatly to be regretted that the mineral statistics of the United States are issued in a form that makes comparisons with the mineral output of other nations difficult; for example, the various values of the metals are reported, not in the form of ore, but in the metallic state, though obviously the value in this form includes the cost of reduction of the metal, and leads to very serious duplication, which the compilers appear to have overlooked, although the introduction lays stress on the statement that "all unnecessary duplication has been excluded." To take an example, the production of iron ore is not given, but instead of it that of the pig-iron smelted from it, namely, nearly 26 million tons, valued at about 530 million dollars. Now the production of coke for the same year was 40 million tons, produced from 62 million tons of coal, valued at nearly 73 million dollars. Practically the whole of the pig-iron produced was made with coke as fuel, and, in the absence of exact figures, it will probably be a near approximation to the truth if we assume that three-fourths of the coke production, or, say, 30 million tons, was consumed in the production of the above pig-iron, so that coal to the value of, say, 55 million dollars was utilised in this way, and this sum is accordingly included in the above valuation of the pig-iron production; it is, however, also included in the sum total of the value of the coal production, and thus enters twice

[1] Mineral Resources of the United States, Calendar Year 1907. Part I., Metallic Products. Pp. 742. Part II., Non-metallic Products. Pp. 897. (Washington: Government Printing Office, 1908.)

into the grand total of 1904 millions of dollars given as the value of the mineral productions of the United States. The same is true of every other metal on the list; in some cases, notably, perhaps, in that of aluminium, the value of the metallic product is many times greater than that of the mineral from which it is produced; thus the value of the aluminium produced is given as 5 million dollars, whilst that of the bauxite from which it is produced is about 450,000 dollars; surely it is the latter figure, and not the former, that should enter into a list of the values of the mineral productions of any country.

In the non-metallic products similar anomalies are also to be met with; cement, bricks, oilstones and millstones are articles that owe a very great, if not in every case the greater, part of their value to the labour, fuel, and power used in their preparation rather than to the crude material from which they are produced; if an American sculptor carves a statue out of native marble, should the value of the finished statue be included in the sum total of the value of the mineral resources? There can only be one answer to such a *reductio ad absurdum*, and yet the principle is exactly the same as that of including the value of the dressed grindstones instead of that of the sandstone or grit from which they are cut.

The above are matters of principle which present, no doubt, great difficulties in arriving at a satisfactory solution; the coordination of the methods of tabulating the mineral productions of different countries, so as to admit of just comparison, has often been tried, but has never been attained successfully yet, so that all that statisticians can do is to take care that they thoroughly understand the differences that obtain between the various systems in vogue. In other respects the present volumes are quite up to the high standard that we have been accustomed to in the United States Geological Survey publications. As already said, they suffer from want of compression, and there are many repetitions that might be avoided and much superfluous matter that might well be excised. In fact, they require more careful editing than they receive at present, and this is all the more necessary seeing that the different articles are written by different contributors, and are of very unequal value.

For example, no careful editor would pass such statements as we find under the item fluorspar, where we are told that the mineral is "only slightly harder than calcite, and consequently crushes easily," whereas the ease or difficulty of crushing has nothing to do with hardness; and again, "When fluorspar is associated with zinc-blende, complete separation of the two minerals has been difficult on account of their nearness in specific gravity"; the specific gravity of fluorspar is about 3·1, and that of blende about 4, a difference which should afford an ample margin for successful separation in a suitable appliance.

Finally, it may be pointed out that although these volumes in their final form may be considered somewhat belated, no serious inconvenience results therefrom, as the wise precaution is taken of issuing the various sections in pamphlet form as soon as possible after the end of the year to which they refer, an advance sheet of statistics being, moreover, issued usually with considerable rapidity. This is a procedure that might well be imitated with great advantage by a good many other nations, our own not excepted.

HENRY LOUIS.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE summer meeting of the Institution of Mechanical Engineers opened at Liverpool on Tuesday, July 27. The president, Mr. John A. F. Aspinall, and the council and members of the institution, were welcomed in the lecture hall of the Municipal Central Technical School by the Lord Mayor of Liverpool, Councillor H. Chaloner Dowdall, and the members of the Liverpool reception committee. The importance of Liverpool as an engineering centre secured an attendance of nearly 500 members, who participated in the excellent arrangements made regarding visits to works and excursions. The institution dinner was held in the Exchange Station Hotel on Tuesday evening, and the Lord Mayor and Lady Mayoress of Liverpool received the visitors in the Town Hall on Wednesday evening. Meetings were held for the reading and discussion of papers on Tuesday and Wednesday mornings in the Municipal Central Technical School. Brief extracts from these are subjoined.

Locomotives designed and built at Horwich were described in a paper by Mr. George Hughes, who is the chief mechanical engineer of the Lancashire and Yorkshire Railway. This company possesses 1517 locomotives, of which there are about 1100 in daily use. When the works at Horwich were opened, Mr. Aspinall, president of the institution, and at that time chief mechanical engineer, resolved to introduce standardisation and, wherever possible, interchangeability. Joy's valve gear was adopted, as it was found that the mileage between repairs was greater, and also that there was a slight economy in coal per engine-mile.

Among other types of locomotives described it is of interest to note six engines which were fitted in 1902 with Druitt-Halpin thermal storage tanks. Where stopping places are frequent on rising gradients there is distinct economy. Certain tests carried out between Salford and Accrington resulted in a saving of one ton of water, and under similar conditions elsewhere the saving was 12 per cent. On other sections of the line, which are not so favourable, the all-round economy of these engines is brought down to 4 per cent.

A four-cylinder passenger and express goods engine, built to the author's designs in June, 1908, is also of interest. Absolutely perfect balancing could have been achieved without the aid of balance weights if the crank angles, the disposition of the cylinders, and the weights of the reciprocating parts had been arranged to neutralise amongst themselves the reciprocating disturbing forces; then, by balancing the revolving masses, the variations of rail load and the horizontal swaying couple would have disappeared. Excepting for a slight vertical component produced by the obliquity of the connecting-rod, the engine would then have been perfectly balanced. This arrangement, known as the Yarrow-Schlick-Tweedy system, would have involved an independent set of valve gear for each cylinder. Actually, the cranks were arranged in pairs at about 180° apart respectively, and the reciprocating masses, being made equal in weight, balance each other. The masses of the connecting-rods were divided between the rotating and reciprocating masses as suggested by Prof. Dalby, and the revolving masses were balanced by revolving balance weights. This engine is a very steady and smooth-running machine.

The discussion centred round the important questions of boiler deterioration, corrosion, and priming. Mr. Hurry Riches expressed the opinion that the best way of avoiding troubles due to the nature of the feed-water is to remove the impurities before feeding into the boiler; it is, however, inadvisable to reduce the hardness of feed-water below 6°.

A paper on reinforced concrete was contributed by Mr. Arthur C. Auden, of the firm of Messrs. William Cubitt and Co. Reinforced concrete is by no means a new thing; it has passed the experimental stage, as is evidenced by important structures erected in London in 1889, and still in use. On the Continent equally large structures exist which are now twenty-five years old, and have never been strengthened or patched. Failures have occurred through bad design or workmanship, but the proportion of these is small. The cost of the proposed structure is affected by the cost of its constituents, and these in turn by the cost of freight and carriage. Hence the author briefly classifies the materials, and gives useful hints on the properties of each.

For aggregates, the eastern counties' flint is often the only stone available locally. Good, tough concrete can be made with this, but is untrustworthy for fire-resisting purposes, owing to its tendency to crack and "fly" under heat. This tendency can be much reduced by first crushing all the stones. The same remarks apply to limestone, a material which is not more fire-resisting after being broken. As it is apt to disintegrate to powder under the action of heat, it is inadvisable to use this material where fire-resistance is an important consideration. Limestone always requires washing before use to get rid of the fine dust which covers it and prevents the cement properly

bonding with it. Sandstone, as a rule, is too soft, porous, and absorbent for use in reinforced-concrete work. It may be safely used if it will stand about 1½ tons per square inch under a crushing test, and also if the difference in weight when clean and dry, and after being two days under water, does not exceed 8 per cent. Quartzite stone is fairly good if not too soft and open in texture, in which case the same precautions apply as for sandstone. It should be noted that the test pieces for crushing tests should have an area of at least 10 inches or 12 inches.

With reference to artificially produced aggregates, broken earthenware and stoneware from the Potteries district make a good aggregate, but these must be unglazed, as the glaze prevents the proper adhesion of the cement. Burnt clay and gault may be used provided they are tough and hard, and do not soften or crumble after being left in water for two or three days. In general, broken bricks are not a good aggregate for reinforced concrete. They may be employed safely if hard and close in texture and free from mortar. Coke-breeze is cheap and readily obtained, but cannot be regarded as being really fire-proof. The effect of any sulphur present must also be considered. Ashes and clinkers may be used. In the case of ashes, only those which will float in water and are of uniform colour and texture, as well as being quite free from coal and dirt, should be used. Really hard and clean clinker alone is serviceable. In both of these sulphur must be considered. Slag from blast furnaces and cupolas makes a good aggregate if hard, tough, and free from dust; any sulphur present must be noted.

Sulphur is apt to attack the reinforcing steel with disastrous results. The maximum allowable percentage of sulphur in reinforced concrete aggregates is now being made the subject of experiments, and it is hoped an authoritative statement will soon be made. In the form of a sulphate sulphur is practically harmless, but is very deleterious if in the form of a sulphide.

It is of importance that no free lime be present in artificial aggregates; carbonate of lime is practically harmless. Washing and exposure to the air and sun will do much to convert sulphides into sulphates and free lime into carbonates. Good and accessible aggregates are often condemned because no discretion is exercised as to the form in which lime and sulphur occur.

A certain amount of sand is absolutely necessary in concrete, and no other material is at present known which can be substituted for it. Generally speaking, the better a sand is for moulding purposes the worse it is for reinforced concrete. Dirt in the form of slime, mud, or vegetable refuse is bad, but a little loam, enough to soil the fingers, but not enough to cause the sand to adhere to them, is no detriment. Small particles or nodules of clay do not appear to affect the strength of the concrete, but it is better to avoid them if possible. It is not good practice to use the stone aggregate, and its smalls and dust, together with some sand, upon the chance that they will be in proper proportion, and that the voids and spaces will be properly filled. Such a practice should not be allowed in reinforced work, where absolute homogeneity is so essential.

With reference to cement, any user is safe if he insists that his cement shall pass the British standard specification in every detail, and purchases from a trustworthy maker. It should not be one of the many mixtures imported into this country as cement, which do not deserve the name, and are costly at any price.

Methods of inserting the reinforcement in beams, slabs, columns, &c., together with hints on erecting various structures, take up the remainder of this valuable paper.

Prof. Unwin spoke of reinforced concrete construction as demanding excellent execution and supervision to be successful. In regard to formulæ of the empirical class, largely employed in this subject, the range of experimental work should rule the trustworthiness of the formulæ. Much of the present methods of design is based on guesswork. He took the opportunity of urging the necessity for more extended experiments.

In presenting his paper on the advance of marine engineering in the early twentieth century, Mr. Arthur J. Maginnis naturally devotes a great deal of his space to the marine steam turbine. While the use of turbines has produced practically no advance or improvement in fuel consumption since 1901, still, an advance has to be recorded in that a greater speed has been attained. During the past eight years experience has shown the trustworthiness of the Parsons turbine machinery. Notwithstanding that there are now more than seventy steamers continuously plying to and fro, no sailing schedules have been upset by a failure of machinery, nor has a turbine steamer ever had to be towed into port. The author has no hesitation in stating that rotary machinery must eventually replace the present system in cargo steamers as well as in liners.

Combined systems of reciprocating and turbine machinery were referred to, but the author does not think that an extensive adoption of this system will be made. In evidence of the saving in weight in the boilers where turbines are installed, owing to the lower steam pressure which may be used, the author states that in the case of the *Lusitania* and *Mauretania* the saving in weight on the boilers alone is about 120 tons over and above that which would have been required if triple or quadruple piston engines had been used.

The author gives a summary of the results attained by marine engineering to date as follows:—vessels of close upon 800 feet length and more than 38,000 tons displacement are being propelled across the Atlantic at an average speed of 25½ knots by turbine machinery working up to about 70,000 horse-power, having a consumption of upwards of 1000 tons per day. Similar results have been obtained in the turbine-propelled warship *Indomitable*, of more than 40,000 horse-power, and maintained across the Atlantic with water-tube boilers.

The electrical operation of textile factories formed the subject of a paper by Mr. Herbert W. Wilson. The principal advantage claimed lies in the fact that a much greater steadiness of drive can be obtained, with consequent higher average speed and increased output. Slight variations in speed above that corresponding to the maximum safe tension breaks the threads, and unless absolutely constant speed can be obtained, it is necessary to allow a margin of safety and to run at a speed materially below the breaking point. In one case in Lancashire, with two mills under the same management and of about the same size, and working under the same general conditions, the results obtained from the electrically driven factory have been distinctly superior to those from the mechanically driven one. The improvement in the quality of yarn was so noticeable that the output from the electrically driven mill fetched a distinctly better price than that from the other factory, the increase being stated at about 2½ per cent. As regards increase in production, mills in this country which have adopted electrical driving may be estimated as showing an improvement of 5 per cent.

A paper on the indicating of gas engines was contributed by Prof. F. W. Burstall, of Birmingham University. The Standards Committee of the Institution of Civil Engineers expressed the opinion in their 1906 report that the indicating of gas engines was open to very much greater errors than was the case with steam engines, and this matter has been considered by the Research Committee of the Institution of Mechanical Engineers. In the tests undertaken by the author, two indicators were used simultaneously, one of the ordinary string type and the other an optical indicator. A Premier gas engine was used having a cylinder 16 inches in diameter by 24 inches stroke, running at 165 revolutions per minute. The only variation in the four tests recorded was the amount of gas admitted, the mean pressure varying from 5½ kg. per cm.^{2} up to about 7½ kg. per cm.^{2}

The string indicator employed was of the Crosby type, selected for these tests by the Crosby Company. Before and after each set of trials the indicator was tested for backlash and friction, and the spring also calibrated. The backlash was in all cases negligible, and the friction amounted to less than 1 lb. with a spring having a scale of 400 lb. per square inch. The optic indicator was lent by Prof. Hopkinson, and was calibrated at the University.

Both indicators were mounted on a branch piece con-

nected to the engine cylinder, and the indicator diagrams were taken simultaneously. The indicator barrel of the Crosby indicator was rotated by a phosphor-bronze stranded wire wound round the barrel and led to a bell-crank lever. The bell-crank lever was driven by a steel wire attached to the usual lever driven by the engine piston. A very heavy spring, in which a compression of 400 lb. produced a contraction of 2 inches, controlled the bell-crank lever. The optic indicator was also driven by means of a phosphor-bronze stranded wire.

The mean diagrams were prepared from no fewer than twelve individual diagrams, each being divided by the method of ordinates, and the heights read by an accurate steel rule. With care it was possible to read the Crosby diagrams to an accuracy of half of 1 per cent. The optic indicator diagrams could readily be measured to the same order of accuracy. The diagrams were plotted on squared paper, and superposed one on the other, so as to exhibit whatever differences there were between the indicators.

Speaking generally, the compression curves are coincident. The maximum pressures practically agree in two of the tests; in a third, the Crosby indicator gave the higher initial pressure, and in the fourth the Hopkinson gave the higher. Down the expansion line the two indicators agree for the third of the stroke. After that the Hopkinson indicator gave a persistently higher expansion line, the difference between the two lines being higher than the probable experimental error of the measurements. The effect of this difference is to make the Hopkinson indicator give about 3 per cent. higher mean pressure than the Crosby.

In the Hopkinson indicator the spring was in the form of a flat bar rigidly fixed at the ends and loaded in the centre; the central deflection of this beam is a direct measure of the pressure on the piston. During calibration with dead weights, from which the scale of the spring is obtained, the ends of the bar may be assumed to be absolutely fixed, but when the indicator is in use it is possible that there is a slight slip in the bar through the screws which restrain it. The effect of this would be to prevent the pressure falling so rapidly in this indicator as in the Crosby indicator. The author believes that this explanation is more likely to be correct than that the effect is due to inertia or friction, and is inclined to prefer the results obtained from the Crosby indicator.

While the results of this comparison do not offer an absolute proof of the accuracy of either indicator, there is still strong evidence that both give results very close to the truth. The indicators are of entirely different types, one multiplying the indicator piston movement by six, the other by about 120, a very similar multiplication being the case with the rotation of the drum and the mirror. In the optic mirror inertia is certainly negligible. That the two give results to within 3 per cent. on the mean pressure, and very nearly the same figures for the initial pressure, is good presumptive evidence that, when either indicator is used with the precautions regarding driving described, the results so obtained are at least as accurate as any other measurement which can be made in engine testing. Unless these precautions are taken, the results can only be regarded as affording a clue to the valve setting, and give no trustworthy figures as to the power developed in the engine cylinder.

The council of the institution has issued the conditions under which the second award of the water arbitration prize will be made in 1910. The prize will have a value of about 30*l.*, and will be awarded to the author of the best original paper dealing with any branch of the mechanics of the supply or distribution of water. The latest date for sending in papers will be September 1, 1910.

MR. HALDANE ON THE PROMISE OF AVIATION.

IN Committee on the vote of 36,464*l.*, including a supplementary sum of 6500*l.*, to complete the sum necessary to defray the charge for sundry grants in aid, scientific investigation, and other grants, there was an interesting discussion in the House of Commons on August 2 on the subject of aviation for naval and military purposes. Mr. Haldane made a statement giving the views and intentions of the Government.

Mr. Haldane said he had made up his mind that there could be no real progress unless we proceed scientifically and in order—that is to say, unless we are perfectly clear about what we want, as to the structure of the machines which will be used for the purposes in view, and the production of them in a way which should be at least effective. The first thing done was to ask the Committee of Imperial Defence to investigate this question and to discuss it with the technical subcommittee. The report was to the effect that the class of machines must be divided into three heads:—rigid dirigibles, non-rigid dirigibles, and aëroplanes. For naval purposes the rigid dirigible is probably the only instrument of the kind which is of real value, at any rate in the present state of knowledge. For the army the rigid dirigible has certain disadvantages. It is more difficult to work, to bring back, and to bring to rest. It is more difficult for the army than for the navy. The non-rigid dirigible is the best for army purposes. The aëroplane may become available for army purposes, but at present it has certain defects. It will have to rise much higher before it can be a safe instrument for reconnoitring. But M. Blériot's splendid feat in crossing the Channel and the successes achieved in the United States point to a time when the aëroplane may be an instrument capable of achieving great results.

To the navy has been assigned the duty of investigating, with the view of constructing, the rigid dirigible, the ship of the Count Zeppelin type. To the army has been assigned the duty of experimenting with the non-rigid dirigible, the machine of varying type, and also with aëroplanes.

To make their study of aviation scientific, Mr. Haldane said the Prime Minister constituted the advisory committee, under Lord Rayleigh's presidency, on which there is some of the best scientific brains in the world. Continuous work has been going on at the National Physical Laboratory. Meetings have been held there and at Aldershot and the War Office. The committee is to advise, its purpose is to scrutinise inventions submitted in the course of the work of the departments concerned, and to conduct systematic experiments. In a few days the first report of this committee will be made public. The committee, said Mr. Haldane, has such men as Lord Rayleigh and Dr. Glazebrook on it, and such men on the practical side as Mr. Lanchester and Mr. Mallock, and others like Prof. Petavel and Dr. Shaw, and also such high authorities on the army and navy side as Major-General Hadden and Rear-Admiral Bacon, and is well furnished from the various points of view. This committee has been at work, and the first thing it has done is to determine the general question which should be studied. There have been various memoranda by the experts on stability, screw propellers, wind structures, petrol motors, and a very difficult thing which has arisen in connection with balloons, the accumulation of electrostatic charges. Everyone knows what a peril electricity is in the air. Then the committee has mapped out the general field of its work. There are certain general questions in aërodynamics, questions specially relating to aëroplanes, such as the mathematical investigations of stability, the effect of rudder action, gusts of wind, and half a dozen other things which I need not enumerate. There are propeller experiments; there are questions relating to these motors which have to be of special construction for air work, general questions relating to airships, and still more general questions relating to meteorology.

The committee has entered into communication with the Aëronautical Society, the Aërial Club, and the Aëro League. The design is to afford assistance to private inventors wherever this can properly be done, because progress in this matter will be, not merely a Government, but a national matter. The Admiralty is concentrating, under Admiral Bacon, Director of Naval Ordnance, on the building of a rigid dirigible of the very largest type, at least the size of the *Zeppelin*. That is being built at Barrow-in-Furness by Messrs. Vickers. The combination of experts and practical men may give us a practical result some time next spring. The War Office is reorganising its factory at Aldershot. The instruction, which is at present given to balloonists under the superintendence of Colonel Capper, is being separated from construc-

tion, and at present preparations are being made for the construction of a shed which will take in the largest size of dirigible. The Admiralty has in prospect one great rigid dirigible, the War Office has three, and besides those we have our balloons for war purposes. At the present time we have certain aëroplanes, and the prospect of two new aëroplanes which are to be presented for experimental purposes, and may hereafter be acquired. That is the actual position of things.

IMPROVEMENTS IN PRODUCTION AND APPLICATION OF GUNCOTTON AND NITROGLYCERINE.[1]

II.

IN the year 1846 Schönbein discovered guncotton. In the year 1886, that is, forty years later, the French chemist Vieille invented his smokeless powder for military purposes. This explosive, which was primarily designed for use in the small calibre Lebel rifle, consisted essentially of guncotton, and the secret of its success lay in the fact that Vieille so altered its physical state that its rate of combustion, when confined, was under complete control. This condition was arrived at by treating the fibrous guncotton with suitable solvents which entirely destroyed the fibre and converted it into a colloidal, horny substance quite devoid of all porosity. The gelatinised guncotton resulting from this treatment burnt, when ignited, from the surface inwards, and by varying the surface area any required rate of combustion could be obtained. The use of smokeless powders manufactured in this way was very soon extended to all natures of ordnance.

The next step in the development of smokeless powders was the combination of nitroglycerine with nitrocellulose. The first powder of this type was the "ballistite" of Alfred Nobel, patented by him in the year 1888. The original ballistite was composed of equal parts of nitroglycerine and of soluble nitrocellulose, a variety of guncotton soluble in nitroglycerine, and no solvent was therefore required in its preparation, although a certain proportion of camphor was used to promote the solution of the nitrocellulose. Another form of nitroglycerine-nitrocellulose explosive is the British service powder, cordite, which originally consisted of nitroglycerine, 58 parts, guncotton, insoluble in nitroglycerine, 37 parts, and mineral jelly, a product of the distillation of crude petroleum, 5 parts. To effect the gelatinisation of the guncotton, the solvent acetone, obtained indirectly from the destructive distillation of wood, is employed. The result of subjecting nitrocellulose in suitable machines to the action of nitroglycerine or of solvents, of which there are several suitable ones besides acetone, is to destroy its fibre and convert it into a gelatinous mass, in which condition it can be formed into any desired shape. Where solvents are used to produce this result they remain in the mass during subsequent operations, and are finally driven off by means of heat. The resulting products, somewhat incorrectly termed "powders," which are manufactured in a variety of forms, such as grains and flakes of different shapes, ribbons or strips, solid cords, tubes, &c., vary in consistence with the quantity of nitroglycerine they contain. The more nitroglycerine present the softer the powder, pure nitrocellulose powders being hard to brittleness.

For practical purposes modern smokeless powders are of two types:—

(1) Those consisting entirely of nitrocellulose, and termed "nitrocellulose powders."

(2) Those consisting of a mixture of nitrocellulose and nitroglycerine, known as "nitroglycerine powders."

Opinions differ somewhat as to the relative merits of these two types; in this country the latter type is preferred. Their characteristic features are, briefly, as follows:—

A nitroglycerine powder is more powerful than a nitrocellulose powder, and the more nitroglycerine present the more powerful the explosive. Therefore, for equal ballistics, a smaller charge of the former than of the latter is required, and, consequently, the chamber capacity and the size and weight of the breech mechanism are reduced; on the other hand, the higher the proportion of nitroglycerine the higher is the temperature of combustion and the greater the erosive effects on the surface of the bore of the gun.

The presence of nitroglycerine in an explosive allows of the more easy and rapid elimination of the solvent used in manufacture and of moisture, a small quantity of which is always present in nitroglycerine and guncotton. The sooner this is attained the better, because the longer the time that the powder is being heated in order to dry it, the more likely is its chemical stability to be affected. Moreover, it is a well-established fact that with nitrocellulose powders it is impossible to remove the volatile matter with anything like the same completeness as can be done in the case of nitroglycerine powders. The consequence is that the slow evaporation from nitrocellulose powders of the residual volatile matter which takes place in store tends to produce changes in their physical character and renders them in course of time liable to alter in ballistic properties, and even to develop dangerous pressures in the gun.

Nitroglycerine powders are cheaper than nitrocellulose powders, weight for weight, and even more so for equal ballistic effects.

The original cordite, the manufacture of which commenced in 1890, contained a high proportion of nitroglycerine, 58 per cent., and the erosion produced, especially in large guns, was considerable. This led to experiments being carried out at Waltham Abbey with the view of the production of a less erosive explosive, and the final result was the introduction into the service, in 1901, of a modified cordite known as "cordite M.D.," in which the percentage of nitroglycerine is reduced to 30 per cent., so that the composition becomes:—nitroglycerine, 30 per cent.; guncotton, 65 per cent.; and mineral jelly, 5 per cent.

The constants of explosion of cordite and cordite M.D., determined at the Royal Gunpowder Factory some little time ago, are as follows:—

Explosive	Density of Loading	Heat of Explosion at Constant Volume, Water Gaseous	Total Gases, Water Gaseous at 0° C., 760 mm.	Temperature of Explosion
		Calories per gram	c.c. per gram.	°C.
Cordite ...	0·2	1156	871	2663
Cordite M.D.	0·2	965	920	2374

An inspection of these figures shows that the alteration in proportions of the explosive ingredients results in a decrease in the heat of explosion of about 16½ per cent., and an increase in the volume of gases of about 5½ per cent., whilst there is a decrease of 289° C. in the temperature of explosion.

As would therefore be expected, the erosion produced by cordite M.D. is very much less than that produced by the original cordite for the same ballistics, and is certainly not greater, if as great, as that produced by the best forms of nitrocellulose explosives.

Although of minor importance to smokelessness, flamelessness is a desirable quality for propulsive explosives to possess. In this respect cordite M.D. is superior to cordite in the case of rifles and machine guns; unfortunately, a suitable ingredient has not yet been discovered which will render smokeless powders flameless in large guns.

A third ingredient in both natures of cordite, viz. mineral jelly, although present in a comparatively small proportion, is a very important constituent.

Cordite in the advanced experimental stage consisted of nitroglycerine and guncotton alone, and as their combustion produced no solid residue of any kind, the surface of the bore of the magazine rifle in which the early experiments took place was not fouled in any way. The result was that the cupro-nickel coated bullets, propelled in succession at high velocity through a clean barrel, deposited some of the cupro-nickel in the bore. In order to prevent this a number of substances were incorporated with the nitroglycerine and guncotton, with the object

[1] Discourse delivered at the Royal Institution on Friday, January 29, by Sir Frederic L. Nathan, R.A. Continued from p. 147.

of producing a deposit in the bore, which it was hoped would get rid of the difficulty of metallic fouling. Of all these various substances the one which appeared to answer the purpose most satisfactorily was refined vaseline, and this material became the third ingredient of cordite as eventually introduced into the British service. When the manufacture was commenced on a large scale, vaseline, which is the proprietary name of one of the refined products of the distillation of petroleum, was replaced by mineral jelly, the same material, but in a cruder form.

The original object with which mineral jelly was introduced was of no importance when cordite was substituted for the black and brown powders used in large guns, but in order to have but one nature of smokeless powder in the service mineral jelly was added to all cordite, whether for use in small arms or artillery. Subsequent experience has demonstrated how very fortunate was the selection of this material for rifle cordite and the extension of its use to all sizes of cordite.

Mineral jelly is one of the best ingredients it is possible to have in smokeless powders from the point of view of their chemical stability. This important fact, not recognised originally, was brought out in the following way. In order to facilitate the explosion of cordite in blank ammunition for the rifle it was cut into very thin flakes, and the non-explosive mineral jelly was omitted from its composition. After a comparatively short storage in a hot climate the stability of the smokeless blank, as it was called, was found to have suffered seriously, whereas the stability of normal cordite containing mineral jelly was not appreciably affected. These facts led to a thorough investigation at Waltham Abbey of the action of mineral jelly in preserving the stability of cordite, and it was discovered that mineral jelly contained constituents which had the valuable property of combining with the decomposition products (the result of prolonged storage of cordite at high temperatures) to form stable bodies, thus removing these decomposition products, which undoubtedly exert a deteriorating influence on the cordite from their sphere of action.

When Abel was engaged on his researches in connection with the production and properties of guncotton, it was obvious to him that some test of a chemical nature was required in order to ascertain whether or not the finished guncotton had been thoroughly purified in manufacture. It will be remembered that accidents occurred in the early days of its production because this purification had not been carried sufficiently far. The test which he devised was based on the principle that if guncotton be subjected to an elevated temperature, traces of oxides of nitrogen will be given off, and will reveal their presence by acting on a suitable reagent.

The test is carried out by heating guncotton in a test-tube placed in a water bath, and suspending over it a strip of moistened filter paper impregnated with potassium iodide and starch. If the purification of the guncotton has not been sufficient, the discoloration of the test paper takes place early; as the result of experience Abel fixed a time before which no reaction should take place. This test, known as the Abel heat test, is a test for the purity of guncotton and of nitroglycerine, and of freshly made explosives containing either one or both of these ingredients. For this purpose no test has yet been devised which equals it. But it was never intended to be, and is not, a quantitative test, and is therefore only a rough guide, though a very useful one, as to the stability of an explosive which has been in store for more or less prolonged periods, or under more or less adverse conditions.

Smokeless powders of the types dealt with are all subject to deterioration, and there is very little doubt that this deterioration is for any given explosive a function of the temperature of storage. The higher the temperature the more rapid the deterioration.

The necessity, therefore, of some quantitative test which would enable a judgment to be formed as to the extent of deterioration suffered by any given sample of cordite is obviously of great importance, because such a test would afford the means of determining how much longer it would be safe to store any given batch of cartridges or lot of cordite at any given temperature. Any such test must be a heating test, and it must be possible to correlate the temperature and duration of the test with any given temperature and duration of storage. The rate of deterioration as a function of the temperature was determined by Dr. Will for guncotton, and later by Dr. Robertson at Waltham Abbey for nitroglycerine. From these and other experiments carried out at Waltham Abbey, a factor of increase in rate of deterioration of cordite with increase of temperature was deduced. This factor having been determined, what is known as the "silvered vessel test" was worked out at the Royal Gunpowder Factory. In this test, of which the details will be described presently, cordite is heated in a specially designed vessel at 80° C., a temperature not too far removed from those to be met with when cordite is stored under the worst service conditions, and the number of hours' heating at this temperature any given sample will stand before it shows signs of active decomposition are ascertained. Then, by means of an equation, containing the factor connecting rate of increase of deterioration with rise in temperature, a calculation can be made converting the hours of heating at 80° C. the sample withstood to years and fractions of a year it would stand at any given temperature of storage, and therefore a knowledge is obtained of how much longer it would be safe to store this cordite at any given temperature.

This test was applied to a considerable number of samples of known age and thermal history. From these data, and knowing the number of hours at 80° C. that newly made cordite of good stability will stand before showing signs of decomposition, the number of hours that the different samples should stand the test were calculated. When the samples were actually tested, the number of hours' heating at 80° C. they withstood were in close agreement with the number of hours it was calculated they should stand.

The form of vessel in which the heating is carried out is the well-known vacuum vessel of Sir James Dewar. A glass bulb silvered externally is enclosed in an outer bulb silvered internally. The space between the two is highly evacuated for the purpose of limiting the dissipation of any heat evolved by exothermic changes on the one hand, and on the other for the purpose of minimising the effect of accidental slight changes in temperature of environment.

In the centre of the inner bulb is situated the bulb of a thermometer, the stem of which passes through a cork in the neck of the vessel. A side tube is attached for the purpose of making observations on the colour of the gases evolved. For heating the vessel a bath is provided with cylinders closed at the bottom, and wide enough to admit the vessel to such a depth as the side tube will permit. The bath is surrounded by insulating materials. The vessels are packed in the cylinders with wool yarn, and the tops of the cylinders are closed with felt discs to exclude draughts.

The bath is fitted with a gas regulator or other means for securing that the temperature of the explosive is kept constant.

The cordite is coarsely ground, and 50 grams are used.

Readings of the thermometer are taken at intervals, and the time is noted when a rise of 2° C. in the temperature of the explosive above the temperature of 80° C. occurs. At the same time, visual observations are made as to the colour of the column of gas in the side tube, since it is found that, previous to the rise in temperature occurring, orange-coloured fumes of nitric peroxide are evolved. When the temperature exceeds 82° C. the test is complete, and the flask is withdrawn. The number of hours which have elapsed since the start of the test is the measure of the stability of the cordite.

Until about sixty years ago, the only explosive known for all purposes was gunpowder. With the discovery of guncotton and nitroglycerine, gunpowder was gradually replaced by them for blasting purposes. In their early days the two explosives were used singly, guncotton as guncotton, nitroglycerine—first of all alone—and then as dynamite. Later on the two were combined as blasting gelatine and explosives of a similar nature, but it was quite forty years after their discovery before either became of practical use for propulsive purposes.

The invention of "Poudre B" by Vieille marked the commencement of a new era in connection with the science of artillery, and it was not long before smokeless powders made from the violent guncotton, or of guncotton combined with the still more violent nitroglycerine, entirely superseded the centuries-old gunpowder. Modern explosives are characterised by very greatly increased power, giving enormously greater range to projectiles fired from both rifles and artillery, thus altering entirely the conditions of both land and naval warfare.

It is at present not easy to forecast in what direction further improvements in propellants will take place. It is also difficult to conceive what the explosive of the future will be which will produce a change as revolutionary as that which took place when smokeless powders superseded the old-fashioned black powders. For some time to come, probably, the manufacturer of explosives will have to content himself with endeavours to improve them as far as he can, both from a ballistic and from a stability point of view, with the ingredients now at his disposal.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. A. ROBINSON, professor of anatomy in the University of Birmingham, has been appointed to the chair of anatomy in Edinburgh University in succession to the late Prof. D. J. Cunningham, F.R.S.

IT is stated by the *Frankfurt Gazette* that the National Assembly of Iceland has decided to establish a university at Reikjavik, the capital of the island. The new university is to have four faculties, with sixteen professors and lecturers.

MR. EDWIN TATE has presented new library buildings to Battersea Polytechnic. The total book accommodation is 20,000 volumes. The cost of the buildings, including fittings, is estimated at about 6000*l.*, and the whole is being defrayed by Mr. Tate.

A CORRESPONDENT informs us that the appointments to the chairs of chemistry in the Technical High School at Munich have just been officially announced. The names of the various professors are:—organic chemistry, Prof. Semmler; inorganic chemistry, Prof. A. Stock; physical chemistry, Prof. R. Abegg. Each professor has an institute of his own, and Prof. Abegg retains, at the same time, his position as extraordinary professor in the University of Breslau. The Technical High School, which is being built at a cost of something like five million marks, is making good progress, and is to be opened officially in October, 1910.

THE commencement address last June at the South Dakota School of Mines, Rapid City, South Dakota, was delivered by the president of the Colorado School of Mines, Mr. Victor C. Alderson, who took for his subject "Artist or Artisan—Which?" "The artisan," he said, "understands machinery; the artist-engineer is a master of the kinematics of machines. The artisan works with his hands and lets his mind rest; the artist-engineer uses his brains to relieve his hands. The artisan becomes a skilled workman and no more; the artist-engineer sees beyond the mere machinery to the economic management of his plant, to the percentage saving possible, to the market for his product, to the efficient service of his employees, to the general success of the entire plant. To do all this he must have an ideal." Every young engineer, he proceeded to say later, should decide early in life whether he will become merely an artisan-engineer or an artist-engineer. Mr. Alderson then gave some inspiring advice to young engineers as to the physical, personal, intellectual, and moral characteristics they should strive to develop. Incidentally, he said the chance for the untrained or uneducated man to make a success in this age is practically *nil*. Taking "Who's Who" as a standard of national prominence in America, it is found, said Mr. Alderson, that it takes approximately 10,000 grammar-school pupils to produce one man worthy to be enrolled in "Who's Who." Of high-school students 250 suffice, while of fifty college graduates one will, on the average, rise to sufficient prominence to be enrolled in this book.

THE proceedings in connection with the celebration of the 500th anniversary of the founding of the University of Leipzig began on July 28, when a reception was given by the University to the representatives of German and foreign universities and learned societies invited to participate in the proceedings. On the following day a festival service in the University Church was attended by the King of Saxony. A commemorative meeting in the new theatre followed the service, and the King delivered an address and presented two medallions to the University to be worn in future by the rector of the University on his chain of office. The medallions bear images of the King of Saxony and of the founder of the University. The Saxon Minister of Education in an address afterwards outlined the history of the University. On July 30 further commemoration speeches were delivered. Prof. Wundt was the principal speaker, and during the course of his speech remarked, although the German people seem to be in the current of an intellectual movement in which the demand for higher education is hardly less strong than was the revival of learning in the Middle Ages, he said, in the words of Leibnitz, "It is the past which contains the future." Prof. Mahaffy spoke on behalf of the British delegates. The following honorary degrees were conferred among others:—Doctor of Medicine, Prof. E. B. Wilson, of Columbia University; Doctors of Philosophy, Sir Archibald Geikie, K.C.B., P.R.S., Prof. J. Loeb, of California University, Prof. J. Ward, of Cambridge University, and Mr. F. L. Griffith, reader in Egyptology, Oxford University.

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