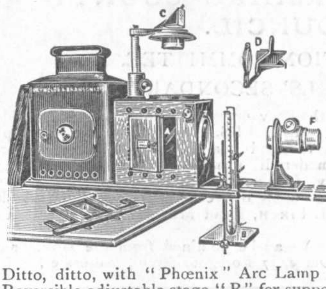
NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

NO. 2412, VOL. 96] THURSDAY, JANUARY 20, 1916 [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]



THURSDAY, JANUARY 20, 1916.

ARC LIGHT.

Electric Arc Phenomena. By Ewald Rasch. Translated from the German by K. Tornberg. xvi+194 pp. (London: Constable and Co., Ltd., 1915.) Price 8*s*. 6*d*. net.

THIS book surprises the reader by its extraordinary inequality: its excellencies in some directions and its absolute badness in others. Either the author, who is understood to be a professor at Potsdam, is amazingly ignorant of scientific and technical progress outside Germany, or else he suppresses the work achieved by discoverers in other nations. And his translator, who is apparently American, makes no attempt to remedy the very obvious limitations of the author: he not even attempts to reclaim for American pioneers in arc lighting—Elihu Thomson, Brush, Steinmetz, and more recent workers—the credit which is justly theirs. As for English investigators of the electric arc, they are almost all ignored except Mrs. Ayrton, whose work the author does not altogether understand, and Prof. Silvanus Thompson, to whom he gives more credit than that industrious person ever claimed. His historical methods are peculiar. For example, when referring to Davy's early accounts of his experiments on taking spark discharges from a voltaic pile between electrodes of charcoal—experiments which certainly did not begin before the invention of the pile in 1800—he quotes a passage in the first person from Priestley's "History of Electricity," so making Priestley, whose last edition was in 1794, responsible for Davy's words. Again, referring to the commercial impossibility of applying the arc for electric lighting so long as a battery of voltaic cells was the only available source, the author, oblivious of Holmes's success in establishing electric lights in lighthouses by means of currents generated by an alternator, oblivious, too, of Faraday's report and lecture thereon in 1862, makes the following absurd statement:—

"But it was not till seventy years later" [than Volta's discovery of 1800] "that the electric arc could become of practical importance as a source of light, when, thanks to the invention of the dynamo by Werner von Siemens, Hefner Alteneck, and others, a convenient and economical source was provided, which substituted electrodynamic action for the electrochemical action of galvanic primary cells."

It is true that in 1867 Werner von Siemens invented a particular form of dynamo, and that in 1873 Hefner Alteneck introduced modifications of the winding of armatures. These improvements scarcely justify such sweeping claims in their favour, or the ignoring of Wilde, Holmes, and Gramme. Again, it is foolish to claim for Davy, as the author does on p. 4, the employment of "a series resistance," and "the selection of a suitable voltage" to produce stable flame discharges. Some of the alleged facts as to arcs cause us to rub our eyes and wonder whether the author, who again and again quotes himself as having taken out various patents on arc lighting, has ever verified them. For instance, he alleges that heat conduction along the carbons is responsible for a waste of 79 per cent. of the energy supplied to the arc. Also he asserts (on the authority of Arons) the impossibility of maintaining an alternating arc between metallic electrodes on account of their great thermal conductivity—an assertion abundantly contradicted by the researches of Pfund, and arc-furnace experience. The author seems to think that the starting of an arc by any other process than bringing the tips of the carbons into contact and then parting them was unknown until he discovered other ways in 1899; and that these other ways are of an importance comparable with the usual contact method. His investigations on the possible use of kathodes consisting of hot metallic oxides and other solid electrolytes are doubtless a useful contribution to knowledge: but they scarcely justify his attitude towards Wehnelt.

On p. 11 the author declares that a stable arc is possible, and can be maintained, only when the kathode surface has a sufficiently high temperature: yet on p. 163 we discover that even comparatively cold liquids, aqueous solutions, and fused salts are excellent kathodes, and are capable of producing surprisingly beautiful arcs. His definition of an arc is as follows:—"Broadly speaking, one must designate as an electric arc any continuous discharge occurring between electrodes of different potential and serving as a source of light, where at least one of the electrodes—the kathode—is kept at a high temperature either by the current passing or by auxiliary means." According to this definition a Duddell arc which serves, not as a source of light, but as a generator of oscillations, is not an arc. The author states that the anode crater acts, "in a sense," as a reflector upon which the kathode radiates its heat. Since the crater anode is hotter, and emits twenty times as much light as the tip of the kathode, its action as a reflector can only be admitted in a very special sense indeed.

The instructions which the author gives on pp. 19–21 for adjustment of the arc seem to miss some essential points. The advice to try always to adjust the arc "by means of the series resistance alone" is ambiguous. To adjust the arc to normal length, and to adjust the arc to take the correct current, are two different matters, and require recourse to different means.

There is an extraordinary dictum on p. 39:—"The close relation between the specific heat of a luminous layer and the radiation thereof is evident, since the efficiency of a luminous body increases rapidly with its temperature." This betrays a strange confusion of thought. The specific heat of a substance is indeed of importance during the period when its temperature is rising. But when the high temperature of incandescence has once attained its steady value, the specific heat of a material has *per se* no more influence on its efficiency of radiation than has its price in the market.

In dealing with Mrs. Ayrton's careful investigation of the relations which subsist in the continuous current arc between arc length, current, and potential difference across the arc, the author is often obscure. He seems to have no grip of the distinction between a dependent variable and an independent one. Thus it appears from Mrs. Ayrton's work that if a current of 10 amperes is passed through an arc (using solid carbons) 5 millimetres long, the arc voltage is about 56 volts, and remains at that figure if length and current are maintained constant. Also that if a current of 8 amperes is passed through an arc 4·5 millimetres long, the arc voltage is still 56 volts. But though the voltage thus appears to be constant, it does *not* follow that on a circuit maintained at 56 volts the current will adjust itself to 10 amperes if the carbons are set to a distance of 5 millimetres. On the contrary, assuming that these values could be momentarily attained, the current would at once increase a little, thereby lowering the resistance of the arc, and with lowered resistance the current would increase still more, and the rush of current will be enormous unless a steadying resistance is introduced into the circuit. The phenomena are perfectly well known, but the interpretation might be more clearly stated if it were plainly recognised that the arc voltage is *not* an independent variable. Incidentally the author points out that J. Stark has shown that spark discharges of not too great length follow a law of the same form as that which Silvanus Thompson gave for the arc, namely $e = m + C/I$; where m is the voltage for minimum length and C the watts per ampere, which for given materials is nearly constant.

The author devotes several pages to the theory of stability of the arc, and comes to the strange conclusion that for every (carbon) arc there is a maximum potential difference across the arc beyond which the arc will extinguish itself, namely that which is exactly half-way between the minimum voltage (about 36½ volts for carbon arcs) and the voltage of supply. If this is true then on 100-volt mains the maximum possible voltage would be 68¼ volts, and the efficiency necessarily limited to 68¼ per cent. Another strange conclusion is that the numerical values obtained by Mrs. Ayrton for the carbon arc are valid only in connection with the particular generator which she used! The author repeats, in the chapter on the distribution of energy in the arc, the opinion that for electrodes the substances used should have a low specific heat, declaring this to be "a physical quantity of paramount importance on the luminous efficiency" of glowing solids, and saying that this accounts for the high efficiency of the osmium lamp. It is difficult to attach a coherent meaning to this, or to the statement (p. 124) that "when an arc increases in length its cross-sectional area does not remain constant, as Ohm's law presupposes." Why should Ohm's law presuppose any such nonsense? The author claims for Bremer in 1899 the utilisation of the introduction into arc carbons of metallic salts that colour the arc, and hints not obscurely that he himself was the discoverer of this property in 1892. He ignores the circumstance that Gaudoin published accounts of this manufacture in 1875.

The author interpolates in the chapter on the distribution of energy in the arc a diatribe against Maxwell's electromagnetic theory of light—"a theory long since exploded"—which "has never been productive of the least progress in the theory or technology of light generation." He lauds Minkowski's four-dimensional theory of relativity. He sets up Weber as advocating Newton's corpuscular theory of light, and claims "as a matter of national pride" to point out that the Germans Weber and Planck have corrected the inaccuracies of those who attempted to apply Maxwell's theory to experimental facts. Everyone who advocated the undulatory theory of light was, it appears, wrong.

"This strife could easily throw a dismal light on the great of our nation. Blind animosity has characterised this combat, surcharged with malice. Even Goethe has taken part therein, as is evident by the very way he mentions the name of Newton."

We can only ask, and in a double sense, *is he dead?*

"VIGOUR" AND "INSTINCT."

(1) *Vigour and Heredity*. By J. L. Bonhote. Pp. xii+263. (London: West, Newman and Co., 1915.) Price 10*s*. 6*d*. net.

(2) *Instinct and Intelligence*. By N. C. Macnamara. Pp. 216. (London: Henry Frowde and Hodder and Stoughton, 1915.) Price 6*s*. net.

(1) IN his experience as a breeder and naturalist Mr. Bonhote has been confronted with the difficulties presented by many of the facts of inheritance. Mendel's law holds good in some cases, Galton's law in others, but many facts seem unconformable, and a consideration of these has led him to a theory of "vigour." By vigour he means "activity of nutrition and function" or "the rate of metabolism," and his theory is that the "initial vigour" of an organism, which in part determines the expression of its inheritance, depends upon the vigour of the parents at the time of reproduction.

The author is in error in thinking that "we have no method of definitely ascertaining or measuring the rate of metabolism," for we can use the absorption of oxygen or the output of carbon dioxide as an index. In default of this, an attempt is made to estimate vigour indirectly "by actions, colour, and condition," and this means slippery ground on which the author does not always keep his feet. By a multitude of interesting illustrations, however, he seeks to show that temperature, humidity, and food supply influence vigour, and through vigour coloration. Thus colour becomes "our best and at the present time our chief index of vigour." It is plain, however, that a brief intensity of metabolism might lead to an abundant production of pigment, and that the organism might thereafter settle down to a humdrum sluggishness indicative of anything but vigour.

Mr. Bonhote adopts the reasonable view that a radical physiological difference in metabolism distinguishes the sexes, but he states the idea too crudely when he simply calls the male katabolic and the female anabolic. According to "The Evolution of Sex" (1889), to which he refers many times, the fundamental physiological difference between the sexes lies in the *relative* predominance of anabolism or katabolism in the metabolic processes. Constructive processes, notably those that have to do with the upbuilding of proteids, must, of course, always exceed disruptive processes so long as the organism continues to be a going concern, but the "Evolution of Sex" thesis was that the *ratio* of anabolism to katabolism is characteristically greater in females than in males, and conversely. Mr. Bonhote prefers to conceive of the fundamental difference as depending on the *rate* of intensity of metabolism, and unfortunately he sometimes uses the concept of metabolism too narrowly (*e.g.*, on p. 244), as if it had simply to do with assimilation processes. In this connection it may be noted that, according to the author, high vigour in the parents tends to a predominance of females among the offspring (though the opposite seems to have been inadvertently stated in the last sentence of chapter v.).

The central idea of the book is that the environment in the widest sense affects vigour (defined as rate of metabolism), that the vigour of the parents at the time of reproduction "is reflected to a greater or less extent in the vigour" (here used in a rather different sense!) of the sex-cells, and therefore in the vigour of any determinant in the inheritance. The development of characters is thus influenced by the vigour of the parents, and also, the author maintains, by the nurture (in the widest sense) of the developing individual. Mr. Bonhote knows that he has not proved his theory, and we are afraid that it will not admit of proof until its terms are made more precise, but attention must be directed to the hundred pages in which the author describes his breeding experiments, conducted *con amore* and under difficulties, on goats, cats, rats, pigeons, and ducks (of which there are three very fine plates), and expounds without any dogmatism the facts that have led him to the conviction that environment affects the physiological condition of the parent, and may have some influence on the characters of the offspring.

(2) Dr. Macnamara takes an interesting survey of the chief modes of animal behaviour, and shows how much there is—from amœba to man—that deserves to be called purposive, though it cannot be called intelligent. In the higher animals the hereditarily engrained instinctive capacities have their seat in the basal ganglia, while the intelligent capacities are localised in the upper regions of the cerebral cortex, notably in the "neopallium" of mammals. The author's thesis is that in human education too little attention is given to the phylogenetically older instinctive impulses and emotions, and relatively too much to trying (not very successfully) to train the intellect. What he advises is that more care should be given to discovering what in each child are the strongest instinctive qualities and adjusting the education thereto; that teachers should know more about the physiology of the nervous system; that there should be more sensory experience at a high level; that exercises in control should be devised;

and that the instincts should be linked on to reason and the finer feelings so that the best in us may inhibit the worst.

The author makes a useful biological contribution to the problem of education, and has a wholesomely strong faith in the importance of "nurture," in the widest sense, in developing the individual's hereditary "nature." We would point out, however, that while Dr. Macnamara starts with Lloyd Morgan's clear-cut conception of instinct, he does not consistently adhere to it, and often uses the term instinctive very loosely; that he seems at times to exaggerate the separability of instinctive and intelligent faculties in children, for they seem to us to be very intimately blended; and that he gives glimpses of a quite untenable theory of energy overflowing or irradiating from one part of the nervous system to another so as to maintain a state of equipartition.

Dr. Macnamara was investigating and writing half a century ago, and we do not wonder that he has overlooked a number of typographical errors, such as "philogenetic," and "exasperating sway" (of women) instead of "way," but he should not have passed a sentence like this:—"The Hydromedusæ present two main forms, the non-sexual polyps or Hydra, and the sexual Medusæ, such as jelly-fish and sea anemones." Here there are at least three mistakes. Nor can we accept the statement that the male stickleback cements grass-stalks together with a layer of mucus exuded from the surface of his body.

INTRODUCTORY TREATISES ON MECHANICS.

(1) *An Introduction to Applied Mechanics.* By E. S. Andrews. Pp. ix+316. (Cambridge: At the University Press, 1915.) Price 4*s.* 6*d.* net.

(2) *An Introduction to the Mechanics of Fluids.* By Prof. E. H. Barton. Pp. xiv+249. (London: Longmans, Green and Co., 1915.) Price 6*s.* net.

(3) *Experimental Physics: A Text-book of Mechanics, Heat, Sound, and Light.* By Prof. H. A. Wilson. Pp. viii+405. (Cambridge: At the University Press, 1915.) Price 10*s.* net.

WRITERS of mathematical text-books on mechanics and of so-called applied mechanics have still much to learn from one another. A too excessive abstract and logical development of the subject by the one tends to make the student lose the sense that it deals with real things; while evident striving for ultra-practicality by the other, and the looseness and inaccuracy of statement often combined with it, irritate him. On the one hand the ordinary student is bored, and on the other puzzled to death. For the difficulties which the industrious student of average ability experiences are more frequently than otherwise due to the fact of his having too logical and clear a mind, or rather perhaps to possessing a mind which requires logical presentment. To a certain extent the three books before us illustrate the above remarks in one direction or the other.

(1) That the first author would generally agree with them is apparent from his remarks in the preface that the older form of text-book was too much a kind of exercise ground for algebraic manipulation, and that many of the more modern give too much engineering application of the principles without sufficient explanation of those principles. And yet in reading through his attempt to strike the happy mean, one is constantly meeting statements which, though not quite wrong, are certainly not quite right. The following are a few samples. On p. 18 the principle of moments follows from Newton's first law of motion, because, since it does not change its state of rest, there is no tendency to rotate about any point. Two pages before it was given as a definition that this tendency is measured by the moment. It requires some thought on the part of the student to find that really he has been deceived into thinking that the principle is proved. On p. 17, "so long as we deal with forces in one plane, moments are scalar quantities." The student is brought to a stop with the query why the scalarity of the moment of a force should depend on the nature of other forces with which it has nothing to do. (Owing to an oversight also here the example given does not agree with the direction of the forces in the diagram.) On p. 40 "we may point out that when in ordinary parlance we speak of power we really mean energy." On p. 139 "stress may be defined as the force between the molecules of a body brought into play by the strain." On p. 124 "inertia is the property of a body which resists a change of motion" recalls Maxwell's classical illustration of this statement by a cup of tea resisting being sweetened by the sugar put into it. It is difficult to see what object is gained by the elaborate drawing of a steamboat on p. 45, or of a traction engine and track on p. 127.

In spite of these defects, the book can be recommended for use by engineering students. The substance is well chosen and the treatment adequate. A student who has mastered it should have a good working knowledge of the dynamical principles underlying every engineer's work. The first eight chapters are an introduction to dynamical principles. Chapters ix.–xii. deal with stresses and strains in joints, frames, and girders; chaps. xiii.–xv. with centres of gravity, friction, and curved paths; and the last with mechanisms.

(2) This introduction to the study of fluids is intended "for candidates for entrance scholarships and other examinations, for naval and military preparation, for those technical students taking the Board of Education lower examination in theoretical mechanics (fluids), or any of a similar character held by the various provincial educational unions." For these purposes it would seem to be an adequate and sound presentation of the subject. In addition, it will also serve to give the student a sound knowledge of the subject—a result almost as important. Part i., on the mechanical basis of the subject, might possibly have been omitted with advantage as the majority of students would come to the study of fluids with a preliminary knowledge of dynamics from other sources. The succeeding parts deal with liquids at rest, in motion, properties of gases, and finally with applications. This last contains a valuable addition to the usual list of old friends, and deals with a number of recent inventions of special interest as illustrating principles. The book affords an excellent example of the combination of logical development and exactness of ideas with the stimulating effect aroused by dealing with real problems.

(3) The scope of this book is best shown by the following extracts from the preface. "This book is intended as a text-book for use in connection with a course of experimental lectures." "The aim of the writer should be to present fundamental principles clearly and accurately." "I have endeavoured to leave out everything not of fundamental importance." "The kind of text-book which contains a little about everything does more harm than good." It is thus seen how much the intention of the author differs from that of the generality of writers of text-books for first year and elementary students. The result is a very clear and excellent introduction to the subject of mechanics, properties of matter, heat, sound, and light, suitable to the needs of university students in their first year and taking curricula for pure science, medicine, or applied science. It is a book for which examinations should be suitable, laying sound foundations for future developments in greater or less degree as may be required for the more specialised curricula of the second and third years. Where an effort has been made to circumscribe the field, differences of opinion may arise as to whether it may not have been carried too far, but each individual teacher can always remedy this in the case of his own students. For example, it may be doubtful if it is desirable to leave out all consideration of radiation or whether more application of principles to explain common and everyday experiences might not have been given with advantage—in spite of the fact that to the author such things may be hackneyed.

No sets of examples for exercise are given. This is a disadvantage for private students. Any competent teacher giving a course of experimental lectures will have his own selection. To such the book can be confidently recommended. It has the good paper, printing, and clearness expected from the Pitt Press. It is curious to see in a book printed in an English University a statement that thermometers may be standardised by sending them to the Bureau of Standards at Washington, U.S.A., or similar institutions in other countries. In another edition the explanation of the total reflection of the ordinary ray in a Nicol's prism should be amended. Also the melting-point of sodium thiosulphate ("hypo") is not 9·9° C.

OUR BOOKSHELF.

A Course in Invertebrate Zoology. A Guide to the Dissection and Comparative Study of Invertebrate Animals. By Prof. H. S. Pratt. Revised edition. Pp. xii+228. (Boston and London: Ginn and Co., 1915.) Price 6*s*.

THIS book is intended as a guide to the study of each of the larger groups of invertebrates. About forty animals are considered in the space of 196 pages, consequently the descriptions of many of them—clear so far as they go, and accurate, the lapses being few and of little moment—are brief, though several, *e.g.* the squid, are more fully treated. The chapters deal respectively with the arthropoda, annelida, flat worms, polyzoa, mollusca, tunicates, echinoderms, Cnidaria, sponges, and protozoa. The revised edition contains instructions for the examination of six types not included in the first edition, namely, a fly, spider, oyster, sea-cucumber, Gonionemus, and a sea-anemone. In the account of the fly attention is directed to the "antennæ, with their pinnate terminal portion" (the portion referred to—the arista—is, however, not terminal but dorsal), but the palps are not mentioned, and no attempt is made to elucidate the structure of the proboscis.

In the classification given in the appendix the sponges are classed with the Cnidaria as cœlenterates—implying a relationship which modern work has shown to be untenable; another obsolete feature is the retention of the "phylum" Vermes to include a heterogeneous assemblage of animals —flat and round worms, rotifers, polyzoa, brachiopods, Phoronis, Chætognatha and Sipunculoidea (the annelids are placed in a separate phylum).

Vicious Circles in Sociology and their Treatment. By Dr. J. B. Hurry. Pp. 34. (London: J. and A. Churchill, 1915.) Price 2*s.* net.

THIS little book, planned on the lines of the author's "Vicious Circles in Disease," is intended to emphasise that, just as in disease, so in social life, various pernicious factors are at work which act and react upon one another, constituting a "circle." Thus crime leads to loss of employment, which leads to loss of means of subsistence, which again begets crime, and tuberculosis leads to poverty, and poverty is a potent factor in the causation of tuberculosis. The author recognises ten such circles met with in sociology, and while they may act separately, several of them may be in simultaneous operation, *e.g.* poverty, uncleanliness, overcrowding, alcoholic indulgence, and disease. The remedy is to break the circle, and according to the author "the first task of the sociologist is to extricate from the symptom-complex those dominant factors that constitute the circle, to discover the weakest link in the unending chain, and to effect a breach at the point of least resistance." The book should be of service to the social worker in assisting him to analyse social problems into their constituent factors, and the references to standard authorities which have been freely introduced will likewise be helpful.

Willing's Press Guide and Advertisers' Directory and Handbook, 1916. Pp. xii+487. (London: James Willing, Ltd.) Price 1*s.*

THIS concise and comprehensive index to the Press of the United Kingdom, as a sub-title describes it, this year reaches its forty-third issue. It is as useful as ever. The classified list of periodicals arranged under subjects is particularly useful. The lists of the principal Colonial and foreign journals add greatly to the value of the compilation.

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.*]

Instruction in Science for Military Purposes.

IN a special war lecture on "Field Telephones," delivered before the Royal Socity of Arts on July 28, 1915, I pointed out how the services of science teachers might be utilised with advantage in training all ranks of our new armies in this important subject. Although in isolated cases work of this kind has been carried out, and highly appreciated by the military authorities, no general scheme of instruction has yet been adopted. As the urgent necessity of such instruction does not appear to be realised, a statement of the present conditions regarding facilities for training in science as applied to military purposes may be useful.

The only officers in the British Army who receive a scientific training are those belonging to the Royal Engineers and the Royal Artillery, who are attached to the regular Army. Some who obtain direct commissions in these branches receive instruction at the Ordnance College, Woolwich, at Chatham, or elsewhere; but this is by no means general. For the cavalry and infantry officers practically no facilities exist. It does not appear to be generally known that the teaching of science at Sandhurst was abandoned many years ago, and even yet has not been resumed. The result is that the greater portion of the British Army is engaged in conducting a war in which scientific knowledge is essential, without its officers having the opportunity of studying some of the most important matters relating to their duties. The circulation of pamphlets dealing with special points cannot be regarded as a substitute for proper tuition, yet it is practically the only means at present employed. It is with a view to remedying this deplorable state of things that this letter is written.

At the meeting of the Association of Public School Science Masters, held on January 5, Mr. C. L. Bryant, of Harrow, presented a scheme for the instruction in military science of boys who were receiving commissions directly from school. The subjects to be taught were suggested by the Director of Military Training in the subjoined letter:—

WAR OFFICE,
November 19, 1915.

To the SECRETARY OF THE ASSOCIATION OF PUBLIC SCHOOL SCIENCE MASTERS.

SIR,—I am directed to inform you that your offer to train future officers in various subjects is very much appreciated.

I am also requested to inform you that the War Office is not in a position, and is not likely to be in a position, to render any assistance in the provision of funds, equipment, or instructors. Subject to these restrictions, it is suggested that the training should consist of the following subjects:—

EXPLOSIVES.—The nature of various explosives in use—methods of firing charges—care in handling—detonators—fuses—methods of lighting fuses—grenades.

TELEPHONES.—Detection and mending of breaks in cables—laying of lines—remedying faults in receivers and senders—reading and sending on the buzzer.

POISON GASES.—Methods of combating same—first aid to men suffering from same.

RANGE FINDING.—Methods of taking range.

I am to enclose a manual, "Guide to Instruction in the use of Grenades," and to recommend that instruction in other subjects be from the Manual of Field Engineering, from the Training Manual, Signalling, as regards Telephones and from the Musketry Regulations as regards Range Finding.

I am to add that every possible assistance will be given to you, but that this department cannot undertake to communicate with all the Public Schools.

(Signed) F. C. HEATH-CALDWELL,
Director of Military Training.

Working on this basis, a syllabus was drawn up by Mr. J. Young, of the Royal Military Academy, Woolwich, and Mr. Bryant, to which the present writer contributed a few suggestions. This work has already commenced at Harrow and a few other schools, and it is sincerely to be hoped that every school will follow on the same lines without delay. The instruction, however, should also extend to boys about to enter Sandhurst, as such will not have an opportunity of studying the first three of the above subjects in a proper manner after leaving school. By avoiding extraneous matters, a single term's work will suffice, even in the case of beginners, to impart a mass of information of the highest practical value. It seems almost incredible that at the present time boys who receive commissions immediately on leaving school are devoting their time to the dead languages, and enter the Army without a scrap of scientific knowledge. Any headmaster who permits this state of things to continue is an enemy both to the boys and to his country.

One difficulty to be encountered is that many science teachers may not be familiar with the matters covered by the syllabus; but by reference to the publications recommended, supplemented by a further list compiled by Mr. Bryant, they will soon acquire the necessary information. No diffidence need therefore be felt on this score; and the teacher who adopts the scheme will have the satisfaction of knowing that he is rendering the highest service to his country.

Work in public schools, however, is only one aspect of the question. There are at present in our armies hundreds of officers who stand in need of instruction, and non-commissioned officers and picked men must also be considered. It is here that our universities, colleges, and technical schools may do invaluable work. It is not possible in these cases, owing to considerations of time, to treat the subjects in the same detail as with boys at school or at Woolwich. From my own experience, however, I can confidently state that twenty hours' tuition, devoted solely to the subjects named, will give any intelligent beginner a grasp of the matters under notice, sufficient to enable him to apply his knowledge to his duties, and so to increase in competence with practical experience. Work of this character has already been conducted with success at the Finsbury Technical College, the Northampton Institute, Clerkenwell, and the Norwich Technical Institute; and if made general throughout the country an incalculable amount of good might be done. At the present juncture, the War Office could not be expected to organise such a scheme, and everything must therefore depend upon the initiative of the individual teacher. To start a class he should approach the officer commanding troops stationed in his locality with an offer to give instructions on the lines suggested by the Director of Military Training. An arrangement may be arrived at for a number of officers, N.C.O.'s, or selected men to attend at specified times; twenty being the average number who may be dealt with to advantage. The teacher must expect neither financial reward nor official recognition, nor assistance in the matter of equipment. Everything will depend upon his own voluntary efforts.

With regard to a syllabus for intensified instruction of this kind, details of apparatus, and sources of special information relating to the subjects taught, I should be pleased, subject to the consent of the editor, to supply these through the columns of NATURE, provided a demand should exist. I appeal most earnestly to all teachers of physics and chemistry, in the interests of the country, to take up this work without delay. One class will suffice to bring home to a teacher the good he can do at the present crisis. With the view of organising future work on the most effective lines I should be glad if all who commence classes would notify me, stating the subjects taught.

We are at present devoting all our attention to the quantity of men in our armies, forgetting that quality is at least equal in importance, and that science alone can prevail against science. Speaking at the recent meeting of Public School Science Masters, an officer returned from France stated that "to his own knowledge hundreds of lives had been needlessly lost through the lack of information that should be in the possession of every officer." It lies within the power of the science teachers of England to impart a portion, at any rate, of this much-needed knowledge; and it cannot be questioned that a united effort on their part, if promptly made, would be of inestimable service to their country.

CHAS. R. DARLING.
City and Guilds Technical College,
Finsbury, E.C.

A Relation between Atomic Weights and Radio-active Constants.

CONSIDER the group of chemically identical (isotopic) elements:—

	Approximate atomic weight	Range of α particles
Radium A ...	$\omega=218$ ...	$a=4\cdot50$ cm.
Thorium A ...	216 ...	5·40
Actinium A ...	214 ...	6·16
Radium C′ ...	214 ...	6·57
Thorium C′ ...	212 ...	8·16
Polonium (Ra. F)	210 ...	3·58

If $\log \omega$ be plotted against $\log \alpha$ the points will be found to lie along a straight line:—

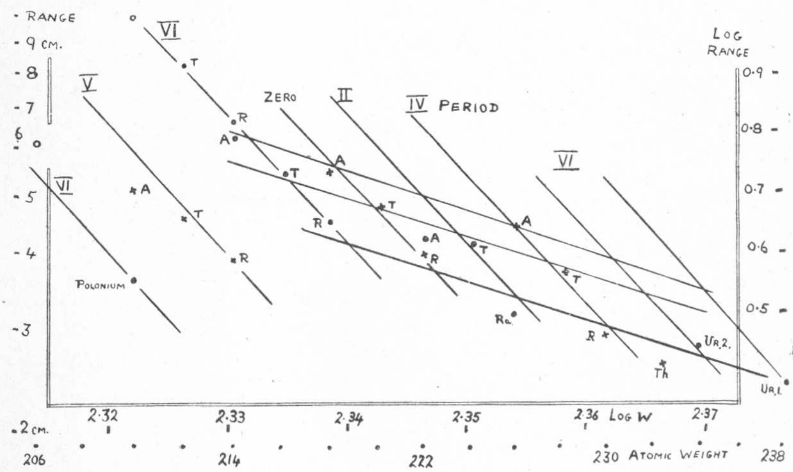


FIG. 1.—The radium elements are all marked R. The thorium elements are all marked T. The actinium elements are all marked A.

The two circles are the exterpolated points referred to in the text.

Fig. 1 shows log a for all the known a-ray elements, as follows:—

Dots.	Period VI.	Uranium 1 (atomic weight 238). Uranium 2 (234).
Crosses.	Period IV.	Thorium (232). Actinium (230). Radio Thorium (228). Radio Actinium (226).
Dots.	Period II.	Radium (226). Thorium X (224). Actinium X (222).
Crosses.	Zero Period.	Emanations from Radium (222). Thorium (220). Actinium (218).
Dots.	Period VI B	Radium A (218). Thorium A (216). Actinium A (214). Radium C′ (214). Thorium C′ (212). [Actinium C′ 210 unknown.]
Crosses.	Period V B	Radium C (214). Thorium C (212). Actinium C (210).
Dots.	Period VI B	Polonium=Radium F (210). [Possible actinium element. 206.]

Though some of the lines are somewhat straggling, still each group of isotopes gives a line, and the lines are approximately parallel and equally spaced. The range is thus universally proportional to about the 21st power of ω in each case. Moreover, the groups follow one another in a rational order, Period No.

VI. of the periodic table being followed by Nos. IV., II., and zero, and then by Nos. VIB and VB.

In period VIB polonium appears to be the starting-point of a new line, the thorium and actinium elements of which are still unknown. No further products of Act C are known corresponding to the polonium branch of the radium series, and Act C′, if it existed, should, by Fig. 1, have the record range of about 10 cm. About 0·17 per cent. of the Act C rays are, however, said to have a range of 6·1 cm., which would be fairly suitable to an element of at. wt. 206 on a line drawn parallel to the others on Fig. 1 starting from polonium.[1]

It is specially noticeable that to make the actinium points lie on the same lines as the corresponding radium and thorium elements, its atomic weight must be reckoned in every case from actinium = 222 instead of 226. This means that the actinium series branches off from the uranium stock at Ur(2) instead of at Ur(1). Either scheme is equally allowable, but no evidence has hitherto been brought forward to decide between them.

Another set of lines can be drawn on Fig. 1, one through the actinium points, one through the thorium points, and the lowest through the uranium elements. The latter are, however, very scattered, and include thorium itself amongst them. The lines do not go beyond the "A" elements.

These relationships were detected from noticing first the evident family resemblance between the γ rays in the isotopic groups. For example, in period IVB we have:—

	"K" Series		"L" Series		Soft Rays		β Rays
Ra B	0·19	...	147	...	85	...	75
Th B	0·13	...	11·8	...	59	...	110
Act B	0·17	...	11·5	...	44	...	—
Ra D	0·36	...	16·7	...	—	...	130
Lead	—	...	17·4[2]	...	—	...	—

Among the β rays something of the sort is noticeable, μ generally falling with increasing atomic weight, but for the very soft (β) rays μ is directly proportional to the 33rd power of ω.

F. GILBERT CARRUTHERS.

December 14, 1915.

The Naming of Earthquakes.

AN earthquake is usually distinguished by the name of the town, province, or country, near or within which it originates, and by its date—the double nomenclature serving to determine its position in space and time. With regard to the latter element, absolute uniformity prevails. The year, month, and day are always given, except for great and long-past earthquakes, for which the year only is sufficient. My object in this letter is to suggest the desirability of similar uniformity in the use of the place-name.

Nearly all seismologists have a different standard for earthquakes of their own country and for those of distant lands. An Italian, for instance, will speak of a Benevento earthquake or a Neapolitan earthquake, but also of an Indian earthquake, or even of an Asiatic or Pacific Ocean earthquake. Temporarily, no doubt, the use of the country's name is convenient; but, as every country contains many seismic regions, its continuance is undesirable. Even in the same country various methods prevail. Thus, Indian seismologists describe a Bengal, a Kashmir, and a Kangra earthquake.

These variations in nomenclature are clearly inconvenient. On the one hand, different names are given to the same earthquake. Thus, one may be called the East Anglian, the Essex, or the Colchester earthquake; another the Indian, the Assam, or the Calcutta earthquake. On the other hand, the same name is applied to earthquakes with different origins. In the writings of Italian seismologists, the terms "Calabrian earthquake" is of frequent occurrence. As a family or generic name it is useful, but it groups together earthquakes which belong, as Dr. M. Baratta has shown, to eleven different seismic zones. Thus the six great earthquakes of the Calabrian series of 1783 affected in succession the Palmi, Scilla, Monteleone, Messina-Scilla, Monteleone, and Girifalco zones, and might with advantage have been designated by their names. Again, the earthquake of 1638 occurred in the Nicastro zone, that of 1659 in the Monteleone zone, that of 1836 in the Bisagnano zone, that of 1854 in the Cosenza zone, that of 1894 in the Palmi zone, and that of 1907 in the Gerace zone. These earthquakes, in like manner, might be named after the corresponding zones. To this rule, however, there must be occasional exceptions. For instance, the earthquake of 1905 originated in five zones, and it would be out of the question to call it the Palmi-Monteleone-Nicastro-Cosenza-Bisagnano earthquake of 1905. When the epicentre covers so large a part of a province, it establishes a claim for this earthquake to be known as the Calabrian earthquake of 1905.

While adhering so far as possible to prevalent customs in naming earthquakes, and especially adopting those assigned to them by their principal investigators, I would suggest that the choice of names should be determined by the following principles:—

(1) Old and obsolete names of districts, such as East Anglian, should be avoided, as conveying little or no impression of locality to foreign seismologists.

(2) Names of valleys, hills, seas, lakes, or other physical features should not as a rule be used, with perhaps occasional exceptions, such as Exmoor or Ochil, when there are no prominent towns or villages in the neighbourhood of the epicentre.

(3) Names of islands as geographical terms may, however, be usefully employed when the islands are small (as Zante), or perhaps large and not well known (as Formosa), but not when they are large and well known (as Jamaica). Thus, it would be more convenient to speak of the Ischian than of the Casamicciola earthquake, and of the Kingston and Port Royal than of the Jamaica earthquakes.

(4) Whenever possible, the name of a prominent or well-known town near the epicentre should be applied. The term Charleston earthquake, for instance, is more descriptive than the Woodstock-Rantowles earthquake, though these places are much closer to the double epicentre.

(5) If there is no large town near the epicentre, the name of a small town or village (with that of the province or county added in brackets) may be used with advantage, such as the Viggianello (Basilicata) earthquake of 1894, or the Strontian (Inverness-shire) earthquake of 1902.

(6) When the epicentral area is of considerable size, the name of a single town ceases to convey the desired impression, and the names of many places would be cumbrous. Thus, an earthquake with an epicentral area at least 290 miles in length deserves the name of Californian rather than that of San Francisco. An earthquake which originates in five seismic zones, which are often disturbed separately, is, as already mentioned, suitably described as a Calabrian earthquake.

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[1] With such a short range of ω it is not easy to distinguish log ω from a. For convenience, ω and a are both shown on this scale, as well as log ω and log a.

[2] The figure for lead is for the characteristic X-ray.

ORIGIN OF GREEK TRAGEDY.[1]

THE object of this, Prof. Ridgeway's latest contribution to the early history of the stage, is to expand and reinforce with additional evidence the thesis which he formulated in his "Origin of Tragedy," published in 1910. The doctrine of this earlier work asserted that the drama of the Greeks was not, as had hitherto been supposed, derived from the cult of Dionysus, but was based on the worship of the dead, and reflects the primal tragedy of human life. In order to secure this position it was necessary to controvert the theories of two allied schools of interpretation of primitive religion, and, as often happens, the constructive part of the work is inferior in interest to the polemical, when the attack falls into the hands of a critic so acute, learned, and witty as the writer.

In dealing with the school represented by "The Golden Bough," Prof. Ridgeway begins by stating that "it is with extreme reluctance and with genuine sorrow that I have found myself compelled to differ on this fundamental question from one of my oldest and best friends." The gulf fixed between Sir James Frazer and himself is, indeed, great. The former holds that vegetation spirits and the phenomena embraced under the term Totemism are primary and absolutely independent of the belief in the existence of the soul of man after the death of the body. Prof. Ridgeway, on the other hand, asserts that vegetation spirits and Totemic beliefs are merely secondary phenomena, all depending on the primary belief of mankind in the continued existence of the soul after the death of its carnal covering. He rejects the famous explanation of the Nemi story, which he holds to be largely based on suppositions and suggestions. The priest of the Arician grove is not the personification of the oak, which is not the sacred tree at Olympia, the centre of the worship of Pan-Hellenic Zeus, but derives its sanctity from its association with a death cult, the worship of Egeria suggesting that honour was paid to the burial place of the Egerii.

[1] "The Dramas and Dramatic Dances of Non-European Races in special reference to the Origin of Greek Tragedy." By Prof. W. Ridgeway. Pp. xv+448. (Cambridge: At the University Press, 1915.) Price 15s. net.

The attempt of Sir James Frazer to account for dramatic performances by the dramatisation of the seasons is also necessarily rejected; magic is not antecedent to religion; and with the abandonment of the vegetation hypothesis goes the doctrine of Dr. Farnell that dramatic performances of this type are primitive, and antecedent to dramas based on human life. The criticism of the school represented by Miss J. E. Harrison and her fellow-workers, Prof. G. G. Murray and Mr. F. M. Cornford, who postulate the Eniautos Daimon and heroes as a projection from certain *choses sacrées*, is even more drastic. An important part of the material adduced to support the supremacy of ancestor worship as the basis of primitive cult and belief comes from India, and

FIG. 1.—Scene in a Rama play: Ram Chandra and Lakshmana. From "The Dramas and Dramatic Dances of Non-European Races."

the euhemeristic views of the late Sir A. Lyall, which regard most of the gods of Hinduism as deified men, are fully accepted. The *mana* of Dr. Marett resolves itself into a development from relic worship, and his dogma that religion develops from the undifferentiated to the differentiated is criticised on the ground of the complexity of savage society, and in particular its highly developed system of relationship.

It would be premature to discuss these positions, which are still the subject of acute controversy, and the forces now on the defensive may be in a position to make a successful counter-attack. This much may be said: while Prof. Ridgeway has doubtless succeeded in proving that the cult of the dead has exercised potent influence on the development of drama—indeed, his leading opponent, Prof. Murray, admits that "it can be shown that every extant tragedy contains somewhere towards the end the celebration of a *tabu* tomb"—many will hesitate to refer such a complex as dance and drama throughout the world to a single concept; and, to take India alone, Sir A. Lyall's view, which excludes the cult of spirits other than human, leaves unexplained the devotion to Siva, who was in origin a storm god, later developed into a deity of fertility, or to the still potent spirits of mountain, river, or spring.

FIG. 2.—The Buffoon (*Tchou*). From "The Dramas and Dramatic Dances of Non-European Races.'

We have almost exhausted our space in discussing the important problems raised in the introductory chapter, in which the learning, acumen, and wit of the author are conspicuous. The material on dance and drama among barbaric and savage races is of the highest value, and must be studied by all future historians of the stage. The facts from India, due to help received from Sir John Marshall and the staff of the Archæological Survey, are of special interest, and the fine collection of photographs taken for this work is admirable. Two of the illustrations are here given, by the courtesy of the publishers. When we are told that the Shiah form of Islam is dominant in India, it may be pointed out that though this sect is more active and fanatical than that of its rivals, the Sunnis, the latter holds a decided numerical superiority. It is to be regretted that the proofs of the chapter on Hindustan were not read by a competent Oriental scholar, who would have been able to detect some irritating perversions of names which detract from the scientific accuracy of the work.

THE METRIC SYSTEM AND DECIMAL COINAGE.

THERE are probably few readers of NATURE who do not realise that what is being referred to in the Press as "The War after the War" is nothing more than a tardy appreciation of the "war before the war" which Germany has been waging against England for a quarter to half a century in the applications of science to commerce. It has been stated over and over again that German firms have been ousting British trade in many countries by issuing price lists containing quotations in the metric system of weights and measures. A further element of success has been that the enterprising Germans have in many cases told prospective purchasers the exact amount of money in their own currency which they would have to pay in order to have the goods delivered at their house, free of carriage, customs dues, or all other charges.

Now scientific men have been preaching the adoption of the metric system for years. The advantages which this country would gain by discarding British weights and measures, and using those which have now become international, are well known to every thinking man. In these circumstances it must be regarded as regrettable that the *Electrical Review*, in a series of articles entitled "Decimal Coinage and the Metric System" (October 15 to November 26), has associated these undoubted claims for standardisation of units with the advocacy of a change of monetary system which nobody understands, and which does not appear calculated to advance the cause of international uniformity.

The editor of the journal in question circulated among business firms about 450 copies of a letter, to which more than 120 replies were received. The following questions were asked of the recipients of the letter:—

1. Do you employ the metric system in your correspondence with foreign clients?
2. Are your products
   (a) described in your catalogues in terms of metric weights and measures?
   (b) priced in terms of foreign coinage?
3. Do you employ the metric system in your workshops?
4. Are you in favour of the adoption in this country
   (a) of decimal coinage?
   (b) of metric weights and measures?
5. May we quote your name in referring to your replies in the *Electrical Review*?

The result has been a very thorough discussion of the advantages of the metric system, and the absence of any substantial evidence regarding the monetary question. Many firms are actually using metric units; in electrical, physical, and chemical work they have become universally recognised, and in cases where they are not exclusively adopted they are at least used in foreign trade. On the other hand, few firms are able to give quotations in foreign currency, owing to the varieties of foreign coinage and the fluctuations of the rate of exchange. Where manufacturers have expressed themselves favourably to decimal coinage their replies strike us as not being based on any substantial grounds.

In examining this aspect of the subject the questions which naturally arise are:—(1) What is meant by decimal coinage? (2) What countries have adopted it? (3) What is the system it is proposed to adopt here?

Now the decimal system of weights and measures which is in international use is based on a distinctive and unique nomenclature for tens, hundreds, thousands, and the corresponding submultiples of the fundamental unit, whether it be a unit of length, capacity, or weight. By a process of natural selection those multiples and submultiples have been retained which have been found most useful; for example, millimetres, centimetres, metres, and kilometres, to the exclusion of other derived units. But no country in the world has adopted a decimal coinage based on this nomenclature. Instead of this we have a perfect chaos of centesimal systems, each based on the subdivision of a fundamental unit into a hundred "cents." In most cases, sums of money amounting to millions of pounds are expressed in terms of a unit no larger than a shilling, while sums less than a shilling are expressed in tenths of a penny, although coins of less than five-tenths are rarely used. In some cases $\frac{2\frac{1}{2}}{100}$ of the larger unit is commonly used in preference to the $\frac{1}{100}$.

The plea for a decimal coinage must therefore either be an advocacy, not of a decimal system, but of a centesimal system similar to one actually in use, or it must represent a demand for something new and different.

Now the disadvantages of uniformity will be evident to anyone who travels in one of the countries of the so-called Latin Union, such as France, Switzerland, Italy. It is often quite impossible to obtain change for a sovereign in the current coin of the realm. Instead the traveller receives a collection of coins of a number of different countries, some of them good, others bad. The only countries in which bad money can never circulate are those, such as Germany and Austria, which have distinct monetary units. If England were to adopt the franc and centime, England would soon be flooded with foreign money. The difficulty of deciding, by means of diagrams, whether a particular coin is good or bad is at least equal to the difficulty of reducing shillings to pence, and most inhabitants of the countries in question have accumulations of bad money that they are only too glad to pass off on an uninitiated Englishman.

If, however, the system is to be different from those of other countries, it is difficult to see how it can facilitate foreign commerce. The exchange value of an English sovereign is well known all over the world, and quotations in pounds are fully understood. The only difficulty may arise among foreign clients with the twelve pence in the shilling. But in foreign trade pence practically never enter into the calculations, and all that the manufacturers need do is to give their quotations in decimals of a pound, which they can easily do.

It is in the last of the series of articles that the contributor of the *Electrical Review* gives himself away. After obtaining overwhelming evidence of the advantages of the metric system, he proposes that the coinage should be changed first, and that the remaining changes should follow within a time-limit of one twelvemonth. It would appear that the proposed coinage should leave the pound and the shilling intact, and should depreciate the value of the penny by about 4 per cent.

We need not have any serious apprehensions that Parliament would ever consent to a proposal which would rob the working-man of a fraction of the value of his penny while leaving the income-tax payer unmulcted. It is, however, fairly evident that if such a scheme were adopted penny articles would not be sold for less than a penny farthing, and we should thus approximate to the system of marks and *pfennige* of Germany.

The writer of the present article happened to be travelling in Austria a little while after the change from gulden and kreuzer to kronen and heller, and although this alteration involved nothing more than doubling the figures, the confusion was very great and the change took a long time to effect.

It is quite clear that any attempt of this kind introduced during the present universal upheaval would lead to a state of chaos in our international trade which would induce our foreign clients to transfer their business to Germany, or to some neutral country with the coinage of which they had become familiar.

In conclusion, whether the attempt to introduce decimal coinage be desirable or undesirable, its association with a movement for adopting the metric system can only have the effect of retarding a change for which the time is ripe, and which is necessary in order that Great Britain may hold her own in the world of international commerce.

G. H. B.

NOTES.

THE recent circular addressed to the dealers in platinum by the Director of Materials in the Ministry of Munitions requiring them to make a return of the whole of the stock of this metal, its ores and residues, on their premises, and forbidding any trading without a permit under a heavy penalty, will cause no surprise to those scientific men who are cognisant of the situation. Indeed, it is to be regretted that this step has not been taken before. It is most unfortunate that this rare, and for many purposes indispensable, metal has been allowed to be used for jewelry and purely ornamental purposes. Either silver or gold is much better adapted to the production of attractive ornaments and is more beautiful than the greyish-white of platinum, while, of course, neither has the high melting point, electrical resistance, and chemical refractory qualities which make platinum so valuable a metal both in science and in the arts. The normal annual world's output of this metal is about 300,000 troy ounces. This figure dropped in 1914 to 250,000 ounces in consequence of the outbreak of war. Russia produces 95 per cent. of the world's total, chiefly from the Ural placers. The crude platinum contains from 70 to 90 per cent. of this metal, but it is invariably alloyed with iron in considerable proportions and with varying amounts of the other metals of the platinum group. Colombia produces about 10,000 ounces, while the total output of other countries does not exceed 2000 ounces. It is obtained in the United States Mint in the electrolytic refining of gold and silver, but only in amounts of about 200 ounces per annum. A small amount is also recovered from the mud resulting from the electrolytic refining of copper. Considerable interest was aroused by the recent announcement that platinum had been discovered in the Lower Rhine region of Germany. No statements as to its possible commercial exploitation have as yet been forthcoming.

SINCE the outbreak of war, the research institutes and stations aided by the Board of Agriculture under the Development Act scheme have been fulfilling useful functions. The new conditions have given rise to many new problems, chiefly in regard to the use of new feeding stuffs and the supply of artificial manures. In relation to the former, the blockade of Germany's imports has led to the appearance on the home markets of a number of oil-seed residues, such as palm-nut kernel, coconut, etc., in regard to the use of which as feeding stuffs little precise information was available; again, the scarcity and dearness of some of the other better known materials have necessitated the use of substitutes, and it has become important to supply agriculturists with advice on the making up of rations containing unfamiliar mixtures of ingredients. The Institute of Animal Nutrition at Cambridge has given valuable aid in this direction, and the monthly notes which it contributes to the Journal of the Board of Agriculture contain information which has been much appreciated by farmers.

THE utilisation of peat, whether as a source of power, for use in the manufacture of explosives, or as the basis of a manure, is attracting much attention at present, and the subject is naturally one in which the Rothamsted Experimental Station is in a position to undertake useful work. At the request of the Board of Agriculture, the station has recently undertaken to make a complete investigation of the claims made in regard to Prof. Bottomley's bacterised peat or "humogen," the nature and properties of which were described in NATURE of December 9, 1915 (p. 399). As they have been stated in the daily Press, these claims appear to be threefold: first, that the substance contains an accessory food substance; secondly, that it supplies soluble humus; and, thirdly, that its nitrogen content is higher than that of most organic manures. The first claim—the presence of an accessory food substance—is the one that will attract most attention, for if it can be substantiated it will not only constitute a distinct scientific advance, but will make the economic problems involved much simpler. "Humus," after all, is the cheapest manure, and it is not likely that for ordinary agricultural crops any manufactured product will be able to compete with such a cheap source as the farm manure-heap. The investigation at Rothamsted will include an examination of the processes by which humogen is manufactured, as well as trials on a field scale under carefully controlled conditions.

MR. TENNANT stated in the House of Commons a few days ago that from the beginning of hostilities to November last, 1365 cases of enteric (typhoid) fever were reported as having occurred among British troops in France and Belgium. Of these, 1150 had been diagnosed after bacteriological examination. In 579 cases where there had been inoculation there were 35 deaths, and in 571 cases where there had been no inoculation there were 115 deaths. We hope that Mr. Tennant's statement will put a stop to the last trace of opposition to the protective treatment against typhoid fever. We do not say that the method is perfect; but we do say that it protects our soldiers from dying of typhoid fever. The figures given by Mr. Tennant are absolutely final; the method, in years to come, may be improved; but the good which it has achieved is past all possibility of sane doubt. Happily, the opposition never came to much, and now is coming to an end. It has had one good effect on the public mind: it has helped to destroy the influence of the "anti-vivisectionists" and the "anti-vaccinationists." These two bodies, never far apart, made common cause against the work of protecting our soldiers against the horror of death from typhoid fever. Among the "anti" assertions, we may note the statement that typhoid and paratyphoid are so like each other that the figures for typhoid are worthless. This assertion is untrue. Even if we add the paratyphoid cases to the typhoid cases, and put them all together, the results of the protective treatment are still above the least shadow of doubt. If any reader wishes to have leaflets for distribution, giving a simple account of the treatment, he should apply to the hon. secretary of the Research Defence Society, 21 Ladbroke Square, London, W.

A LUNCHEON was given to Sir Edward Carson, on January 12 at the Savoy Hotel, by the Institute of Industry. In his address Sir Edward Carson referred to a number of questions which would have to be answered after the war, and urged the need for concentration of effort. He said there should be no essential article, either for the arts of peace or for the arts of war, upon which we could not within the Empire lay our hands. He never could understand, he continued, why the question as to what was best for our industry, commerce, and finance should be any concern of the party politician. It was a pure business question, and it was there that the Institute of Industry came in. It was for them, by strengthening it and working out these problems, to make themselves felt in the settlement of these great matters. A discussion was opened by Mr. J. Taylor Peddie, chairman of the institute, by an address on the new national business policy. He explained that among the objects of the institute it was intended to secure the establishment of a Ministry of Industry, to develop national and Imperial industries, and to stimulate and encourage the standardisation of our educational system. The following resolution was adopted unanimously:—"That this meeting of manufacturers and other representative men closely connected with all phases of industrial activity in the British Empire, fully endorses and approves of the objects and policy of the Institute of Industry, and recommends all persons or companies interested in the industrial life of the British Empire to support the institute by becoming members."

MR. F. M. LLOYD, Besselsleigh, Douro Road, Cheltenham, has issued a circular in which he urges the establishment of a Board of Investigation and Experiment, not only to consider suggestions, but also to carry out experiments upon them, with the view of bringing any that are of practical utility before the notice of military or naval departments, or otherwise promoting their development for national purposes. The weakness at present results from want of organisation. It cannot be expected that the officials of all the great Government departments are able to judge of the practicability or value of the scientific suggestions or inventions placed before them; so it often happens that ideas are pigeon-holed or correspondents are advised to apply to other officers or departments. Mr. Lloyd gives several instances of this repressive policy; and he asks that the whole question of invention and experiment should be placed on a sounder basis, and that greater facilities should be given to the inventor. A new department had been established in France to co-ordinate the work of men of science and engineers for the service of the country, to examine what proposals are feasible, and assist in the realisation of promising ideas. A like centralisation seems to be needed here, so that suggestions shall not be passed over because they have been sent to a wrong department, and that promising ideas may first be tested by scientific experiments and be put into practical application if successful. We have advisory boards of invention and research connected with the Admiralty, Ministry of Munitions, the Board of Education, and other Government departments, but Mr. Lloyd emphasises the need for a new department which will co-ordinate the whole service for the promotion of science and invention. He invites all who are willing to help to attain this end to communicate with him.

SEVERAL letters on the relation between science and industry, with particular reference to the decline of our dye-stuff industry, appear in the *Observer* of January 16 as comments upon an article contributed by Prof. H. E. Armstrong to the issue of our contemporary a week before. On one side we are told that the old patent laws, which allowed the Germans to make our dyes, but prevented us from making theirs, was chiefly responsible for the loss of the dye industry; and on the other that the decline was due to the neglect of science by our manufacturers and commercial men. As to the employment of chemists, Mr. W. G. Black asserts that "the British manufacturer is alive both to their value and limitations," and the editor of the *Dyer and Calico Printer* that "the British colour-making trade generally has never been without good business men and clever research chemists." Mr. J. W. Green, registrar of the Institution of Chemical Technologists, supplies the answer to these views in a statement of the training and position of the technical chemist in this country. The college and the factory are admittedly not in sufficiently close touch, but the relationship between them will become much stronger when the prospects of a properly trained industrial chemist are improved. Mr. Green says that one of the largest concerns of its kind pays its chemists thirty-five shillings a week each as a maximum salary, while a skilled labourer in the same firm can earn five or ten pounds a week, and his wages never drop to the level of the chemist. This is typical of the value which our manufacturers usually place upon the work of the chemist, and it is not surprising that such an attitude has had its effect on academic circles. What is urgently wanted is a definite training and status for the profession of chemistry, and efficient co-operation between the technical chemist, the chemical manufacturer, and the Government.

THE Guthrie lecture of the Physical Society will be delivered at the Imperial College of Science on Friday, January 28, by Mr. W. B. Hardy, upon the subject of "Some Problems of Living Matter."

MAJOR F. W. MOTT, F.R.S., will deliver the Lettsomian Lectures to the Medical Society of London on February 7 and 21 and March 6, taking as his subject the effects of high explosives on the central nervous system.

IT is announced in the *Daily Mail* of January 18 that Dr. Aylmer May, principal medical officer of Northern Rhodesia, has been selected by the War Office to undertake research work on the western front in connection with wound infection.

AN exhibition of photographs demonstrating the application of photography to marine biology, by Mr. F. Martin-Duncan, is open free to the public on presentation of visiting card at the Royal Photographic Society of Great Britain, 35 Russell Square, W.C., and will remain open until Saturday, February 12.

OWING to the generosity of Mr. J. S. Corder, a member of the committee of the Ipswich Museum, the whole of the remainder of the collection of flint implements of the late Lieut.-Col. Underwood has now passed into the possession of this institution. The Ipswich Museum had already purchased all the Dovercourt and local specimens belonging to Col. Underwood, and this new acquisition will add greatly to the extent and value of the prehistoric stone implements displayed in the building. The arrangement of the specimens has been placed in the hands of the curator, Mr. J. Reid Moir.

THE railways of Asia Minor and Syria attract much attention now in view of their relation to the war in the Near East. A useful paper on the subject accompanied by a large folding map appears in the Bulletin of the American Geographical Society for December, 1915 (vol. xlvii., No. 12). The nationality of the dominant control in each line is shown by distinctive colouring on the map. The German railway through Asia Minor from Scutari to Aleppo is complete except for the Taurus tunnel. It has coastal links by a French railway to Smyrna and Söke, and by German lines to Mersina and Alexandretta. From Aleppo it runs to Harran, but later reports announce its completion to Ras-el-ain. The only part of the Bagdad railway in working order is between Samarra and Bagdad. When the Taurus tunnel is completed there will be through railway communication from Scutari *viâ* Aleppo to Damascus, and thence by Turkish lines to Medina, or to Gaza, near the frontier of Egypt. Details are wanting of the reported line, now being built, from the Syrian lines into Egyptian territory. The Medina line is to be extended to Mecca and Jedda. The whole cost of this line from Damascus southward is said to have been met by offerings of faithful Mohammedans.

AN earthquake of some importance for this country was felt in the Midlands on January 14, at 7.29 p.m., chiefly in Staffordshire, though the disturbed area also included the greater part of the adjoining counties of Cheshire, Shropshire, Warwickshire, and Derbyshire. From the reports so far collected, it appears that the shock was felt from the neighbourhood of Manchester on the north to Hartlebury and Henley-in-Arden on the south, and from Leicester on the east to Malpas on the west. The disturbed area must therefore be at least 85 miles long from north-west to south-east, and 65 miles wide, and containing about 4340 square miles. The centre of the area is in the neighbourhood of Stafford, a district which has not been the seat of a strong earthquake for many years. The earthquake was probably a twin earthquake, for the shock consisted of two series of vibrations throughout a large part of the disturbed area. Mr. J. J. Shaw states that the earthquake was recorded by his seismograph at West Bromwich. The movement began at 7.29 p.m. For the first two minutes the vibrations were very rapid and ceased to be perceptible about 7.40.

A GREAT earthquake was recorded at Sydney on January 14, the seismograph at the River View College being disturbed so violently that the needle left the recording sheet. It is estimated that the epicentre lay about 500 miles to the north-west of Port Darwin. On the same day a disastrous earthquake is reported from New Guinea, especially at Raboul, the seat of the Government when that portion of the island was under German control. No times are as yet known for either earthquake, but it is evident that the reports can scarcely refer to the same shock unless there is some error (say, north-west for north-east) in the estimated position of the epicentre. It is worthy of notice that a large part of New Guinea is almost aseismic, though earthquakes are not infrequent at Dorei, and near the eastern extremity of the island.

MR. GEORGE TUCKER, chairman of the *Electrician* Printing and Publishing Co., Ltd., died last Saturday after a long illness. He was sixty-four years of age, and had been connected with the *Electrician* since 1878. Starting as a compositor, he won his way to the supreme control of the *Electrician* Co. by sheer hard work and business ability. In 1883 he was appointed overseer of the printing department, and in 1887 was made publisher and business manager. It was, we believe, largely due to his representations that the proprietors of the *Electrician* decided on the policy of publishing technical books and advanced text-books on electrical subjects, the earlier volumes of which particularly did much to advance the accurate study of applied electricity.

WE notice with regret the announcement in the *Times* of the death, on January 16, of Dr. H. Williams, medical officer of the Port of London. Dr. Williams was born in Weymouth in 1862, and received his medical education at St. Bartholomew's Hospital. His appointment as medical officer of health for the Port of London was made in 1901. He took a deep interest in all that concerned the welfare of the Port, and it is due to his scientific enthusiasm that the work there has been of so progressive a character. He was a vigilant detective of disease, and he spared no pains to shut the door in the face of epidemic conditions.

WE see in the *Chemist and Druggist* the announcement that Dr. Georg Grübler died last November in Jena. In his early days he was a pharmacist, but he soon became an earnest student of physiological chemistry, and in 1880 he founded a laboratory at Leipzig, where he devoted himself to physiological and bacteriological research. He became well known for his work in connection with the proteins, and after he retired to Dresden in 1897 became interested in the subject of enzymes, and especially in their preparation in as pure a form as possible. His so-called "pure" pepsin, trypsin, and steapsin are well-known preparations. He is, however, most widely known for his bacteriological stains, which have a world-wide reputation.

NOTICE.

For the convenience of readers of NATURE wishing to inspect books *published abroad* which have been reviewed in NATURE such volumes are kept for the period of six months at the publishing office of the journal. The books are retained for the purpose of examination free of charge.

St. Martin's Street, London, W.C.

PRINTED IN GREAT BRITAIN BY R. CLAY AND SONS, LTD., BRUNSWICK STREET, STAMFORD STREET, S.E., AND BUNGAY, SUFFOLK.

THE war has just inflicted another heavy loss upon King's College, London, in the death of Capt. Matthew Thomas, 7th Loyal Lancashire Regiment, who was shot in France on December 31, 1915. Capt. Thomas was a fellow-student with Thomas Wright (whose death we reported last May). He passed in 1909 from the Grammar School, Wigan, to the training department at King's College. While there he obtained first-class honours in physics at the B.Sc. examination in 1912. He stayed on for two more years, winning the Layton Research Scholarship and doing tutorial and research work under Prof. Barkla. Soon after Prof. Barkla took up his present post in the University of Edinburgh, Mr. Thomas obtained a junior appointment there under him, but he was prevented by the outbreak of war from entering upon what would assuredly have been a very valuable career in science. He was given a commission in August, 1914, and obtained his company eleven months later. He fell whilst warning his men to take cover from a dangerous sniper, to whom, alas! he himself became a victim.

THE problem of Cape horse-sickness is discussed by Sir Arnold Theiler in the *South African Journal of Science* for October, 1915 (Vol. xii., No. 3). The microbe of this disease is not known, as it is a "filter-passer"; it is probably conveyed by a winged insect, though this also is unknown, for horses stalled in stables made insect-proof are protected from the disease. There is a definite horse-sickness season, so that the virus must be maintained in some "reservoir" in the intervals, but so far the species responsible has not been discovered. No form of treatment is of much avail, and for the time being the eradication of horse-sickness lies in the protection of animals against infection.

IN the December issue of *Man* Dr. W. L. Hildburgh describes, with illustrations, a large collection of amulets from Cairo and Japan. Of the former some are dependent for their supposed virtues primarily on qualities inherent in their materials, though in some cases these qualities have been enhanced by art. Silver, which is regarded as a protection against evil supernatural beings, is largely used in their construction, and the mounting is generally such as to give the amulet the form of a pendant. Among the Japanese examples that of the *manjinai,* intended to attract the love of a person, is common. It often takes the shape of a dog, supposed to act as an agent to cause the arrival of a person desired. The magical intention is prominent in this series of examples, as in the case of a special form, prepared with the eyes left blank, of the tumbling toy representing the legless ascetic Daruma. To secure the attainment of what is desired the image is promised the gift of one or both eyes if the desired result be secured.

OF the parasitic hymenoptera known as "Chalcids" more than four thousand species have been described. Several hundred new Australian species have now been added to this list by Mr. A. A. Girault. These are fully described in vol. iv. of the Memoirs of the Queensland Museum. The labour expended in preparing this volume must have been enormous. But whether the author was justified in creating such an array of new species from the evidence of single specimens time alone will show. Only in a few very exceptional cases, it would seem, was it possible to give the name of the hosts of such parasites. As a rule the author can do no more than describe the habitat as "Gordonvale, Queensland." In his introduction he comments with enthusiasm on the remarkable diversity in structure and coloration which these minute flies exhibit. The family, he remarks, "is open to philosophical treatment of the highest order."

To discover whether the various objects carried about on the spines of the purple-tipped sea-urchin (*Echinus miliaris*) were accidentally picked up or deliberately placed there has recently formed the subject of a series of experiments by Mr. H. N. Milligan. He gives the results of his inquiry in the *Zoologist* for December. While usually stones, sea-weed, or shells are carried, tube-worms, hydroids, periwinkles, or tunicates, as chance may determine, are also used, apparently for the purposes of disguise and protection from enemies. That such objects are borne with a purpose, and not as a result of accident, is shown by the fact that when all foreign bodies are removed from the spines of urchins living in an aquarium, they will invariably be speedily replaced as soon as their loss is perceived, the tube-feet being used to perform this office. Young individuals were more assiduous in this regard than adults, but in all cases particular care was taken to conceal the anus, which is apparently a very vulnerable spot. In the same number Mr. J. M. Dewar concludes his noteworthy observations on the relation of the oyster-catcher to its natural environment. The presence of a large human population in the vicinity of its haunts has an important bearing on the permanence of its breeding stations. If these are to be maintained they must afford a safe temporary refuge at no great distance off, when the actual breeding area is invaded.

MESSRS. SHERRATT AND HUGHES, Manchester, have published a summary, written by Mr. J. Arthur Hutton, of the evidence given at a Board of Agriculture and Fisheries inquiry into the salmon fisheries of the river Wye. There had been a marked depreciation of the river during the period 1892 to 1900, and various scientific investigations, by Mr. Hutton and others, had been carried out. From 1902 to 1904 netting was prohibited in the Wye, and this restriction was followed by a notable improvement in the fishery. A further restriction for the period of rod-fishing was then suggested, and this proposal was the subject of the inquiry. The pamphlet contains a summary of the statistics collected by Mr. Hutton.

THE presence of manganese in plants has been repeatedly observed, but it has hitherto been considered to be an accidental constituent. Mr. W. P. Headden, of Colorado (*Journ. Agric. Research,* November 22, 1915), adduces evidence to show that this is probably an incorrect view, and that its constant presence in certain cereals indicates it is not an unessential constituent. It occurs in wheat wherever grown, irrespective of soil and climate, in about the same proportion as iron. If Mr. Headden's view is correct, the discovery opens up a new field of research in order to determine the physiological function of manganese in vegetable metabolism.

AN account of an exceptionally heavy rainfall during a thunderstorm at Malta has been received from Dr. Thos. Algius, the officer in charge of the meteorological observatory attached to the university. The thunderstorm passed over the island during the early hours of November 22 of last year, and the amount of rain registered is said to be nearly equal to that known as the St. Nicholas day outburst some forty years ago. The barometer fell nearly two-tenths of an inch prior to the downpour, and the direction of the wind was south-easterly, increasing in velocity to 25 miles an hour and to nearly 30 miles an hour in gusts. The air temperature dropped suddenly from 65° to 58°. The rainfall registered at the observatory was 7·24 in., but 11·57 in. fell during the cloudburst on October 16, 1913. Rainfall returns supplied by the elementary schools well scattered over the Maltese islands have provided data for mapping the fall, which ranged from 8·60 in. to a much more modest measurement.

THE mean salinity and surface temperature of the North Atlantic and English Channel for June, July, and August, 1915, are shown in a series of charts on the Monthly Meteorological Chart of the North Atlantic for January, 1916. Charts are also given showing the average salinity and surface temperatures of the English Channel for the same months during the last eleven years. The charts were prepared by Dr. E. C. Jee, from British and Dutch data. They all show a persistent decrease in salinity from the mouth of the Channel eastward to the Straits of Dover, but they show no marked deviation among the three months. In addition to the usual features of the monthly issue, the January number contains also a table giving the percentage of days with fog at lighthouses on the Newfoundland coast, in most months for an average of ten years.

THE papers on the heating of electric wires and cables by Messrs. Melsom and Booth, which are reproduced in vol. xii. of the Collected Researches of the National Physical Laboratory, form the starting-point of an investigation of great importance in electrical engineering. So little is known about the heat conductivity of materials in which cables are enclosed when in use that the views held by different authorities as to the greatest currents they will safely transmit are widely divergent The National Physical Laboratory is obviously the authority to whom a difficult subject of this kind should be referred, and electrical engineers will look forward with confidence to the publication of further reports.

PALM-OIL, which is used in very large quantities in the soap industry, is bleached (1) by exposure in thin layers to air and sunlight; (2) by blowing air through the hot oil; (3) by the action of bleaching-powder, or chromic acid. The very great development in this country and elsewhere of catalytic reduction, as a means of hardening fats and oils, appears to have suggested the desirability of applying similar methods to the oxidation and bleaching of the oils. The experiments of Mr. S. G. Sastry (Trans. Chem. Soc., 107, 1828) showed that a large number of metallic compounds could be used to stimulate the oxidation, the most effective being those containing manganese and cobalt, although nickel, iron, and lead were also active. Of the various compounds employed the borates were found to be more efficient than the oxalates, palmitates, sulphates, or oxides, and the most efficient of a dozen catalysts was cobalt borate. Using only 0·01 per cent. of this salt, a reddish sample of oil was bleached white in the course of 3½ hours by passing air through it at 80° to 90° C. The bleaching was found to be permanent during fifteen months, and did not destroy the faint odour of violets which is characteristic of the oil; the bleached oil also gave a colourless soap, and its soap-making qualities were not interfered with in any way.

AN account of a research on stable biplane arrangements, conducted at the wind tunnel of the Massachusetts Institute of Technology, is given in *Engineering* for January 7 and 14. The author is Mr. J. C. Hunsaker, assistant naval constructor in the United States Navy. The object of the research was to discover whether the longitudinal instability of the typical cambered aeroplane wing may be overcome without material sacrifice of lift, or increase in resistance. It is believed that the experiments show that the ordinary biplane, using wings of standard section, may be made longitudinally stable by giving the upper plane a stagger forward of 50 per cent. of the chord, and at the same time inclining its chord about 2½° to the lower chord, "decalage" 2½°. The loss in maximum lift to drift ratio ("efficiency") is less than 5 per cent. The maximum possible lift is not diminished, but increased slightly, and the landing speed of the aeroplane is thus the same whether this arrangement or the ordinary one be used. Further, the maximum speed is identical in both cases. In practice, the unstable pitching moments of ordinary biplane wings are balanced by a large horizontal tail surface. The increased structural weight due to inclined struts in a staggered biplane should be compensated, at least in large part, by the saving in weight due to a smaller tail surface and lighter supporting structure.

Engineering for December 31 contains a paper on recent progress with the active type of gyro-stabiliser for ships, read by Mr. Elmer A. Sperry at the Society of Naval Architects and Marine Engineers, in New York, on November 19 last. The paper describes the first commercial gyroscope-stabilising equipment to be installed, which was fitted on the yacht *Widgeon*, owned by Mr. H. M. Hauna, jun., of Cleveland. This was placed in service in the autumn of 1915. The system of control is practically identical with that adopted in former experiments on the *Worden*; a small auxiliary gyro feels out the incipient rolling of the ship by closing electrical contacts, and, through a relay switch, actuates a small reversing motor, which is geared to the case of the stabilising gyroscope and causes it to precess in its bearings. The stabilising gyroscope then exerts a powerful restoring couple on the frame of the ship. The arrangement appears to have been very successful, and rolls of 25° on each side of the vertical have been quenched to 3°, the quenching being accompanied by much steadier steering. By no means the least interesting part of the paper is the collection of accompanying photographs and drawings of the arrangement; some of the latter are from working drawings, and enable the construction of the gyroscope to be understood perfectly.

DR. J. E. STEAD has collected the results of analyses of a large number of German shells and has given them recently in a paper read before the Cleveland Institute of Engineers, and reported in the *Engineer* for January 14. Dr. Stead discusses our own specifications for shell steels. The actual tests applied to such steels are confidential, but it is of interest to note that Dr. Stead, speaking as an analytical chemist, is of the opinion that no shell steel should be rejected on the results of chemical analysis provided the mechanical tests are satisfactory. Our enemies are not particular in having shell steel of uniform quality; the steel used is generally of relatively high tenacity, and is much more liable to break up by shock than what we produce and prescribe. It is most probable that some of the German shells are made by the basic Bessemer process, judging from the relatively large amount of nitrogen present in one of the toughest and best fragments, which also contained 0·07 per cent. of sulphur and phosphorus. The analysis of armour-piercing shells agrees with that of similar material made in other countries. German shells with between 0·07 and 0·1 per cent. of phosphorus did not burst in the gun, hence it seems probable that great freedom from that element has been found to be unnecessary.

OUR ASTRONOMICAL COLUMN.

COMET 1915*e* (TAYLOR).—There continues to be a dearth of information regarding this comet. Its actual position now differs very considerably from the only ephemeris available. Thus on January 13, 11.0 p.m., an observation made at the Hill Observatory showed that the ephemeris required corrections of +4·0 min. in R.A., and −1° 15′ in declination. The comet was easily seen in spite of strong moonlight, and was bright enough to show the cross wires in the eyepiece.

Employing observations made at Rome, December 5, Bergedorf, December 18, and on January 3, 1916, at Bamberg, M. J. Braae and Mlle. J. Vinter-Hansen have calculated the following elliptical orbit and ephemeris :—

Epoch 1916, *January* 0·5 *G.M.T.*

Mo	= 355° 15′ 49″·3	ϕ	= 32 54 206″
ω	= 354 39 37·6	μ	= 564·209″
☊	= 113 57 46·5	Log a	= 0·532378
i	= 15 28 9·1	T	= 1916 Jan. 30·7205 G.M.T.
		U	= 2297·02d (6·29 years).

12*h*. *G.M.T.*

		R.A. h. m. s.		Dec. ° ′
Jan. 20	...	5 8 39	...	+15 47·2
22	...	9 38	...	16 38·3
24	...	10 49	...	17 28·9
26	...	12 12	...	18 18·9
28	...	13 48	...	19 8·1

The comet's distance from the earth has been slowly increasing. The comet is stated to be about eleventh magnitude.

COMET 1915*d* (MELLISH).—We are informed by Prof. Edwin B. Frost, director of Yerkes Observatory, that Mr. John E. Mellish has taken up residence there as volunteer research assistant. Comet 1915*d* was found with the 6-in. comet seeker, and Prof. Georges Van Biesbroeck, who is spending the year at Yerkes as visiting professor of practical astronomy, subsequently obtained the accurate positions of the comet using the 12-in. telescope and filar micrometer (see NATURE, December 2, 1915).

MIRA CETI.—American observations of this variable star during the 1914–15 cycle show that from a minimum of 9·0 mag. on October 15, 1914, the brightness increased to a maximum of 3·6 on February 11, 1915. By August it had again fallen to nearly 9·0 mag. (*L'Astronomie,* December, 1915). With regard to the present maximum, unless undue weight be given to an observation made on December 27 through a momentary rift in clouds, this star did not quite attain to the magnitude of α Ceti (2·7). Although it is still the next brightest star in the region, it now appears distinctly weaker than at the beginning of the year.

SECOND TYPE STARS OF LOW DENSITY.—At the present time the crucial evidence on the question of stellar evolution is stellar density. Numerical data accumulates which more and more insistently proclaims the existence of stars extremely different in mean density, yet capable of giving rise to almost identical spectra. As these data result from complicated calculations of orbital elements, Dr. H. Shapley has successfully sought for a method of deriving limiting mean densities merely from length of period and the duration of eclipse. The results obtained by this direct method are in close agreement with those already published in his "Orbits of Eclipsing Binaries" (Proc. Nat. Acad. Sci., vol. i., p. 459).

THE DISTRIBUTION OF SPECTROSCOPIC BINARIES OF CLASS M.—To the already long list of objects showing a preference for low galactic latitudes must now be added the spectroscopic binaries of class M (Antarian). C. D. Perrine (*Astrophys. Journ.*, xlii., p. 370), dealing with ten such binaries, finds the average galactic latitude is 9°, whilst omitting one (β Andromedæ), the average sinks to 7°. Orbits are available for only α Orionis and α Scorpii. Comparison with the Cepheid variables discloses some significant resemblances and differences, *e.g.*, light variations, small proper motions, and for the two known orbits the masses of the secondary bodies are similar, whilst some of the differences pointed out are the large value of $a \sin i$, and consequently periods measured in years instead of days.

REPORT OF THE NIZAMIAH OBSERVATORY.—The annual report (1914–15) of the Nizamiah Observatory (director, Mr. R. J. Pocock) shows that work on the astrographic chart has been actively advanced both as regards number of plates secured with the recently installed astrographic equatorial, and their measurement, although, through illness, the director had unfortunately to spend some weeks in hospital.

THE VARIABLE NEBULA, N.G.C. 6729.—There is very little definite information of the light variations of nebulæ, notwithstanding the great importance of the matter. Perhaps this apparent neglect is merely a measure of the atmospheric humidity where most observational work has hitherto been carried on. At Helwân, however, Mr. Knox Shaw has been able to make a good beginning with a photographic study of the well-known nebula N.G.C. 6729—the fan-shaped appendage of the variable star R Coronæ Australis. Some results obtained since 1911 are described in a preliminary note (Bulletin No. 16). It is found that the nebula is bright when R Coronæ Australis is bright, and selectively variable areas have also been noted.

BRITISH RAINFALL IN 1915.

A DIGEST of the rainfall returns over the British Isles for the year 1915 is given in the *Times* of January 18 by Dr. H. R. Mill, director of the British Rainfall Organisation. For the purpose of the discussion 130 stations, scattered over the British Isles, have been selected from a total of 3000.

A table shows for each of the 130 stations the rainfall for 1915 with the average fall for thirty-five years, and the difference of 1915 from the average, also the percentage of 1915 fall on the average. The heaviest rainfall at the 130 stations was 103·52 in. at Seathwaite, and the least 24·56 in. at Bury St. Edmunds. Other records as yet to hand give 138·99 in. at Llyn Llydaw, in Snowdonia, and 138·97 in. on the Stye, overlooking Borrowdale, in Cumberland, whilst at Huntingdon the fall was only 23·99 in., and at Cambridge 23·00 in.

The percentage of the average rainfall for the year over the British Isles is given on a map which shows at a glance that the most excessive rainfall occurred in the south-east of England, south of the Thames, where the fall was 130 per cent. of the average. From the Bristol Channel to Mid-Norfolk there is a belt with practically normal rainfall, whilst to the north of this in the Midlands the rainfall was relatively higher. The east coast, as far north as the Moray Firth, had a rainfall in excess of the average. The whole of the west of Scotland and the north-west of England had a rainfall below the average; the deficiency was greatest in the West Highlands. The lack of rainfall in the north-west of Great Britain is said to have been a feature of the year's weather as striking as the excess in the south. In Ireland the distribution of rainfall during 1915 was not very different from the normal. For the British Isles as a whole there was practically an average rainfall with a tendency to excess rather than deficiency.

A table is given showing the general rainfall for the several months. The winter months—January, February, and December—had the greatest excess of rain in England and Wales, whilst the heavy summer rains in July were slightly the heaviest in Ireland.

The rainfall in London for 1915 was 28 per cent. above the average, the year being the wettest in fifty-nine years, with five exceptions—in 1903, 1879, 1878, 1872, and 1860; whilst the number of days with rain was 7 per cent. below the average. Rain fell for 568·9 hours, which is 136·1 hours above the average, and the highest in thirty-four years, except in 1903 and 1909.

SCIENCE AT EDUCATIONAL CONFERENCES.

II.

A PREVIOUS article (January 13) summarised the papers and discussions at conferences of teachers with reference to the national aspect of early training in science. The number and variety of the meetings was so great that many other points of general scientific interest deserve notice. First may be placed the exhibition of scientific apparatus at the meeting of the Public School Science Masters' Association, as it marks a new era. Formerly a large proportion of the laboratory ware and appliances were of German or Austrian origin; this year, with the exception of a few balances from Rotterdam, all the exhibits were British. Naturally, the size of the display was reduced, but there was no falling off in quality. So far as visual and handling tests can be trusted, the goods shown were of a high grade of material and workmanship. There was a large selection of electrical apparatus, mostly measuring instruments, suitable to all grades of teaching, from the most elementary forms of magnetometers or electroscopes to the elaborate potentiometer sets. Messrs. Philip Harris, F. E. Becker and Co., Gallenkamp and Co., and Gambrell Bros. all contributed to this section. Messrs. Baird and Tatlock (London) made a special feature of laboratory glassware, and a number of science masters paid a visit to their works at Walthamstow. Messrs. Philip Harris exhibited lamp-blown glass apparatus suitable for volumetric and research work, also moderately-priced strong instruments suitable for field-work in physical geography and meteorology. Balances were also a strong feature in the exhibits of the above-mentioned firms, and of Messrs. Townson and Mercer, the last-mentioned providing a good variety of glass apparatus. It was satisfactory to observe that those essentials, best quality porcelain and filter papers, have not been neglected. There is evidence that the efforts of the British Science Guild have stimulated the manufacturers; without doubt the guild, by bringing before the Government the fundamental importance of the supply of scientific apparatus, has done a great service to science teaching. It is inevitable that prices should be advanced, and doubtless there will be some shortage in the supplies here and there; but it is a matter for congratulation that the main requirements are being so well met by British firms under conditions of exceptional difficulty.

Exhibitions of books were held at the University of London, and also at the Science Masters' and the Assistant-Masters' meetings. New scientific books are being steadily issued, and the general state of the book-trade, so far as leading publishers of educational works are concerned, appears to be far more normal than could have been anticipated. This implies that instruction is proceeding with but little disturbance.

The inventiveness of the Science Masters shows no diminution. The Rev. W. R. Burton (Sandwich) showed several of those simple and cheap devices which combine the merits of economy with pedagogic effectiveness. An instance was an electroscope costing one shilling, the main insulator being a piece of candle deprived of its wick. Mr. D. R. Pye (Winchester) showed a most effective wave-motion model; even more educative was his model illustrating diffraction at a straight edge, of light from a point source. From Rugby came an admirable exhibit of chemical preparations made during the summer holidays, under the direction of Mr. E. R. Thomas. The Rugby exhibit included useful devices in the fitting of apparatus, and stereochemical models made almost instantaneously by the use of plasticine—a useful lecture "tip." To the present writer it seems a pity that these exhibitions should not be accessible to a larger number; if they could be transferred to South Kensington as soon as the P.S.S.M.A. meeting was concluded, their sphere of stimulating usefulness would be widened.

Mr. M. D. Hill (Eton) opened a discussion on "School Museums," the general outcome of which was the importance of frequent change in the objects shown, and the relatively great value of living objects, aquaria, etc. The curator must regard the function of the museum as dynamic rather than static. It was so much easier to follow the arguments of the speakers whenever the hearer knew the buildings in which the work was done, that it is here suggested that the British Association committee which is dealing with the subject should obtain a collection of photographs and lantern-slides of school museums.

The meeting of the Science Teachers' Association was largely attended by science mistresses, the proportion of men present being small. Miss Durham gave a lucid account of Mendelian laws, and described successful researches on the heredity of mice, canaries, and primroses. The association has recently formed small committees with the object of making it easier for teachers in schools to follow the growth of various branches of investigation. During the past year some papers have been read and circulated among members, of which we may instance "Development in Chemistry during the War," by Miss S. T. Widdows. Membership of the association is open to science masters, and it is hoped that those who realise the value to the nation of science in the schools and desire to promote efficiency by combined effort will communicate with the honorary secretary, North London Collegiate School, Sandall Road, N.W., with a view to membership.

These notes may finish with a quotation from the address on "The Teaching of Imperial History," by Sir Charles Lucas, to the Historical Society:—"What differentiated modern from ancient and medieval history was science and scientific invention. Scientific teaching has never been treated as the central and omnipotent force in the life of the nation, but democracy is the direct result of scientific invention and not of Acts of Parliament. The history of the past fifty years has been a record of the manner in which scientific invention has helped us by federating the different groups of Dominions."

G. F. DANIELL.

MODERN SYSTEMS OF INDEPENDENT LIGHTING AND HEATING.[1]

III. *Lighting by Electricity.*

THE problems of lighting country houses by electricity vary greatly according to the size of the installation. The owner of a large country house has the advantage of being able to afford a competent engineer, and, since he generates on a large scale, he may obtain electricity at a relatively cheap rate, in some cases even at a lower rate than that ordinarily allowed by the local supply company. On the other hand, many country mansions are but little used by their owners during a great part of the year. This intermittent demand for electricity is a drawback, as it does not conduce to economy, and makes it difficult to maintain the plant in a state of continued efficiency. It is naturally inefficient to have a large engine and dynamo running to supply only a few lamps.

In small houses, on the other hand, the demand, though comparatively small, is more constant. It is probable that in such cases, taking due account of the running cost of generation, the interest of the original cost of the plant, and the repairs to the plant and batteries, the cost of generation will probably not be less, and may be more, than 4*d*.–6*d*. a unit; however, with some of the most recent automatic types of plant, generation at a rate of 2*d*. per unit is said to be practicable.

In a large country house the source of power may be a steam engine or an engine run by suction gas or oil gas. When water-power is available a water-turbine would probably prove the most economical and convenient source of energy. It is also necessary to instal a battery of accumulators in order to provide a steady voltage, and the usual arrangements for the control of the supply, including the switchboard, measuring instruments, resistances, etc., must be provided. It is generally agreed that the current of accumulators alone gives the most steady source of supply, and accordingly the battery may be used for the lighting during the evening and charged during the day. Special arrangements may also be made to run the lights from the battery and dynamo in parallel. One advantage of a large battery, as well as a dynamo capable of supplying the entire load, is that one has an emergency supply in case of the engine breaking down. The maintenance of the battery in good order is one of the chief difficulties in those installations where little current is used during the summer. Accumulators ought to be charged and discharged at regular intervals. There are even cases in which it is necessary occasionally to discharge the battery through a resistance as an "artificial load" during the summer, thus wasting current in order to keep the cells in good order.

It is very difficult to quote definite figures of the cost of country lighting installations; generally speaking, the cost for a fairly large installation, including the plant, battery, and switchboard of mains to the house, might work out as follows:—

No. of lights (16 c.p.)	Initial cost of plant, etc. £
25–30	100
40–50	130–150
80–100	150–170
200	200–220

To this must be added the expenditure on fittings and the cost of internal wiring. The cost of wiring in country districts may be as high as 25*s*. to 35*s*. a point. It is remarkable how the expenditure under this heading varies, especially in converting old mansions, where unexpected obstacles in wiring, due to the structure of the building, are often met. In many cases it is also desirable to allow a fair margin in estimating as to the size of the plant, as it is often useful to have electricity available for other purposes, such as heating radiators and driving pumps and agricultural machinery, etc. In large country houses with a big plant, electric radiators are frequently used for heating rooms. The small consumer, however, will scarcely go to this length, but may make good use of small heating accessories, such as electric kettles, irons, etc.

The possibilities of electricity for lighting a country house have been much simplified by the introduction of the metal filament lamp, the improved efficiency of which as compared with carbon filaments makes it possible to light a house of a certain size with a much smaller plant. It is usual to work at a pressure of 50 volts for lighting, as this enables metal filament lamps to be used under the most efficient and economical conditions. Small candle-power lamps having stout filaments and exceptional durability are available for 50 volts. On the other hand, if power is to be transmitted a considerable distance the cost of mains becomes an important item, and it may be desirable to raise the pressure to 110 volts in such cases, so that the current to be carried by the cables may be diminished.

To the small householder, the care of the plant is naturally an important item, and he may have to rely to a great extent on his personal efforts in this direction. It is therefore essential that a plant for small users should be as simple and easy to operate as possible. For small installations, the usual practice is to employ a dynamo driven by a small petrol engine. During the last few years there have been great improvements in the simplification of such plants, which have reduced the attention necessary to a minimum. In particular, devices have been adopted to enable the plant to run automatically, ceasing to generate when all the lamps are turned off, in the same way as a petrol-air gas plant.

[1] Continued from p. 553.

One of the best known automatic plants of this type is the "Lister-Bruston." This plant has been specially designed with the view of avoiding the expense of the large batteries of accumulators ordinarily demanded by country-house lighting. The plant consists of a dynamo driven by an internal-combustion engine, but only a small set of accumulators is needed. These accumulators are sufficient to supply three or four lamps without running the plant. When, however, more lights are switched on, the current demanded by the lamps causes a relay, or automatic switch, to make contact, and the current from the battery then passes to the dynamo, which rotates for a few seconds as an electric motor, this starting the engine. From this point onwards the load is taken up by the engine and the dynamo, the battery, however, being in parallel. By this means the battery is kept charged, and has a steadying influence upon the electric pressure. In the same way, when the lights are sufficiently reduced, the relay breaks the circuit to the dynamo and the engine stops, the few remaining lights being again run by the accumulators.

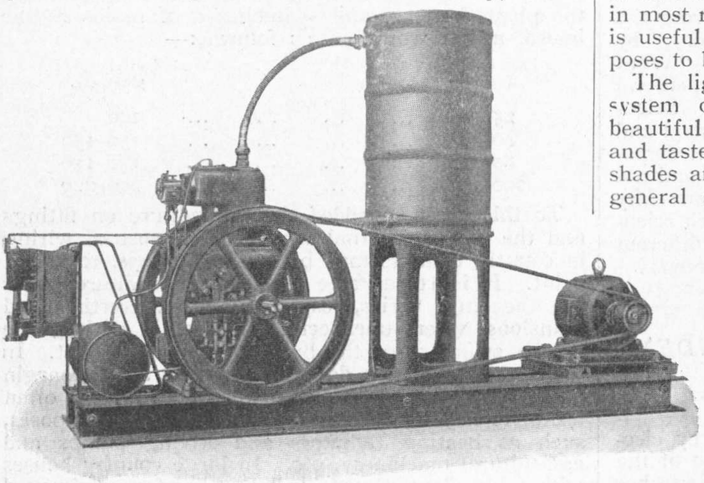


FIG. 1.—The Lister-Bruston electric generating plant. A petrol-driven engine drives a small dynamo, supplemented by a battery of small accumulators. By means of a special relay switch (shown on the left) the battery starts up the engine when more than a few lamps are put on. Similarly the switch is automatically released and the engine stops, when the load falls below a certain value. The plant is thus automatic in action and only a small battery is needed.

The plant is thus automatic in action, and is not run when the load is very small. In the event of the engine failing, the load will be taken up by the battery for several hours while the defect is put right. One advantage of the system is that the charging of the battery is automatically attended to, and the danger of permanent damage owing to the cells being allowed to remain uncharged for a long period is avoided. The success of such an automatic system demands an exceptionally robust type of cell, but it is claimed that these cells can be left to themselves for a long time without deteriorating. The firm also undertakes to keep plant and battery in order for a small annual sum.

While this system is mainly intended for lighting for country houses, it has also been applied to the lighting of small villages. In this case, the usual arrangement is to have several engines of varying capacity, which are automatically switched into circuit as the load increases and disconnected when the demand is small. This ensures that the plant is always working at full output and maximum efficiency.

Finally, a few words may be said on the illumination of country houses in general. It is most essential that the arrangement of the lights in the house should be carefully studied. Cases are sometimes encountered where a large, and even an unnecessarily large, plant has been installed, and yet the electricity available is not used to the best advantage. It is necessary to consider the purpose of the lamps in each room, and their positions should be selected with care. Bare metal filaments are inconveniently bright, and appropriate shades, softening the light and distributing it where it is chiefly needed, should be provided. By attending to these points it is often possible to manage with a much smaller plant than would otherwise be necessary. When electric light is used, the consumer should be cautioned against undue economy in the matter of switches and plugs. It is best to arrange for full control of the lights, so as to avoid the waste of burning an unnecessary number; in most rooms a series of plug outlets round the walls is useful in enabling portable lamps for special purposes to be employed.

The light should also be regarded as part of the system of decoration of the room. An otherwise beautiful interior may be marred by an incongruous and tasteless fitting; on the other hand, appropriate shades and fixtures harmonising with the colour and general style of decoration of the room add to its effect.

In converting old mansions to modern illuminants, considerable skill and artistic perception are often needed. Moreover, the lighting of each particular room, hall, dining-room, drawing-room, kitchen, bedroom, etc., presents a different problem. On the care with which this problem is studied the whole utility of the generating plant depends.

Petrol-Air Gas for Heating.

IN the article entitled "Modern Systems of Independent Lighting and Heating" in NATURE of January 6, p. 522, the section dealing with heating was necessarily curtailed, and Mr. W. Willett directs our attention to one point relating to his petrol-air gas system on which further explanation is needful. It should be explained that either a rich or a poor mixture of petrol and air can be obtained, the richer mixture being preferred for heating. For example, as stated, with the Willett plant a mixture of 2 per cent. of petrol is recommended for lighting; but the plant can be worked at either a 2 per cent. or a 6 per cent. mixture, according to the use for which it is intended. In country laboratories a richer mixture than 2 per cent. would be employed. Those selecting a plant would naturally turn to the makers for fuller particulars on this point.

THE BONAPARTE FUND FOR 1915.

THE committee appointed by the Paris Academy of Sciences to examine the requests for grants from the Bonaparte Fund make the following proposals, which have been confirmed by the academy:—

3000 francs to Auguste Lameere, professor at the University of Brussels, to enable him to continue his researches at the Roscoff Zoological Station.

4000 francs to Charles Le Morvan, assistant astronomer at the Paris Observatory, for the publication of a systematic and photographic map of the moon.

2000 francs to Paul Vayssière, for the continuation of his researches on the various species of cochineal insects.

3000 francs to François de Zeltner, to contribute to the cost of a proposed expedition to the Sudanese Sahara, more particularly in the Aïr massif.

2500 francs to Léonard Bordas, to assist him in pursuing his investigations relating to insects attacking trees and forests, and more especially species which at the present time are devastating the woods of the central plateau and west of France.

3000 francs to Joseph Bouget, botanist at the Pic du Midi Observatory, for realising his cultural experiments on a larger scale, with special reference to the improvement of the pastures of the Pyrenees.

3000 francs to Henry Devaux, professor of plant physiology at Bordeaux, for the continuation of his researches on the cultivation of plants in arid or semi-desert regions.

2000 francs to Victor Piraud, for the continuation of his studies on the fauna of Alpine lakes and torrents, particularly at high altitudes.

2000 francs to Marc Tiffeneau, for the continuation of his studies on the phenomena of molecular transposition in organic chemistry.

THE PRINCIPLES OF CROP PRODUCTION.[1]

IN any discussion of the principles of crop production it is necessary to begin with the year 1840. By that time it was definitely known that plants consist mainly of organic matter along with a little mineral matter—phosphorus, calcium, potassium, sodium, etc.—to which, however, very little importance was attached. The practical man knew that farmyard manure was the great fertiliser; he also knew that other substances, bones, salt, etc., had, in certain circumstances, considerable fertilising value. The most obvious facts were the large amount of organic matter in the plant and the large amount of organic matter in the best manures; and it is only natural that chemists and physiologists should have connected these, and argued that the object of the manure was to furnish organic matter for the plant.

By a brilliant stroke Liebig, in 1840, brushed aside this obvious connection and declared that the true function of the manure was to provide, not organic matter, but the mineral constituents which the chemists had ignored. The first step, he said, was to find out what mineral constituents the plant contains, and then to supply these substances in a suitable form. If any one of them is lacking the soil is rendered infertile, and matters will not be put right until that one is added. Thus the whole art of manuring was reduced to an exact science.

Unfortunately Liebig's prescriptions failed in practice. The Rothamsted experiments showed that his ash constituents gave little better crops than no manure at all. Liebig had left something out; it was necessary to add nitrogen as well before complete growth could be obtained.

The critics urged that the effects would only be temporary; that in time the land supplied with "artificials" would give out. Experience has shown that this is not so; similar good results have been obtained at Rothamsted over the long period of more than sixty years (Fig. 1).

Part, therefore, of Liebig's principle is perfectly correct: the mineral constituents are indispensable and must be supplied to the plant. The mistake was to suppose that they were sufficient. We may take it as established that crops can be grown satisfactorily and indefinitely by supplying proper quantities of suitable compounds of nitrogen, phosphorus, and potassium. This we can call our first principle. Difficulties arise, however, directly one tries to develop it in practice. Trouble began with the attempts to find out what are suitable quantities to use. Liebig had supposed that the requirements of a crop could be gauged by the composition of the ash. Lawes and Gilbert showed that this was not the case. Thus the ash of the turnip crop contains a considerable amount of potash but only little phosphate; according to Liebig, it should have required mainly a potassic fertiliser. Lawes and Gilbert showed, however, that it required phosphates and not potash, and they concluded that the special requirements of a crop could only be discovered by actual trial.

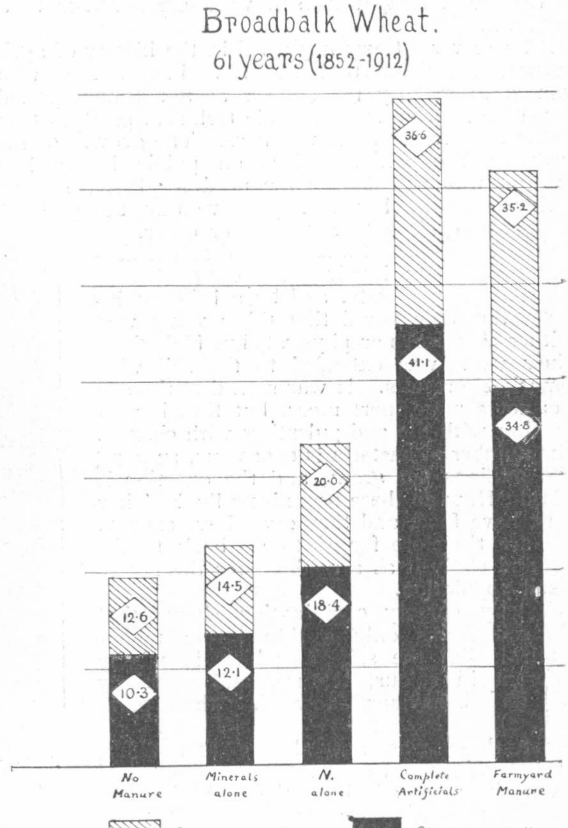


FIG. 1.—Yield of wheat on the Broadbalk plots, average of sixty-one years' results. (The figures in the diamond-shaped spaces denote bushels of grain and cwts. of straw respectively.)

When nitrogen compounds are withheld the yield is little better than on the unmanured plot. Complete artificial fertilisers give a full crop which is fully maintained to the present time, and in this case is better than that given by farmyard manure.

This view was developed in the 'sixties in a series of brilliant lectures by Ville. After numerous experiments (he says "many thousands"), he drew up the following list, showing the special need, or, as he called it, "the dominant," for each crop:—

Ville's List of Dominants.

Nitrogen	for	Cereals.
,,	,,	Beetroot.
Potash	,,	Potatoes.
,,	,,	Vines.
Calcium phosphate	,,	Cane-sugar.
No dominant	,,	Flax.

In order to ascertain the special needs of the crop on a particular soil, he grew the plants on a series of plots, one of which was given the complete manure,

[1] Lecture delivered before the Chemical Society on November 18, 1915, by Dr. E. J. Russell. Abridged from the Journal of the Society for December, 1915.

whilst the others each had one constituent left out. Thus for wheat he obtained the following results, and, therefore, concluded that on this soil wheat requires a good supply of nitrogen, less phosphorus, and still less potassium :—

	Crop per acre. Bushels.
Normal manure	43
Manure without lime	41
,, ,, potash	31
,, ,, phosphate	26½
,, ,, nitrogen	14
Soil without manure	12

The method, of course, is perfectly sound, and it has been very widely adopted. It is, however, frankly empirical, and empirical work is never very inspiring, so that for a long time soil work came rather to a standstill.

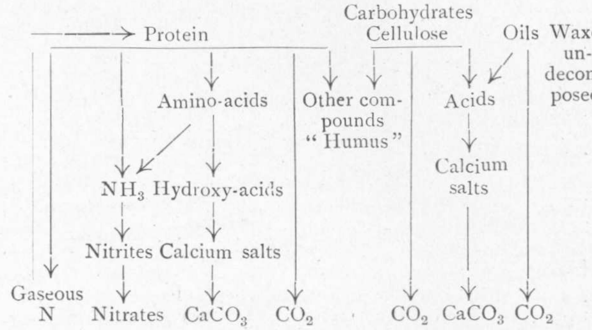
It has several times happened in the history of agricultural chemistry that the new illuminating idea wanted to revivify the subject at a stagnant period has come in from some outside technical problem that had to be solved. So it was here. The growth of the towns and of stricter ideas on public health had brought into prominence the need for better sewage purification, and it was imperative that the problem should be dealt with somehow or other.

Schloesing and Müntz found that satisfactory purification involved the conversion of ammonia into nitrate, and by a brilliant investigation they found that this process was neither chemical nor physical, but biological. Their work was extended to the soil with remarkable results. It was seen that the soil was not a mere inert mass, but that it was teeming with life and pulsating with change. The number of bacteria is enormous, running into millions per gram, and the question is raised: How do these organisms live? They must have food, and they must have energy. We are therefore forced to go back to the soil and study it as a medium for the life of a soil population.

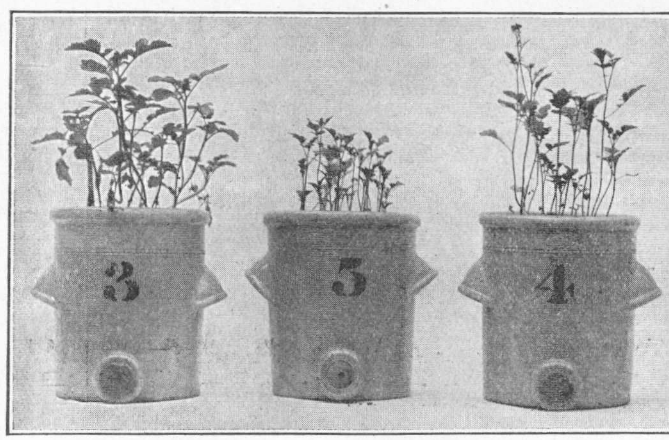
A very cursory examination shows that the soil forms only a thin layer; underneath it lies the subsoil, which is wholly different in colour, texture, and especially in its behaviour towards the plant (Fig. 2).

Yet there was not always this difference. When the soil was first laid down it was all like the subsoil, and whenever a new surface becomes exposed, either by landslips, cliff-falls, etc., it is always the subsoil type that appears. The first vegetation has no great supply of plant nutrients, but plants suited to the conditions nevertheless spring up. They take what they can from the crude soil, they take carbon dioxide from the air, they synthesise sugars, starches, cellulose, proteins, etc., deriving the necessary energy from sunlight. When the plants die they fall back on the soil and return to it all that they took, and a good deal more of new material besides. That introduces a fundamental change.

The new material thus added contains stores of energy and food substances suitable for the bacterial population, which forthwith flourishes. Decomposition goes on, nitrates and other substances are produced, and the conditions are made more favourable for the growth of a new race of plants. One of the most obvious changes is the formation of nitrates, but other products are formed as well. It is proving exceedingly difficult to trace out full details, but the following is probably in the main accurate :—



Unfortunately, not much is known about the details, but the reaction is extremely important. The initial products are of little value to the crop or the soil. The final products are invaluable for plant nutrition, and some of the intermediate products are very valuable for the soil. This, therefore, is the reaction on which plant nutrition depends, and it is of the highest importance that it should proceed rapidly and smoothly. Where for any reason it does not, the soil becomes unproductive.



Soil Sand Subsoil

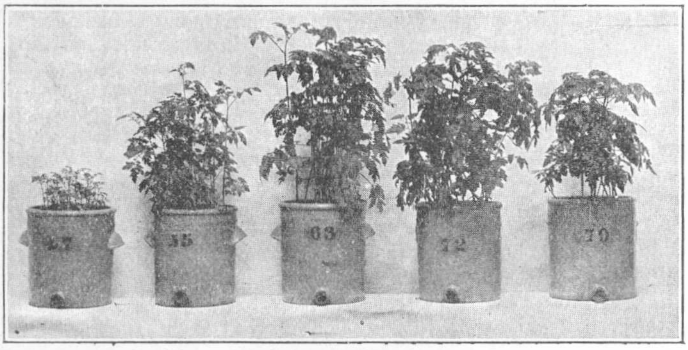
FIG. 2.—Plants grown in soil, sand, and subsoil respectively, all without manure, showing the marked differences in behaviour towards the growing plant.

Scientific crop production depends largely on controlling this reaction. Three things are necessary: the conditions—the air supply, water, temperature, etc.—must be favourable; the organisms must be of the right kind; and the supply of raw material—plant residues—must be kept up.

We shall see later on how the favourable conditions are obtained. Hitherto little has been done to control the organisms beyond improving the conditions, but beginnings have been made in the direction of inoculation and partial sterilisation. The supply of raw material is kept up in several ways; probably the oldest is to leave the ground alone, so that it covers itself with wild vegetation, which is then ploughed in. This formed part of the Mosaic law; it was the regular medieval custom in our own country, and it is practised to this day in Connemara. It is too haphazard for modern use, however, and so nowadays the farmer grows a special crop with the express intention of ploughing in all or part of it, or of feeding it to animals and ploughing in the excretions.

The second broad principle of crop production is, then, that the biochemical decompositions in the soil must proceed smoothly and rapidly.

New difficulties arise as soon as one begins to develop this principle. Reverting to the scheme just given, it is seen that the decomposition of proteins may proceed in two ways, either ending with nitrate or with nitrogen. Now the nitrate ending is desirable enough, but the nitrogen ending is highly undesirable. Yet this happens directly the process is speeded up too much. The more intense the cultivation becomes the more serious are these losses; they are bad on the prairies, but still worse under conditions of intense cultivation. To some extent this is inevitable; it is equally true of engines, but just as the engineer has increased the efficiency of engines, so the agricultural chemist has to increase the efficiency of the nitrogen utilisation processes.



Pot No. 47 55 63 72 79

FIG. 3.—Tomatoes supplied with increasing doses of nitrate of soda.

Pot 47.—No nitrate. Pots 55 to 79.—Increasing dressings of nitrate. This increases the amount of growth up to pot 72, but it depresses growth in pot 79, where too much is given. The middle pot, 63, is best for fruit. Phosphates and salts, potassium, calcium, etc., were given equally to all pots.

Unfortunately, the purely chemical work on the decomposition of protein has not gone far enough to enable a full working hypothesis to be mapped out. The decomposition does not stop at amino-acids; under bacterial action there is a further change to bases and acids. These are under investigation in several chemical laboratories, but the results have not yet helped us much. Here, therefore, we have an economic problem of the first importance waiting for the solution of a chemical problem which, at first sight, seems rather academic and remote from practice.

These biochemical changes, important as they are in crop production, do not end the matter. The soil comes directly into the reaction. The calcium carbonate neutralises acids produced during the decomposition. The clay and some of the other constituents possess colloidal properties, so that all these reactions proceed on a jelly-like surface and not in a fluid medium, and they are liable to be affected by all the complications produced by surface actions.

The plant plays an even more active part. Its roots absorb some of the products—the nitrates, the phosphates, etc.—and might therefore be expected to hasten the whole process; but this does not happen. On the contrary, the growing plant appears to retard it, and nitrate is always formed in higher quantities on fallow than on cropped land, even after allowing for what is taken by the crop.

Whether the growing plant affects the nature of the change or only the rate is not yet known. The essential point is that, so far as plant nutrients are concerned, neither the soil nor the plant plays an entirely passive part. The soil is not an inert medium, and the plant is not a mere passive bucket into which the products of the reaction are drawn; each plays an active part, disturbing both the reaction and the distribution of the products.

The recognition that the plant is a living thing has broadened our conception of the factors necessary for plant growth. In much of the literature of the 'seventies and 'eighties it is tacitly assumed that the whole art of crop production is a question of manuring. Whitney's investigations on American tobacco, however, led to the recognition that the type of the soil is an important factor in crop production, which has had some extremely interesting developments. Mechanical analyses to determine the type became an indispensable part of the routine of soil analysis. The perspective was restored, and the fact emphasised that the plant not only wants food, but also proper water supply, air supply, and temperature.

Now there is a very simple rule that applies to all these factors. Plant growth increases with increasing supply of any one of them, but this only happens so long as the supply of every other factor is adequate. When anything is lacking the increase in growth is not kept up, and additional supplies give no extra crop. Finally a stage is reached when extra supplies may do harm, either by direct injury or by cutting out another indispensable substance. This is shown in the tomato experiments of Fig. 3, where successively increasing doses of sodium nitrate are applied in the four pots 55, 63, 72, and 79, although no further growth is obtained in 72 and 79 because of the insufficient water supply. The conditions for favourable growth are all present in pots 72 and 79 excepting only this one, but it effectually prevents the plant from taking full advantage of the good conditions. All this is expressed in a generalised form in the curve of Fig. 4, which thus represents our third principle of crop production. It has only recently been revived in agriculture, although the fundamental idea is old; it can be found in the writings of the political economists of the Malthusian school; it was used in a special form by Liebig in his "Law of the Minimum"; it was developed by Horace Brown and F. F. Blackman. In its full generalised form it is proving extremely useful.

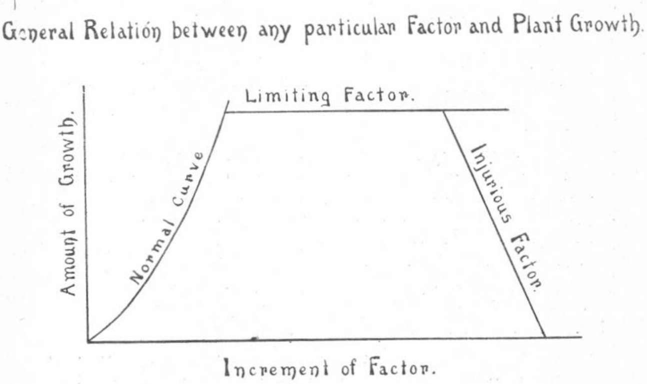


FIG. 4.—Increases in amounts of the various factors necessary for plant growth do not cause indefinite increases in growth. After a time some other factor becomes insufficient and operates as a limiting factor.

Problems of soil fertility generally have to be approached from this point of view. Whenever a case of infertility has to be studied the first question to settle is: What is the limiting factor? And the next: How can this limiting factor be put out of action? As a rule the limiting factor is one of the following:—

Limiting factor.	Put out of action by:
Wetness	Drainage, liming
Dryness	Irrigation, suitable cultivations
	Addition of organic matter
Lack of temperature	Drainage and cultivation
Sourness or acidity	Liming or chalking

The removal, although simple in principle, may be very difficult in practice: it has often proved to be the rock on which many beautiful schemes for increasing food production have been wrecked.

We have seen that, broadly speaking, three general principles of crop production can be laid down:—

(1) The plant must have a sufficient supply of all necessary nutrients, especially of nitrogen, potassium, and phosphorus.

(2) The biochemical decompositions in the soil must proceed smoothly and quickly.

(3) All the requirements of the plant must be satisfied. Any one left unsatisfied constitutes a limiting factor preventing further growth. Increases in any one factor give increases in growth until something else proves insufficient and becomes a limiting factor.

We go back, then, to our three established principles. Each of these can be recognised broadly in every case of crop production, but considerable difficulties arise when one tries to develop any of them; there are so many factors involved and their interaction is so complex. I can best illustrate this by taking one of the factors in some detail, and I will choose one that has received very much attention from chemists, namely, the supply of phosphates.

Phosphates are indispensable for plant growth, and well conducted physiological experiments in sand have shown a simple connection expressible by a mathematical equation between the amount of phosphate supplied and the amount of growth. But such simple results are never attained in soil. To begin with, there is always some phosphate already present. At first sight it looks easy enough to take account of this, and simply add it on as a constant in the equation. It has proved almost impossible, however, to give any precise value to the amount of phosphate in the soil that is of any use to the plant. Ville showed years ago that the amounts revealed by chemical analysis are far beyond anything the plant can ever get, and he rather gloomily concluded that "chemistry is powerless to throw light on the chemical properties of the soil." One could scarcely expect chemists to acquiesce in that view, nor did they. Instead of using strong acids, they used dilute acids; several were suggested, and by a happy inspiration Bernard Dyer selected 1 per cent. citric acid as being the most suitable; although that was twenty-one years ago, 1 per cent. citric acid still holds the field in this country.

The part extracted by dilute acids was called the "available" portion to distinguish it from the "unavailable." The new method at once proved very helpful; difficulties, however, began to arise. It was found impossible to assign any definite value to the amount of available phosphate present. Variations in the conditions of the experiment gave wholly different values for the amount of "available" phosphate, whilst in the case of nitric acid the longer the acid acted the less phosphoric oxide (P_2O_5) was extracted.

Now that gave the clue to the problem. It is obvious that there must be two actions going on: a direct solvent action and a reverse action, resulting in the withdrawal from the solution of the dissolved phosphoric oxide. The direct solvent action was found to be much the same for all dilute acids.

The reverse action proved to be the ordinary adsorption isotherm, similar in type to that obtained with charcoal and dilute acids. The constants are not the same for the different acids, and from these curves it is possible to go back and explain the apparently erratic action of the different acids on the soil.

Thus it appears that when phosphate is added to the soil for the purpose of increasing the growth of a crop it does not simply stop in the soil, waiting for the plant to take it up. It reacts with the soil; it is adsorbed, and the amount available for the plant at any time depends on the adsorption relationships. There is, in short, a competition between the plant and the soil for the phosphate. The curves for clay and sandy soils show that adsorption is greater for clay than for sand; in other words, the clay competes for the phosphate more vigorously than does the sand. An amount, therefore, which is sufficient for the plant growing in a sandy soil proves inadequate on a clay soil. This has thrown light on an interesting problem in manuring, for it has long been known that clay soils stood in more need of phosphatic manures than sands. The field results bring out this fact: the yield of barley on the heavy Rothamsted soil falls when phosphates are omitted, but it does not react nearly so quickly on the Woburn sand.

It seems a far cry from the logarithmic curve expressing an adsorption isotherm to the management of barley and turnips, but the connection is really simple and direct.

This, however, does not settle the matter. The plant is a living thing, and consequently its requirements are not rigidly constant, but vary with the conditions. There are very good grounds for supposing that the plant actually requires more phosphate on a clay soil than on a sand. The effects produced by phosphates are promotion of early growth, root development, and early ripening; they are specially valuable on clay soils, in wet regions, and for shallow rooting and quick growing plants, for example, swedes and turnips.

It is possible that some simple connection underlies all these, but no one has yet discovered it.

Again, seeing that the need varies with the conditions, it is clear that if the conditions are altered the needs may change. When, for instance, a dressing of farmyard manure is applied, some of the properties of the soil are altered; it becomes more porous and more retentive of water, and phosphates may behave differently from what they did before. That is well shown on the Saxmundham plots.

It is unnecessary to go any further. The point I want to bring out is that the simple and incontrovertible statement that phosphates increase plant growth proves very complex when applied in practice. So it is with the other factors. They can be disentangled and investigated, but it is not yet possible to put them together again and predict the resultant. One cannot set out from first principles and reconstruct the normal case of crop production; the factors are too numerous and too complex.

Yet something has got to be done. The technical chemist has the advantage over his colleague in the purely scientific laboratory that he cannot shelve an inconvenient problem. A method has been evolved, an empirical method, which, whilst not very rigid, has at least the merit that it works. It consists in going into the field and finding out the actual agricultural properties of the soil by observations, inquiries, and direct field experiments; these have to be repeated for two or three years because the first results may only have been a trick of the weather, but if the same result is obtained for several seasons running, one may be sure of being right.

All that is old; it is, of course, Ville's method over again. The new part consists in trying to extend the results to other soils. For this purpose a soil survey of the area, usually the county, is arranged. In this way a collection is made on one hand of the agricultural properties, on the other of the chemical, bacteriological, and physical data, of typical soils. It is obvious that the possession of these standard soils helps the analyst and expert adviser very considerably; if a farmer asks for information it is much easier and safer to compare his soil with the standard than to attempt any absolute measurements. Moreover, these soil surveys are greatly facilitating advisory and analytical work.

They do far more than that, however. The normal case of crop production can never be decided on purely laboratory methods because there are always two or three varying factors, whereas in the ideal laboratory experiment there is only one factor varying. We are not, however, confined to the ordinary laboratory methods. Statisticians have to deal with problems involving two or three variables, and they have worked out a method—the method of correlation—which, when intelligently applied, gives valuable results. It is hoped to apply this to crop production. The necessary masses of data are slowly being accumulated, and it is anticipated that very interesting results will be obtained.

The ordinary laboratory method, however—the one factor method—may still on occasions work satisfactorily. It sometimes happens in nature that one of the various interacting factors overshadows all the rest and virtually eliminates them, so that here, too, it is possible to apply laboratory methods with satisfactory results.

For example, on a certain type of clay soil the whole situation is controlled by the circumstance that phosphates are almost absent, whilst the need of the plant for phosphates is particularly great. The addition of basic slag in these circumstances has caused most remarkable improvement. The best instances are seen at Cockle Park, and the results are given in their bulletins.

Another illustration is furnished by our work on the partial sterilisation of soils. The simplest explanation of the phenomena is that the soil population can roughly be divided into two groups: one favourable to the production of plant food, the other not. The useful population is, on the whole, more resistant to adverse circumstances than the harmful organisms, and therefore survives more drastic treatment. Hence any method that kills some, but not all, of the soil population effects an improvement and leads to good results. A continued spell of favourable conditions, however, enables the harmful organisms to establish some sort of superiority. This hypothesis throws important light on the behaviour of the soil in natural conditions, and it reveals another factor in crop production.

We have not yet succeeded in making much of it in the normal case; indeed, we have scarcely attempted to do so, because there are so many interacting factors. There are, however, cases where this one factor largely dominates the situation. In glasshouses run at a high pitch, where the soil temperature and water content are high, and where large dressings of organic manures are used, the bacterial efficiency falls off so much that the plants begin to suffer. The soil, in the picturesque language of the practical man, is said to become "sick." This sickness proved so difficult to deal with in practice that the soil was thrown out and new soil brought in to take its place.

It was not difficult, however, to suggest a remedy. The reduction of bacterial activity seemed clearly due to an excessive development of the detrimental organisms. It was only necessary to adopt partial sterilisation to get rid of these and to give the useful organisms a better chance of action. The basis of a suitable method was already in existence; steam had been used to kill insect pests in the houses, and by suitable modification this process was successfully used for the treatment of sick soils.

The most fruitful ideas for working out the development of our subject have often been got from abnormal cases brought in by the growers. Practical men have the great advantage that they are compelled to keep their eyes open for nature's problems; they cannot shirk them, or they find their crops suffering and themselves losing money. The close association of science with an industry is, therefore, a great advantage, because it brings in new problems which, if properly investigated, may prove extremely valuable in opening up new fields of knowledge. There is an exhilarating freshness about all this work that one often misses in the more academic investigations.

All the same, while speaking in praise of applied science, one must recognise that science cannot be applied until it is developed. We have seen, and instances might have been multiplied, how the hydrolysis of protein throws light on the proper management of a manure heap, and how the adsorption isotherm worked out for charcoal and dilute acids clears up a difficulty in the manuring of turnips. It is impossible to set any limit to the value of good work in science honestly carried out. The fact is that science and creative industry are one and indivisible, and any attempt to divorce them may only end in disaster.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE *Morning Post* of January 18 announces an anonymous gift of ten thousand guineas to King Edward's Hospital, Cardiff, towards the cost of new extensions.

THE *Times* of January 14 announces that Sir Alexander M'Robert has given to Aberdeen University an endowment of about 750*l.* per annum for a Georgina M'Robert lectureship on pathology, with special reference to malignant diseases.

THE National Diploma Examination in Agriculture of the National Agricultural Examination Board will be held at the University of Leeds on April 14 and following days, and examinations in the science and practice of dairying will take place in September at the British Dairy Institute, Reading, and at the Dairy School, Kilmarnock. Entries for the first-named examination must be sent in not later than March 1, and those for the latter ones not later than August 15.

THE December issue of the *Reading University College Review* is largely a record of the continued effect of the war upon the work of the college. All the conditions during the first year of the war have affected also the first term of the present session, but in greater measure. The number of men day-students at the beginning of the term had fallen to about forty, and of this number some left at the end of last term in order to undertake military service. More members of the academic staff have undertaken military or Government service, and others are likely to follow their example. Wantage Hall is again in military occupation, and the council has agreed to place rooms and offices at the disposal of the Flying School which is about to be formed in Reading. Munitions work has been instituted in the physical laboratory, and the making of splints for use in hospitals is being carried on in the building devoted to craft work. The lists of military distinctions and of officers killed in action, as well as the list of present members of the staff, past and present students, and present servants of the college serving with the Forces of the King or in the French Army, printed in the magazine, are a splendid tribute to the loyalty and patriotism of the institution.

FOUR points relating to the place of science in education are dealt with by Sir E. Ray Lankester in a letter to the *Times* of January 14. The first consideration is that instruction in the elements of physics, chemistry, and biology must not be limited to the few, but be a part of the education of all; for they are equally necessary for the conduct of public affairs in a progressive spirit as for the development of industries. The view that attention to scientific knowledge necessarily leads to the barbarisms committed by our German adversaries is as illogical as it is untrue. The men who are responsible for the present conflict are not men of science but historians and other official advocates of world-power by Germany; and the military authorities have made use of whatever forces scientific discovery can give them. The third point referred to is that science in the public schools and universities is regarded as specialisation, whereas Greek and Latin and allied subjects are considered to be parts of a general education. This view is a legacy of past centuries, and should be the reverse of the truth for modern times, though classical headmasters will not understand the different needs of to-day, and will not depart from the ways of traditional instruction. Sir Ray Lankester places the chief burden of responsibility for existing conditions upon the Civil Service Commissioners, who assign an overwhelming excess of marks for classical and literary learning in examinations for the chief posts in the national service. He would give one-half of the possible total to science, which should be compulsory for all candidates, one-quarter to mathematics, and one-quarter to the classical and literary group; and he believes that "the one and only way of saving the country from utter inefficiency and consequent ruin is for the Legislature entirely to remodel the competitions for the valuable posts of the Home and Indian Civil Services."

AN interesting supplement on "War and Education" appeared in the *Times* of January 14. It is a commonplace that a great war is invariably followed by educational reform, and in the first article this is illustrated in English education from Alcuin to the South African war. It was the last-named which led to measures —medical inspection and provision of meals—for securing better physical care of school children. In most of the articles the importance of character training receives due recognition, the columns headed "A Lesson of Empire" and "Teaching Patriotism" being written with force and judgment. The editor directs attention to the great need of the immediate future, the training of boys and girls between the ages of fourteen and seventeen. At present two millions below the age of seventeen are receiving little or no education either in school or in skilled work. All who have given thought to the matter are in agreement as to the importance of educating our adolescents, both from the point of view of ethical training for citizenship and of increasing productive efficiency, but not all thinkers will agree as to the methods advocated by the editor of the "Educational Supplement." Dr. M. E. Sadler discusses the comparative merits of German and English education, and gives as the defects of English education: (1) too low a standard of *mental* training, hence failure to realise the value of pure science; (2) uninstructed parental opinion; (3) failure to stimulate intellectually the average boy and girl; (4) inertness of mind towards science in industry, public administration, and domestic management; (5) neglect of personal hygiene in its widest sense. British schools must impart love of knowledge and care for conduct; love of adventure and readiness to endure routine; capacity for individual initiative, and patience in the work of scientific co-operation. All the articles are useful so far as they go; it is a matter for regret that Dr. Sadler is alone in recognising the necessity for greater attention to science. The unfortunate and serious omission to give proper consideration to this vital need is a defect in an otherwise able and helpful symposium.

With the approval of the War Office, Colonial Office, and Board of Education, and of the High Commissioners of the Dominions beyond the Seas, an organisation has been formed with the title of "The Fighting Forces Book Council." This organisation, of which Lord Bryce is president, and Sir Edward Ward the chairman of the executive committee, is intended to supplement, and not in any way to overlap, existing bodies, such as the Camps Library, which is the recognised collecting and distributing depôt for the books sent through the medium of the General Post Office, the Red Cross, and St. John's Ambulance War Library, which supplies the hospitals, and the Young Men's Christian Association. Through the machinery of these various organisations large quantities of books —mainly light fiction—are being regularly distributed to the forces on active service, naval and military hospitals, and convalescent camps, both at home and abroad. It has been found, however, that books of a more solid kind are asked for by an immense number of educated men now in the military service of the Empire. The objects of "The Fighting Forces Book Council" are to try to meet this need, and at the same time to assist the existing organisations in every possible way. It proposes to: (1) raise funds for providing reading matter of the kind indicated above for his Majesty's Forces at home and abroad, including the wounded and convalescent and the British prisoners of war; (2) procure, by purchase or gift, books of this kind in sufficient quantities, and arrange for their distribution through the Camps Library to the various organisations and corps; (3) draw up lists of such books required by, or suitable for, various types of men. An appeal is made for funds to carry on this work, and we trust that it will meet with a ready and generous response. Contributions should be forwarded to Dr. I. Gollancz, treasurer of the Fighting Forces Book Council, Seymour House, Waterloo Place, London, S.W., or to the London County and Westminster Bank, Law Courts Branch, W.C.

SOCIETIES AND ACADEMIES.

LONDON.

Aristotelian Society, January 3.—Dr. H. Wildon Carr, president, in the chair.—Prof. A. N. **Whitehead**: Space, time, and relativity. Mathematicians have succeeded in defining diverse Euclidean measure-systems without any reference to distance. There are alternative groups of such congruent transformations of space all equally applicable, but, while the distance P_1P_2 may equal the distance Q_1Q_2 for one measure-system, it will not equal it for another. The extraordinary thing is that each of us does, as a matter of fact, employ a determinate measure-system which remains the same, except probably for very small variations, and that the measure-systems of different human beings agree, within the limits of our observations. This, however, is different in regard to time. Owing to the fact that points of space are incapable of direct recognition, there is a difficulty in determining what is at rest and what is in motion, and a further difficulty of determining a definite uniform flow of time. If all physical influences require time for their propagation in space, the idea of an immediate presentation to us of an aspect of the world as it in fact is must be abandoned. What we perceive at any instant must, in that case, already be ancient history, with the dates of the various parts hopelessly mixed. Again, if all physical influence is electro-magnetic, all influences are propagated with the velocity of light *in vacuo*. But what dynamical axes are we taking as at rest? There are two possibilities. We may assume either (*a*) that one set of axes are at rest and that the others will show traces of motion in respect to the velocity of light, or (*b*) that the velocity of light is the same in all directions whichever be the dynamicial axes assumed. The first supposition is negatived by experiment, and hence we are driven to the second, which immediately lands us in the whole theory of relativity.

Geological Society, January 5.—Dr. A. Smith Woodward, president, in the chair.—E. B. **Bailey**: The Islay anticline (Inner Hebrides). Other observations in regard to the "Schistose Islands" of Scotland are passed in review, and many of them confirmed. Certain new interpretations are offered. (1) An important fault, perhaps the Great Glen Fault, passes through the hollow separating Colonsay and the western peninsula of Islay from the rest of the archipelago. (2) The dolomitic "Fucoid Beds" are not the highest geological subdivision of the district. They are earlier than, and structurally they underlie, the greater part of the Islay Quartzite, as well as the whole of the Port Ellen Phyllites and Easdale Slates. (3) Several correlations must now be abandoned. Thus the Scarba Conglomerate is not the equivalent of the Portaskaig Conglomerate, but is of considerably later date. (4) Small-scale isoclinal folding is of less significance in the greater part of the district than has sometimes been thought. The main feature of the tectonics of eastern Islay is a comparatively simple isoclinal anticline overthrown towards the north-west upon the Loch Skerrols Thrust. (5) Finally, grounds are given for believing that an accurate knowledge of the structure and rock-succession of Islay is of crucial importance in determining the tectonic plan of the West Highlands generally.

Paris.

Academy of Sciences, January 3.—M. C. Jordan in the chair.—G. **Bigourdan**: The manuscrips of the works of Jean de Lignières.—G. **Humbert**: Continued fractions and indefinite binary quadratic forms.—Paul **Appell**: The hidden relations and the apparent gyroscopic forces in non-holonomial systems.—Henry **Le Chatelier**: The laws of solution. A reply to M. Colson.—M. de **Sparre**: The projectory of projectiles shot with high initial velocity with an angle of projection in the neighbourhood of 45°.—Pierre **Delbet**: The action of antiseptics on pus. Experiments on the effects of antiseptics on pus *in vitro* gave unexpected results, as even after twenty-four hours' contact sterilisation was the exception. A 2 per cent. solution of carbolic acid was sterile in six cases out of fifteen; ether, corrosive sublimate, hydrogen peroxide, Dakin's solution, Labarraque's solution, were all less effective.—J. Comas **Solà**: Some astronomical applications of stereoscopic photography. Description of a special apparatus, the "stereogoniometer."—Pierre **Humbert**: The simplification of a formula of Liapounoff.—L. **Tschugaeff** and W. **Lebedinski**: A new series of platinum compounds analogous with Cossa's salts. Acetonitrile resembles ammonia and the organic amines in its reaction with soluble chloroplatinites.—Domingo de **Orueta** and S. Piña de **Rubies**: The presence of platinum in Spain. Between Malaga and Gibraltar, in the Ronda massif, there is a series of rocks strongly resembling the platiniferous rocks of the Urals. Borings made near Taguil gave proportions of platinum varying from traces to 28 grams per cubic metre, the average of fifty borings giving about 3 grams per cubic metre. On account of its importance, the matter has been taken up by the Spanish Government, with a view to the thorough investigation and ultimate exploitation of the deposit.—Emile **Saillard**: The attack of beetroot by *Cercospora beticola*.—Jules **Regnault**: A case of lateral thoracic cords, probable embryonic vestiges of Wolf's band in a man.—Paul **Godin**: The individual formula of physical growth for children of both sexes.—Maurice **Mendelssohn**: Galvanotaxy of the leucocytes. A description of changes of form and motion observed in leucocytes when acted upon by galvanic currents.—C. **Houlbert** and C. **Galaine**: The formation of shell partitions (*chambrage*) in oysters and the possible infection of these spaces by a parasitic Annelid of the shell.

BOOKS RECEIVED.

Board of Agriculture and Fisheries. Fishery Investigations. Series II.—Sea Fisheries. Vol. ii., No. 3. Pp. 31. Vol. iii., No. 1. Pp. 46. (London: H.M.S.O.; Wyman and Sons, Ltd.) 2*s.* and 3*s.* respectively.

An Inquiry into the Statistics of Deaths from Violence and Unnatural Causes in the United Kingdom. By Dr. W. A. Brend. Pp. v+80. (London: C. Griffin and Co., Ltd.) 3*s.* 6*d.* net.

A Student's Heat. By I. B. Hart. Pp. vii+376. (London: J. M. Dent and Sons, Ltd.) 4*s.* 6*d.*

Applied Mechanics, First Year. By H. Aughtie. Pp. 184. (London: G. Routledge and Sons, Ltd.) 2*s.* net.

Textile Mechanics. By W. Scott Taggart. Pp. vii+117. (London: G. Routledge and Sons, Ltd.) 2*s.* net.

Proceedings of the London Mathematical Society. Second Series. Vol. 14. Pp. xxxviii+480. (London: F. Hodgson.)

Elementary Applied Mechanics. By Profs. T. Alexander and A. W. Thomson. Third edition. Pp. xx+512. (London: Macmillan and Co., Ltd.) 15*s.* net.

An Outline of Industrial History, with special reference to Problems of the Present Day. By E. Cressy. Pp. xiv+364. (London: Macmillan and Co., Ltd.) 3*s.* 6*d.*

Macmillan's Geographical Exercise Books. Key to I.—The British Isles. With Questions by B. C. Wallis. Pp. 48. (London: Macmillan and Co., Ltd.) 2*s.* 6*d.* net.

Willing's Press Guide, and Advertiser's Directory and Handbook, 1916. Pp. 472. (London: J. Willing, Ltd.) 1*s.*

Canada. Department of Mines. Geological Survey. Memoir 50: Upper White River District, Yukon. By D. D. Cairnes. Pp. iv+191. Memoir 60: Arisaig—Antigonish District, Nova Scotia. By M. Y. Williams. Pp. vi+173. Memoir 81: The Oil and Gas Fields of Ontario and Quebec. By W. Malcolm. Pp. ii+248. (Ottawa: Government Printing Bureau.)

Engineering Geology. By Profs. H. Ries and T. L. Watson. Second edition. Pp. xxvii+722. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 17*s.* net.

Mathematical Tables for Class-room Use. By M. Merriman. Pp. 67. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 2*s.* 6*d.* net.

Decorative Design. By J. C. Chase. Pp. vi+73. (New York: J. Wiley and Sons, Inc.; London: Chapand Hall, Ltd.) 6*s.* 6*d.* net.

A Plea for an Orderly Almanac By A. Philip. Pp. 62. (Brechin: D. H. Edwards.) 1*s.* net.

Report on the Operations of the Department of Agriculture, Madras Presidency, for the Official Year 1914–15. Pp. 56. (Madras: Government Press.)

Meteorological Office. British Meteorological and Magnetic Year Book, 1913. Part iv., Section 2. Hourly Values from Autographic Records: Geophysical Section, 1913. Pp. 97. (Edinburgh: H.M.S.O.; London: Meteorological Office.) 5*s.*

Egyptian Government. Almanac for the Year 1916. Pp. viii+248. (Cairo: Government Press.)

Problems in the Calculus with Formulas and Suggestions. By Dr. D. D. Leib. Pp. xi+224. (Boston and London: Ginn and Co.) 4*s.* 6*d.*

The Apple: a Practical Treatise dealing with the latest Modern Practices of Apple Culture. By A. E. Wilkinson. Pp. xii+492. (Boston and London: Ginn and Co.) 8*s.* 6*d.*

The Mechanism of Mendelian Heredity. By Prof. T. H. Morgan, A. H. Sturtevant, H. J. Muller, and C. B. Bridges. Pp. xiii+262. (London: Constable and Co., Ltd.) 12*s.* net.

Aircraft in Warfare: the Dawn of the Fourth Arm. By F. W. Lanchester. Pp. xviii+222. (London: Constable and Co., Ltd.) 12*s.* 6*d.* net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 20.

ROYAL INSTITUTION, at 3.—The Utilisation of Energy rom Coal: The Chemistry and Economics of Coal and its By-Products: Prof. W. A. Bone.

LINNEAN SOCIETY, at 5.—The Definition of "Right" and "Left" in relation to Coiled, Rolled, Revolving, and Similar Objects: a Problem in Scientific Terminology: Miller Christy.—Some Aspects of the Bagshot Sands Flora: H. W. Monckton.—Colour-photographs of Mollusca: B. B. Woodward.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—The Middle Tees and its Tributaries: C. B. Fawcett.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Principles of Modern Printing Telegraphy: H. H. Harrison.

INSTITUTION OF MINING AND METALLURGY, at 5.30.—Chinese Mining Legislation: W. F. Collins.—Taylor's Pulp Sampler: W. H. Trewartha-James.

FRIDAY, JANUARY 21.

ROYAL INSTITUTION, at 5.30.—Problems in Capillarity: Sir James Dewar.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—The Flow of Air through Nozzles: Capt. T. B. Morley.

MONDAY, JANUARY 24.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Cyrenaica: Prof. J. W. Gregory.

TUESDAY, JANUARY 25.

ROYAL INSTITUTION, at 3.—The Physiology of Anger and Fear: Prof. C. S. Sherrington.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—*Discussion*: The Electric Locomotive: F. W. Carter.

WEDNESDAY, JANUARY 26.

ROYAL SOCIETY OF ARTS, at 4.30.—The Effect of the War on Cotton Growing in the British Empire: J. A. Hutton.

THURSDAY, JANUARY 27.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Theory of the Helmholtz Resonator: Lord Rayleigh.—A Collision Predictor: Prof. J. Joly.—Discussion of Kew Magnetic Data, especially the Diurnal Irregularities of Horizontal Force and Vertical Force, from ordinary days of the eleven years 1890 to 1900: Dr. C. Chree.—A Portable Variometer for Magnetic Surveying: G. W. Walker.—The Single Line Spectrum of Magnesium and other Metals and their Ionising Potentials: Prof. J. C. McLennan.—The Microscopic Structure of Semipermeable Membranes, and the Part Played by Surface Forces in Osmosis: F. Tinker.—The Reduction of Metallic Oxides with Hydrogen at High Pressures: E. Newbery and J. N. Pring.—Discontinuous Fluid Motion Past a Curved Boundary: H. Levy.

ROYAL INSTITUTION, at 3.—Fuel Economy from a National Standpoint: Prof. W. A. Bone.

FRIDAY, JANUARY 28.

ROYAL INSTITUTION, at 5.30.—The Science of Clothing and the Prevention of Trench Feet: Dr. Leonard Hill.

PHYSICAL SOCIETY, at 5.—Guthrie Lecture: Some Problems of Living Matter: W. B. Hardy.

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Printed in Great Britain by R. CLAY & SONS, LIMITED, at Brunswick Street, Stamford Street, S.E., and published by MACMILLAN AND CO., LIMITED, at St. Martin's Street, London, W.C., and THE MACMILLAN CO., 66 Fifth Avenue, New York.—THURSDAY, January 20, 1916.