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Inventions and Grants in Aid.

A NOT inconsiderable result of the Great War and its long continuance was the flood of invention which threatened to overwhelm complacent bureaucracy. That procedure, admirably adapted to a Crimean or a South African campaign, was altogether inadequate for coping with the necessities of a nation in arms; and a people whose very existence as an independent State was threatened became more and more apparent, and at length penetrated the inner fastnesses of officialdom. New weapons of offence, improved systems of attack, and almost superhuman devices for stemming murderous onslaughts were demanded. The exigencies of a situation which had become grave, if not critical, compelled the opening of the ranks of a hitherto jealously guarded profession and the unstinted admission of the efforts of the civilian to whom organisation, the employment of scientific method, and the adoption of the latest invention, through keen competition in the open market, had become daily routine. Thanks to the Press and to many another non-official organisation which proclaimed the advent of a new era in military and naval operations, the inventive faculty of the community was aroused and stimulated to action. To such a length did this proceed that it may not be too much to assert that there was scarcely an occasion when a problem definitely and precisely formulated did not result in a solution through well-thought-out invention.

The knowing and the wary, before submitting the product of their inventive genius in their country's defence, obtained letters patent, and, for good or for ill, invoked the aid of the law for securing remuneration proportional to their ingenuity or to the proved ability of their inventions. In this respect such a one was wise, for from the First Report of the Royal Commission on Awards to Inventors[1] it is seen that the Commissioners interpreted liberally the sections of the Patent Acts of 1907 and 1919 which gave to the inventor, as against the Crown and its Departments, rights comparable with those prescribed where the mere subject was concerned. As regards inventors who, possibly esteeming their country's interests superior to their own, omitted to exchange a five-pound note for a patent, the Commissioners point out that the exercise of bounty was wholly within the discretion of the Crown, there being no statutory right to payment or reward for the use of their inventions. Nevertheless, it would appear that according to the terms of the Warrant under which the Commissioners were appointed, unpatented inventions were to be investigated, and, where shown to have been used in the service of the Crown, a just measure of compensation was to be recommended. In the instance of a lapsed or expired patent the Commissioners were careful not to recognise any right to compensation, as the invention was open to the world, and, indeed, might have been used by our enemies to our detriment.

As regards subsisting patents, by section 29 of the Patents Act of 1907, a section which inured for some time after the appointment of the Commission, the final arbitrament in the matter of compensation for the use of an invention lay solely with his Majesty's Treasury. By the substituted section 8 of the Patents Act of 1919, where a dispute as to user or as to terms was present, the High Court was given jurisdiction. But, manifestly, it was to the interest of the patentee—and, indeed, of all parties—that disputes should be avoided so far as possible. This desirability, amounting almost to a necessity, was fully recognised by the Commissioners, who considered that an equitable basis for compensation was to be found in the amount that a willing licensor could obtain from a willing licensee bargaining on equal terms. In private bargains the

[1] Royal Commission on Awards to Inventors. First Report. Cmd. 1112. Pp. 13. (London: H.M. Stationery Office.) 2*d.* net.

consideration was often fixed on the basis of a royalty, and the Commissioners saw no reason for departing from this method of assessment.

Even when this position was reached, it was seen clearly that in estimating payment upon a percentage basis there were still present many special factors which, varying almost in each case, were to be taken into account, as, for example, where an invention which could be supplied at a cheap rate produced consequences out of proportion to the cost of the article. Where some doubt was present as to the validity of a patent, or as to the use of an invention, a more or less empirical discount or deduction had to be made. A deduction was also required where the inventor was in the Government service, in a military, naval, or civil capacity, and had been allowed to patent his invention jointly with an official representative. A further notable instance lay in the case of an official who had been placed in a situation with the full knowledge that the opportunities presented to him might lead to successful invention to which the Government might justly lay claim. In general, such instances were relegated by the Commissioners to the two categories of inventions in respect of which no legal right to compensation was present, and, on the other hand, where the inventor, at the request of a Department of State, or on the broad ground of public policy, had refrained from securing a patent.

As regards that large class of unpatented inventions which came before the Commissioners, applications for reward by originators were considered broadly and with due regard to all the circumstances of the case, and not merely from the stricter legal point of view which was taken up when the patented inventions were under investigation. But, the position having been reached of rewarding patentees upon the basis of "a willing licensor and willing licensee bargaining upon equal terms," it would have been altogether unjust to refuse similar terms to those who abstained from securing recompense as of legal right.

A class of case which presented difficulty was where a general idea or suggestion of extreme importance had been put forward, but had not been extended to a concrete example. Without the idea there could have been no embodiment; without the embodiment the idea would have been useless. The embodiment might have been solely due to the action of Government officials, yet it would manifestly have been unjust to refuse to acknowledge pecuniarily the originator of the idea. In passing, we may remark that there is to be found here a flaw in the protection afforded by our Patent Law. So often the concrete example which an inventor has put forward is virtually useless until the eye of the expert user has been directed to it and suitable modification effected. Such modification may not have within it, as the law stands, that degree of inventive ingenuity which would secure validity to a patent, but without which, nevertheless, the original invention would prove abortive. This consideration was evidently present to the Commissioners, for in every case their decision depended on how far the inventive idea of each claimant, whether proximately or remotely, caused or contributed to the use by the Crown of the particular invention or device. As the Report puts it, the claimant had to show that his idea or device formed at least a link in the chain of causation leading to the use of the invention.

Those who are in constant touch with inventors know full well how the crudest ideas and the most elementary notions are put forward from time to time in all seriousness and with full belief in their efficacy. It is also common knowledge that when examples perfected by the close attention and prolonged application of the expert, without the slightest knowledge of the suggestions of others, become known, claims to inventorship are made by those who had submitted their immature ideas. So, too, the Commissioners found it necessary to deal with a large number of claims which upon their face showed no reasonable chance of success. In order that the time of the Commissioners might not be frittered away upon applications of a trifling or negligible character, a preliminary sifting was effected by a small committee. If the committee was unfavourable to an investigation by the Commission as a body, full opportunity was given, in all but the most hopeless examples, for the applicant to appear personally to urge his claim. This procedure worked well.

As regards the actual sums recommended to the Treasury for disbursement, they do not appear to have erred on the side of niggardliness. Possibly this was right. When it is remembered how great, over and above normal commercial profits, were those which were secured by contractors and others to whom the manufacture of munitions was deputed, it would seem just that the reward to originators of the designs which were under construction should bear some relation to the excess of profits which the originators, in favour of others, were primarily the cause of bringing into being. Thus one may see how the whole scale or plane of payment to inventors became raised.

But the Commissioners considered themselves bound by the terms of the Patent Acts and by the state of public opinion, which had slowly crystallised during a long period when such a cataclysm as a world-wide contest was not in contemplation. With respect to those inventions which were not patented, more credit is perhaps due to their originators, since, rather than tie the hands of the Executive by appeal to statute, they were content to leave over the settlement of any claim which might be theirs to calmer times, and to rely upon the just sense of the community for the recognition of their services. In this respect we should like to have seen more acknowledgment of this disinterestedness than is evinced by the Report.

After all, the question arises as to the morality of the recommendation of grants. At a time when so much was at stake, when the call was sounded for the endeavour of every individual towards the single object of winning the war, is it altogether right, it may be asked, that huge sums of money should be paid over by the State to those who, gifted with inventive genius, were successful in solving in a practical manner the problems with which the nation was temporarily confronted? That some recognition should have been accorded, no one could gainsay; but it is a different matter to attempt to recompense on a business footing those who, at a period of grave national stress, might justly have been called upon to exert their utmost towards staving off imminent peril without excessive fee or reward. As regards inventors who took advantage of the protection afforded by Patent Law, and secured thereby legal rights to compensation, the arbiters before whom the question of recompense might finally have come could with fairness and reason have called into review the duty incumbent upon every citizen to employ at such a time every faculty with which he was endowed, and to have recommended reward proportionate thereto.

As it is a "First Report" that we have been considering, we look forward with interest to a supplementary publication, when it is to be hoped that the terms of the Warrants under which the Commissioners were appointed may appear. In the present instance the terms are absent. In the next Report we would also suggest typographical improvement in its presentation, such as the employment of marginal references, a "display" of paragraphs, the grouping of closely allied subject-matter under informative cross-headings, and a less rigid economy in space and paper. Moreover, a greater freedom in style and exposition would be of assistance to the reader. By the adoption of suggestions such as these, a far more readable document could be secured, and much valuable reasoning and information run less risk of being overlooked. And if the price of twopence were raised to sixpence, or more, in order to secure these advantages, few would be found to complain. As is the case with so many Reports which emanate from Government sources, the force and value of this First Report are not spent with its publication. The close reasoning with which it is packed, the equitable manner in which the Commission directed its conclusions, and the discrimination which it brought to bear upon the difficult tasks with which it was faced, render the Report a valuable document to all who in any way are, or may be, concerned in assessing compensation or reward for the use of inventions patented or unpatented. Indeed, the Report might well form the basis of a chapter in a classic which concerned itself with the patent system of this country and its administration. We can give it no higher praise.

As regards rewards for future inventions and discoveries, and means for stimulating research, the best method of arriving at satisfactory conclusions is, from the nature of the case, far from settled. Circumstances in respect of men and objects to be secured or aims to be achieved vary to such a degree that principles capable of general application and acceptable to large bodies of workers are difficult to formulate. As described in NATURE for February 21, 1918 (vol. c., p. 484), Mr. Walter B. Priest would assimilate the allocation of funds to scientific research through a special Statute modelled upon our Patent Law. Since that time Mr. Priest has continued to keep in the forefront his scheme for the promotion of scientific research, and has adapted it to the work of the Advisory Council of the Department of Scientific and Industrial Research. In a series of memoranda the working of the scheme, as modified by special conditions, is set out at length.[2] These memoranda, supplementary to the original scheme, were submitted to the Department. In due course Mr. Priest was thanked for his views, and informed that they would receive careful consideration. Mr. Priest is particularly anxious to assist in scientific discovery, for which in-

[2] The Administration of Grants for Scientific Discoveries. Scheme and Memoranda. By Walter B. Priest. (Privately circulated, 1921.)

adequate remuneration exists on account of patents not being obtainable for them, or for some other cause, but which has effected or contributed to the attainment of any industrial purpose.

The scheme to which attention is again directed would affect the bestowal of grants in the case of discoveries which, for example, elucidated specified phenomena or solved specific problems. The promotion of research by means of rewards, Mr. Priest considers, would also obviate the difficulties connected with the selection of research workers, their remuneration, the duration of their employment, and their control or supervision. The chief purpose of the scheme is to provide trustworthy means for the administration of grants for rewarding the discoverers in the subjects specified in the proposed allocation of the grants. Endeavour has been made to provide for all contingencies, such that no earnest student or investigator need despair of receiving pecuniary assistance at a time when it is most needed.

Mr. Priest is far from sanguine that the methods foreshadowed by the Advisory Council of the Research Department would solve the problems how best to encourage inventors and to assist individual manufacturers who desire assistance. He thinks that a procedure which based awards on personal knowledge of the research worker, or of the individual recommending the research worker, is inequitable, and that the methods of promoting research by grants in aid are fundamentally defective.

The memoranda, which are far too long to be summarised adequately here, may be considered as an advocacy of the system which Mr. Priest has outlined in his draft of a Bill which has for its object the regulation of the allocation of money grants for discoveries in a manner analogous to that of grants of letters patent for inventions.

The Embryology of Crinoids.

Papers from the Department of Marine Biology of the Carnegie Institution of Washington. Vol. xvi. Studies in the Development of Crinoids. By Th. Mortensen. (Publication No. 294.) Pp. v+94+xxviii plates. (Washington: The Carnegie Institution of Washington, 1920.) 6 dollars, post free.

THE early stages in the life-history of recent crinoids have always been regarded with interest, because it was hoped that they would throw light on the evolution of this class, so rich and various in ancient seas, and on its relation to the other very differently fashioned classes of Echinoderma. Unfortunately, the only forms that have up till now furnished material for the embryologist are the unstalked comatulids, or feather-stars, and in the past such material has come from but a single genus, and from only three closely allied species of it—*Antedon bifida* of our own coasts, *A. mediterranea,* and *A. adriatica.* The accounts of their development by W. B. Carpenter, Bury, Seeliger, and others have shown slight differences, due, in part, probably to specific distinctness of the material. Even if it were not feasible to obtain the early stages of any stalked crinoid, still a study of other species, representing other genera of comatulids, was much to be desired, since it might then be possible to infer which features were peculiar to Antedon and which were common to comatulids generally, if not to the whole class Crinoidea. Such a study has now been made by Dr. Mortensen, who has obtained a fairly complete series in four genera, and the pentacrinoid larvæ of two others. His results are set forth in clear English with his usual care, and the memoir is illustrated by admirable drawings from his own pencil. His many interesting results are discussed in a "General Part" which demands the attention of professed morphologists. Here we shall select for comment a few observations that bear on the past history of the class.

The three species of Isometra, Notocrinus, and Thaumatometra from the Antarctic Sea resemble other echinoderms from that region in protecting the brood. *Tropiometra carinata,* from the coral reefs of Tobago, and *Antedon petasus,* of the Scandinavian fjords, set their eggs quite free. These two extremes are clearly modifications of the normal plan in which the eggs cluster round the genital openings, and the pentacrinoids attach themselves to some part of the mother or her immediate neighbourhood. This agrees with the colonial habit of many fossil crinoids, in which the roots of the young are frequently attached to the stem of the putative parent. As in echinoderms generally, protection of the brood appears to involve yolk-laden eggs with meroblastic cleavage; but the normal egg with less yolk retains the regular cleavage.

In its early days the crinoid larva has no mouth, but in the normal plan the primitive gut (archenteron) curves ventrally to meet the invagination (vestibule) into which the mouth afterwards opens. We may infer that there was once a stage in which a larval mouth, opening in that position, persisted as the mouth of the adult, and this probably represents an ancestral stage of all echinoderms.

The opening of the hydrocœl (the subsequent water-ring) to the exterior has a strange history. First a prolongation from the incipient hydrocœl is cut off as a canal, called parietal. This effects an outer opening (pore No. 1), which afterwards closes. At a later stage a fresh canal (stone-canal) grows out from the water-ring and opens into the remains of the closed parietal canal; and a fresh pore (No. 2) opens from outside into the same parietal canal. Thus the water-ring is for the first time connected with the outer medium. Dr. Mortensen regards pore No. 2 as homologous with the madrepore openings in other echinoderms, and he is probably right. Yet he also regards it as identical with pore No. 1 when speaking of its "temporary obliteration," although several ancient stalked echinoderms, in various classes of Cystidea, have two neighbouring but distinct openings, one of which is plainly a water-pore (pore No. 2), while the other has been regarded as the opening of the parietal canal (pore No. 1). These facts suggest that pore No. 1 never was a water-pore, but may have been a gonopore, or excretory, or both. Close to the parietal canal, in the dorsal mesentery, is a group of cells regarded by Dr. Mortensen, following Russo, as a primary gonad homologous with the genital organ of Holothurians. Dr. Mortensen believes that this structure is soon absorbed, and that the genital organs arise as a new structure connected with the axial organ. If the original cells are not carried over into the subsequent gonad, their genital nature seems unproved. It is not impossible that some persistence may ultimately be detected. Meanwhile, their position harmonises with the suggestion that the genital products were set free into the parietal canal and emerged through its pore (No. 1), which was the gonopore of the cystids.

The crinoid larva normally fixes itself by its anterior end, and the vestibule then moves up towards the future oral end of the pentacrinoid. Thus the cup of the crinoid is erect on a straight stem with a flattened base (like a wineglass). In Tropiometra the suctorial disc is weak; many embryos fall to the bottom, and the migration of the vestibule is hindered by pressure; thus the crinoid grows with a curved stem. May not such a cause have initiated the evolution of the curved stems and pendent crowns in Herpetocrinus and the Calceocrinidæ?

Dr. A. H. Clark has maintained that the anal plate of comatulids represents the radianal (the lower half of the right posterior radial), while others have homologised it with the other anal (x) of palæozoic inadunate crinoids. Dr. Mortensen believes that his observations fully confirm the latter view, and, further, indicate that x was derived by vertical fission from the upper half of the right posterior radial. This seems a sound hypothesis, and it really differs very little from that implicit in the tentative term "brachianal." Opposed to all these is the fourth hypothesis, that the anal x was an entirely new growth. It must be left to fossils to decide.

Infrabasals have been detected in *Antedon mediterranea* and *A. adriatica*, but not in *A. bifida*; Dr. Mortensen, however, always finds them in that species. Isometra, Florometra, and Thaumatometra are the only forms in which he has not found them. In all cases the first cirri are radial in position, as they are in all Crinoidea Dicyclica, whether the infrabasals have atrophied out of existence or no. It is not realised that the position of the cirri depends on the position of the nerves of the aboral system, a position originally governed, no doubt, by the presence or absence of infrabasals, but maintained without regard to the subsequent history of the skeleton.

Dr. Mortensen observes that in the growth of these crinoids the pinnule-bearing brachials no longer make their first appearance as axillaries. Since he admits, however, that each pinnule has the morphological value of an arm, the brachials which bear them are, morphologically, axillaries. That the pinnules did originate as arm-branches is confirmed by palæontological evidence.

Palæontologists have long since given up Lovén's attempt to homologise the elements of the crinoid cup with the apical plates of echinoids. It is satisfactory to find Dr. Mortensen led to the same conclusion. But that is a big subject. We have said enough to show that for this fruitful memoir our Danish colleague and his American publishers deserve the thanks of morphologists, embryologists, and palæontologists.

F. A. BATHER.

Electrical Theory and Relativity.

The Mathematical Theory of Electricity and Magnetism. By J. H. Jeans. Fourth edition. Pp. vii+627. (Cambridge: At the University Press, 1920.) 24s. net.

SINCE the third edition of this volume was published in 1915, the theory of relativity has been developed. It is now recognised that Maxwell's theory that the ultimate seat of electromagnetic and optical phenomena is in the æther may have to be modified or even abandoned. Experiments have proved that natural phenomena go on exactly as if there were no æther. We agree with the author in thinking that "the hypothesis that there is an æther may give a possible explanation of the phenomena, but the hypothesis that there is no æther provides an equally possible and very much simpler explanation." Einstein's theory, unfortunately, although it helps us to discover the laws according to which phenomena occur, cannot lay claim to provide a mechanical explanation of them. Electricians know the importance of discovering the mechanisms by means of which electric and magnetic forces are transmitted through space. When the nature of these mechanisms is discovered, there will probably be a great advance in the practical applications of electricity. The theory of relativity, a very convincing explanation of which is given in this book, proves that it is unnecessary to presuppose an æther. This is welcome, as it is known that highly complex properties must be ascribed to an æther in order that it may explain both electrical and magnetic forces. In the kinetic theory of gases, forces and pressures are explained by a flow of momentum, and a similar explanation might be given of electrical, magnetic, and gravitational forces.

From the practical electrician's point of view, the value of this volume would be increased if the ordinary working formulæ for the high-frequency resistance and inductance of cylindrical wires were given. Kelvin's electrostatic and hydro-kinetic analogies are useful in this connection. The engineer also wants the formula for the capacity between parallel cylindrical wires. The fact that a brush discharge begins at a perfectly definite value of the potential gradient is the principle on which accurate high-pressure voltmeters are constructed, and it is known that the sparking between spherical electrodes occurs at a definite potential gradient. Kelvin's formulæ for the attraction and repulsion of electrified spheres are proved, but no explanation is given of the column headed "Ratio of charges for equilibrium." We doubt whether the average reader would infer from this that spheres electrified with like charges would repel one another when far apart, and attract one another when close together. In conclusion, we can recommend this book to every student who has a sound mathematical training, and every man of science should read the new chapter on the theory of relativity.

A. R.

Mathematical Text-books.

(1) *The Elements of Plane Geometry.* By Dr. C. Davison. Pp. viii+280 (with answers). (Cambridge: At the University Press, 1920.) 10*s.* net.

(2) *A Primer of Trigonometry for Engineers: With Numerous Worked Practical Examples.* By W. G. Dunkley. Pp. viii+171 (with answers). (London: Sir Isaac Pitman and Sons, Ltd., 1920.) 5*s.* net.

(3) *Pure Mathematics for Engineers.* By S. B. Gates. With an Introduction by H. A. Webb. Part i., pp. xi+191. Part ii., pp. xi+179. (The New Teaching Series.) (London: Hodder and Stoughton, Ltd., 1920.) 4*s.* 6*d.* net each vol.

(4) *A Second Course in Mathematics for Technical Students.* By P. J. Haler and A. H. Stuart. Pp. viii+363. (London: W. B. Clive, University Tutorial Press, Ltd., 1920.) 6*s.*

(5) *Elementary Applied Mathematics: A Practical Course for General Students.* By Prof. W. P. Webber. Pp. ix+115. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 7*s.* 6*d.* net.

(6) *The Laws of Mechanics: A Supplementary Text-book.* By S. H. Stelfox. Pp. xi+201. (London: Methuen and Co., Ltd., 1920.) 6*s.*

(7) *Elementary Dynamics: A Text-book for Engineers.* By J. W. Landon. Pp. viii+246. (Cambridge: At the University Press, 1920.) 10*s.* 6*d.* net.

(1) THIS is a book in the old style, written by an old hand, and it has all the lucidity that we have learnt to expect of its author. The subject-matter is that of the first six books of Euclid, with the addition of some miscellaneous theorems on such subjects as concurrency and loci. The method and the arrangement are approximately those of Euclid, with some modern improvements. The book is the latest of its kind and probably the best.

The difficulties of a geometry of this type come mostly at the outset. When we went to school, in a less enlightened decade, we were taught that "a straight line lies evenly between its extreme points," and this elusive phrase, which seems to have a meaning, has haunted and mocked us ever since. Dr. Davison says (p. 1):—

"A straight line is sometimes defined as a line which has the same direction from one extreme point to the other. The definition is, however, imperfect owing to the use of the word 'direction,' to which no meaning has been given. The following definition is free from this objection.

"*Def.* 1. A straight line is a line such that any part of it, however placed, may be made to lie upon any other part of it."

Alas! there are twenty-five words in this definition, and "no meaning has been given" to at least twenty-one of them. It is here that trouble lies for every beginner, and here lies also one reason why the modern teacher has taken to experimental geometry.

In a geometry which is essentially logical and metrical we should like to find the mechanism of measurement treated more fully. Dr. Davison does define "greater" and "less" in terms of "between" for segments of straight lines; but this is scarcely satisfactory for angles (p. 4), although thereafter the idea of magnitude is supposed to be sufficiently known. Again, in the subject of proportion incommensurables are given only a little paragraph in small type (p. 186). It is to be regretted that the author has not followed Prof. M. J. M. Hill in giving adequate treatment to this important notion.

(2) There is now a great host of books on mathematics for engineers, and most of them are bad. Here is a good book. Mr. Dunkley's programme is modest; it covers the ground as far as the solution of triangles. The main text is clear and sound, and it is incorporated with well-chosen examples of mechanisms which are fully worked out and illustrated with excellent diagrams. Each theme that is entered upon is followed through to the finish in a way that will give mental satisfaction to the student. Mr. Dunkley describes himself as a machine tool designer, and is apparently not a teacher.

(3) These two unhappy volumes are in contrast with the last. The author sets himself the task of covering the whole range of pure mathematics from the beginnings of algebra to volume integration, but it is difficult to see why the book is "for engineers," as there is scarcely a reference to engineering in the whole of it. The quality of the mathematics may be judged by a single citation (p. 97):—

". . . for a series to be convergent the following conditions must be satisfied. . . .
"(3) The ratio of each term to the preceding must always be less than 1."

(4) This book is considerably better than the last. Much less ground is covered and there is a large collection of relevant exercises, which is the chief merit of the book. The text is not good. There is the tendency, familiar in such books, to introduce advanced subjects too early, *e.g.* infinite series on pp. 28–32 before simple equations. The treatment of the calculus is pedagogically unsound. Thus a differential coefficient is explained graphically as the slope of a graph (p. 150), but the authors say nothing about tangents until the foot of p. 154. When a tangent is at length introduced, it is explained as "the tangent to a circle which most closely coincides with the small portion of the graph on either side of the point." The introduction of differentials (p. 158 *seq.*) without any explanation is to be deprecated. It becomes unpardonably loose later on: "$dy = \frac{1}{3}(3x^2) = x^2$. Hence the integral of $x^2.dx$ is $\frac{1}{3}x^3$" (p. 181).

(5) "Applied mathematics" does not here mean mechanics. The book is written "to meet the needs of students who want some elementary mathematical training that they can use in everyday affairs." The chief need of American students appears to consist in having every problem turned inside out, and may be judged by the following typical exercise (p. 74):—

"Sold cotton on 5% commission, invested the proceeds in sugar at 2% commission. My whole commission was $210. What was the price of the sugar and cotton?"

We do not need to work out such problems this side of the pond: we know the price of our sugar before we start; we find it easier.

There is, however, one thing in Prof. Webber's book that we do need, and do not often find in English books, and that is half a dozen pages on statistics.

(6) We like this book. The author calls it "a supplementary text-book," and makes no effort at completeness of exposition, but selects a number of subjects which are not often satisfactorily dealt with in ordinary text-books, and he dwells upon them at length. His style has the *naïveté* and freshness of first discovery, and there is nothing of that supercilious haste that one is accustomed to expect in a book designed for engineers. Although the author does not aim at completeness, he achieves nevertheless a certain continuity and unity. Among subjects that receive a chapter each are:—Dimensional arithmetic, calculus notation, the laws of equilibrium, and velocity diagrams. The last chapter contains an illuminating discussion of four or five examples of applied mechanics.

(7) Mr. Landon's book combines a text on more or less academic lines with well-selected examples from engineering as it is taught in colleges. The examples are clearly stated and neatly worked out, but somehow the author does not seem to dwell

upon them as if he liked them. A special feature is made of the treatment of the "laws of momentum," which replace Newton's laws of motion. This treatment is as follows:—After a cursory reference to mass on p. 2, two chapters are devoted to kinematics. In chap. iii., p. 57, momentum is defined. Then the "first law" appears (p. 58):—

"In any body or system, the total momentum remains constant unless the body or system is acted upon by some external force. . . .

"The first law introduces a new term, viz. force, which may, for the present, be defined thus:—

"Force is that which produces or tends to produce a change of momentum.

"The law is the result of observation."

We prefer Newton, but it is only fair to recognise that "laws" are always a difficulty in elementary mechanics, and on the whole we are inclined to recommend the book. H. B. H.

Our Bookshelf.

Animal Life in South Africa. By S. H. Skaife. With an introduction by Prof. F. Clarke. Pp. x+281. (Cape Town: T. Maskew Miller; Oxford: Basil Blackwell, 1920.) 15s. net.

THIS book is intended to help teachers and pupils in South Africa to get to know some of the common animals of every grade. It is clearly written and abundantly illustrated with simple "thumbnail" sketches, many of which will enable the student to identify what he has seen. More critical sifting of the illustrations would have eliminated a number—*e.g.* that of Apus—which blur the total impression. It is almost impossible, except for men like Huxley, gifted with an unusual educational sense, to write a book useful for teachers and pupils alike, and though Mr. Skaife has done well, he sometimes falls between two stools—being sometimes too simple, sometimes a little difficult. There are also various statements requiring reconsideration, we think; thus we do not believe that the liver-fluke feeds partly on bile, and we are sure that a sea-urchin's teeth do not work up and down in their sheaths. But these are small matters; we mention them only as instances of a kind of defect that might easily be remedied, for the book as a whole is sound and careful, and it will be of great service. The chapters on insects, spiders, scorpions, and ticks are particularly good. We are interested to read that Peripatus may be fed on raw minced liver. "A female with twenty to thirty young ones clustering around her like chicks round a hen make a very pretty family party." Two educational remarks seem called for: (1) It is very doubtful whether we are warranted in using a word like "ugly" for such animals as the fishing-frog or Galeodes—it seems like undoing one of the endeavours of Nature-study, which is to show that no wholesome free-living wild creature can be called common or unclean. (2) Is there not more than once—*e.g.* in regard to flat worms and gapes-worms—a distinct and deplorable tendency to bowdlerise the elementary facts of sex? Because we appreciate Mr. Skaife's good workmanship, we would ask him to reconsider these points. The book appears to be extraordinarily dear.

Anniversaries and Other Poems. By Leonard Huxley. Pp. x+82. (London: John Murray, 1920.) 5s. net.

A BOOK of dignified and melodious poems, in which it is interesting to observe the natural history touches—the child's poetic vision is compared to that of some under-water larval creature, glimpsing the sky, seeing "crooked tops to the tall, straight trees"; the full waves of the floral tide in a southern April, breaking on the hill "with white narcissus for their foam," are contrasted with the shyer coming in the north, with "less of fire and more of dew," and yet with its own exuberance, for

bluebells thick in budding woods
Stretch pool on pool from tree to tree,
All heaven in their dew-drenched floods
Of blue that mock your Midland sea.

Mr. Leonard Huxley is a lover of Nature, both of the great appeals and of the tiniest things that pass from sense to soul, from Nature's heart to man's. Common things are dear to him in themselves, not merely as emblems. Of the speedwell, "blue flower of happy name," he writes:—

It buds on every fallow swell,
And the bright wish it bids me frame
Fills earth as music fills a shell.

Nature may or may not be fathomable, but surely it is still unfathomed, and we are among the heretics who think that of some of its depths not reached by the scientific dredge we get an inkling by the medium of disciplined feeling. Mr. Huxley makes his contribution, a perfectly clear-eyed one, and we do not agree more than a very little with the mood of the last poem, "The Land of Might-Have-Been," "portioned with felicity" though that mood be. The author has gone much further than that.

Mechanism, Life, and Personality: An Examination of the Mechanistic Theory of Life and Mind. By Dr. J. S. Haldane. Second edition. Pp. vii+152. (London: John Murray, 1921.) 6s. net.

THE new edition of Dr. Haldane's little work is substantially the same, so far as subject-matter is concerned, as the first edition, which was reviewed in NATURE for October 22, 1914. It is in the fourth lecture, on personality, that the main changes have been made. The whole chapter has been recast, and some additional matter inserted with the object of bringing home to the reader more certainly the meaning of this admittedly difficult subject.

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.*]

The Common Occurrence of Aurora in the South of England.

SEVERAL observers have from time to time reported that the green auroral line (λ 5578) is commonly observable in the sky at night. I have often tried to see it myself with various instrumental arrangements, but without success. Slipher, however (*Astrophys. Journ.*, 1919), succeeded in photographing the line on every clear night that he tried. He worked at the Lowell Observatory, California, as far south as lat. 35° N.

Stimulated by his results, I have succeeded in photographing the line on many nights for the past month. I do not always get it, and one of the failures has been on a fairly clear night. On the other hand, many of the successes have been on cloudy, though not, of course, extremely dark, nights.

At the present time sun-spot minimum is much nearer than during Slipher's experiments, and for this and other reasons I am inclined to think that I have been dealing with fainter auroras than he did. Success has been due in the main to the use of Marion's new "iso record" plates, which are very sensitive in just the spectral region which is needed.

The programme in view is a systematic comparison of the auroral intensity with sun-spots and magnetic disturbances, and also a comparison of its intensities in different localities in Great Britain and elsewhere. So far as I have been able to learn, the auroral spectrum has not previously been photographed in this country.

RAYLEIGH.

Terling Place, Witham, Essex, March 21

Mount Everest.

AN important event which will add greatly to our knowledge of physical geography, as well as of all branches of science, has come to pass. The permission of the Dalai Lama has been obtained to our entry into Tibet. For this we have to thank Sir Francis Younghusband for his early love of travel, which took him through so many miles of elevated wastes in Central Asia, culminating in his present influence, the result of a successful military expedition, and the presence to-day of a Political Officer in Lhasa, Mr. Bell.

The president of the Royal Geographical Society (*Geographical Journal*, February, p. 73), after summing up what has to be done in the country, says, "Our geography of it must be complete"; he could not say more than he did in these few words.

The changed conditions at once opened up the possibility of knowing more of the highest peak in the world, Mount Everest, the surrounding topography, the best way to it, and, lastly, what will be possible on its flanks. After all, the supreme advance and gain are centred upon the survey of Tibet; if this can be extended at any point on the thousand miles or so between Kashmir territory and Assam, through Rudok, Gartok, Hundes, the northern boundary of Nepal, Sikkim, Bhutan, Aka, etc., our successors may in time look forward to the possession of maps of the whole Himalayan chain, including its northern side. Another great advance will be to master the secrets of its internal structure and to extend what we at present know of Himalayan geology to where so few with the necessary knowledge have as yet penetrated.

In thinking of a vast country one is led to dream, and in the making of this great map my thoughts tell me that the Tibetans can be employed. Their artistic abilities are great; art they have practised for centuries. Almost alone among the Asiatics I have known they can use a map intelligently; they would soon excel in surveying. When I taught a few Lama draughtsmen perspective they were delighted. Thus I am led to contemplate a branch office of the Indian Survey Department at Lhasa, for instruction there would be better for many reasons than in India.

The Duke of the Abruzzi's expedition to the Mustakh glaciers has been taken as a model for the present one, yet it must not be forgotten that all the conditions are different. In the former case the country was known; it was in a native State under the control of the Indian Government, and not far distant from a well-populated district with a sufficient supply of food. It did not matter how many Europeans were attached to it; it was carried out luxuriously and at great expense—so expensive was it that I fear these great expeditions will render future travel over the same ground almost impossible for the ordinary explorer.

For this first advance into Tibet I would have preferred myself, and taken for a model, the work of Sir Aurel Stein. His topography (the work of two native surveyors) of the Kuenlun range, etc., is excellent, and surveyors with similar training would be the fitte.t men in Tibet. It is unfortunate that the native surveyors, excellent, really splendid, men as some of them are, have not the education and knowledge to observe and write on the country they map; but we cannot have perfection.

In a recent article on Mount Everest in the *Surrey Advertiser* I said: "Of this I am convinced, the smaller the party and the less fuss made about it the better." This is truer now than when it was first written. From what I read in the papers and from a circular from the president of the Alpine Club the size of the party is indicated and its growth is fast—five and a doctor. To this has to be added the survey party.

A great deal has since been published from various sources regarding what has to be done before Mount Everest is reached; it is mostly imaginative, for we know really nothing, having so little to guide us. No more is known than I knew when I left the top of the Senchal Trigonometrical Station, Darjeeling, in December, 1863. I had been examining the position of Mount Everest far away on the west, and this with a surveyor's eye, noting the points and peaks to be visited and the general lie of the ground. I have a vivid recollection of it; all remains the same and is common knowledge. The best authorities at present are Ryder, Younghusband, and Bruce, for they have seen the Everest mass at shorter distances. Darjeeling is now the terminus of a railway a few hours' run from Calcutta. This fact much affects an expedition starting from it, which is well set forth by Lt.-Col. C. Howard Bury in the *Geographical Journal* for February, p. 121. Still, some things have not altered, and I can confine myself to what I would have done so many years ago had I been deputed to survey the head-waters of the Arun River—of course, with the Tibetans prepared to see me and with political troubles absent, as they are at present. I would have worked precisely as I had done in the previous summer when I surveyed the Pangkong Lake and the high country of Changchingmo (*vide* Proc. Royal

Geograph. Soc., December, 1866). I would have proceeded by the head of the Tambur River, with Hooker as my guide—made the attempt, at any rate, and, failing in that route in Nepal, taken that of the Doukia La and got on to the Arun drainage as soon as possible. I would have gone, preferably alone, with a very small establishment of hillmen, Lepchas or Bhutias—men who know something of the country and of the habits of the people. It is essential also to have a man of position and rank with the party; success depends greatly on him.

I would have taken a very limited store of preserved food, trusting as much as possible to the country for all supplies for my men and myself. Sheep are always procurable; on the Pangkong I lived solely on mutton and the few birds I shot. At that time I had an invaluable man as chuprasie and interpreter; he had come with me from Ladak. Born at Leh, his father was a Kashmiri merchant and his mother a Ladaki. He spoke Hindustani, Punjabi, and Tibetan; he had the assurance and manner of the Indian, with a knowledge of the religion and habits of his mother's race. His religion, Mohammedan, sat lightly upon him, and he was quite at home among Buddhists.

The survey work over a large area is easy, but some of it must be stiff, particularly where the descent off the high plateau commences. The accurate fixing of stations in advance will necessitate going over much ground and take time, for trigonometrical points are few. The base of my work in 1863 would have been in Sikkim, since all surveyed. The present base is the frontier itself, and I fancy a large area of this is known north of Chumbi. It is really only one man's work. To show this, I put on record here how the topography of the Kashmir territory was done, and refer anyone interested to my paper read before the Royal Geographical Society on January 11, 1864, with a map of Baltistan attached. This covers some 4000 square miles plane-tabled in the summers of 1860 and 1861—a most difficult, lofty, and glaciated country, entailing much climbing.

The Duke of the Abruzzi had this map to guide him when he made his expedition to the great Baltoro glacier. This glacier I was fortunate to be the first European to see and follow up to the base of the second highest peak in the Himalayas, and I was then within seventeen miles of the summit.

Having spent the best years of my life on the Himalayas or in sight of them, and collected and written on the fossil and recent fauna, I naturally take a deep interest in the exploration of Tibet which now seems possible. I should be sorry to see any difficulty arise, political or otherwise.

We are living in an extravagant age. Nothing apparently can be done except on a vast scale; more is spent than need be. The size of the expedition may frighten the Tibetans and lead to difficulties, as it did before when another large expedition was to have entered the country. H. H. GODWIN-AUSTEN.

Nore, Godalming, Surrey, March 16.

Molecular Size and Range of Molecular Attractions in Solutions.

THE dimensions of a molecule of starch, according to the estimate of Lobry de Bruyn, are of the order of 50 Ångström units. Protein molecules containing sulphur in the form of a cystine group, if that sulphur amounts only to 1 per cent., as is commonly the case, must have a molecular weight of not less than 6000; and in the case of hæmoglobin, as is familiar, the percentage of iron points to a molecular weight nearly three times this value. The dimensions of protein molecules are probably, therefore, of the same order as those of the starch molecule.

The radius of the sphere of molecular attractions is also commonly estimated at 50 Ångström units. This means that in a solution of a substance the molecules of which are of the size attributed to the molecules of starch and many proteins, a molecule of the solute will keep the molecules of the solvent on opposite sides of it at such a distance from each other as to be just out of range of each other's influence. The molecules of the solvent at its surface must tend to behave as if they were in a free surface of the solvent faced by the solute—that is to say, they will be subject to internal pressure the resultant of which will act in a line normal to the surface tending to draw them away from it. Supposing that the molecules are spherical, and that a sphere representing one of them has as its diameter the radius SC (Fig. 1) of the sphere of molecular attraction about a molecule of solvent at its surface at C: if a plane bisecting this sphere of attraction be drawn tangential to the molecule of solute through the line AB, which passes through the molecule of solvent at the point C, then the hemisphere ALB is the space within which other molecules of solvent are all free to exert their attraction upon C, the resultant being a force acting in the direction CL, as would be the case were it in a plane

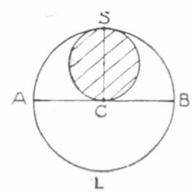

FIG. 1.

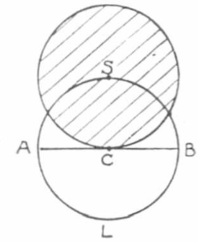

FIG. 2.

surface of the solvent. The other hemisphere ASB is occupied as to one-quarter of its volume by the molecule of solute, and the remaining three-quarters is so disposed that the resultant of the attractions exerted by the molecules of solvent in it which acts in the direction CS is a fraction much smaller than three-quarters of the opposite force acting in the direction CL, and therefore the sum of the two opposing forces is a considerable force in the direction CL, much greater than one-quarter of the internal pressure of a molecule in a plane surface of the solvent; in the case of water, therefore, more than 2500 atmospheres.

If the diameter of the molecule of solute were but half that attributed to the molecule of starch, its volume would be reduced to one-eighth of that in the case presented in Fig. 1, and the fraction of the hemisphere ASB which it would occupy would be one-thirty-second instead of one-quarter. The force acting in the direction CS would be correspondingly increased, and the resultant of this and its opponent would be a force in the direction CL merely somewhat more than one-thirty-second of the internal pressure on a molecule in a plane surface.

In the case of a molecule of the size attributed by Nernst to a molecule of carbon dioxide, little more than one-twentieth of that of a molecule of starch, the fraction of the hemispherical space ASB which it would occupy would be about 1/32000, and the force tending to remove a molecule of solvent from its surface would be about eight thousand times smaller than that acting on solvent molecules in contact with a molecule of starch, and something of the order of 1/32000 of the internal pressure in a free plane surface.

If, on the other hand, a suspended particle of dimensions double that of a molecule of starch be considered, the fraction of the hemisphere ASB (Fig. 2) which would be occupied by the suspended particle would be five-eighths, and would include all that part of it where any effective component in the direction CS could be developed, so that the resultant acting on a molecule of the surrounding liquid at C in this case would be considerably more than five-eighths of the full internal pressure at a plane surface.

From such considerations it is clear that in passing from molecules of the dimensions estimated for those that give true solutions to molecules of the size that is compatible only with colloidal solution, if the relation between these dimensions and the radius of the sphere of molecular attraction is such as has been presented, a very great change in the behaviour of a solvent such as water must be observed. Considering only, as has been done in this letter, the relations between the molecules of solvent, the force tending to withdraw these molecules from the surface of molecules of solute will be found to increase eight-thousandfold. The large molecules must be far more unstably dispersed than the small. As soon as they come within a distance of each other which is less than the radius of attraction for the solvent, they will be forced together by the internal pressure of the solvent.

The force tending to remove a molecule of solvent from the surface of a particle 100 Å. in diameter $>\frac{5}{8}$ say $=75$ per cent. of the internal pressure at a plane surface; a starch molecule 50 Å. in diameter $>\frac{1}{4}$ say $=33$ per cent.; a molecule 25 Å. in diameter $>1/32$ say $=5$ per cent.; a CO_2 molecule 2·5 Å. in diameter $>1/32000$ say $=0{\cdot}005$ per cent.

In this consideration of the conditions obtaining in solutions no account obviously has been taken of any forces except those in play between the molecules of solvent. The supposition of such forces carries with it the supposition also of similar forces acting between molecules of solute, and especially, too, between them and the molecules of solvent. When there is no attraction between solute and solvent, even the small residuum of unbalanced internal pressure which a particle leaves free to act on the molecules of the dispersing medium when its dimensions are as small as those assigned to the molecule of carbon dioxide must result in its joining up with others of its kind—in fact, in its being insoluble. The difficulty that such considerations taken by themselves leave untouched is the difference between the finite degrees of solubility peculiar to each kind of substance capable of dissolving in a solvent.

J. B. LEATHES.

The University, Sheffield.

Oceanographic Research in the British Empire.

IN the interesting leading article in NATURE of March 10, and in the discussion which preceded it, one method of conducting oceanographic research appears to have been practically ignored. We mean its encouragement in permanent institutions and by continued marine surveys in the diverse parts of the British Empire. You have rightly laid stress on the importance of intensive study in particular localities, but we doubt whether research of the kind can be carried out in a satisfactory manner by parties detached for limited periods of time from an expedition of world-wide scope. There is nothing that has struck us more in our own work on the Indian seas and lagoons than the importance of returning again and again to the same place to investigate special problems. For example, in the investigation of the fauna of the Chilka Lake, a small offshoot of the Bay of Bengal, now being completed by the Zoological Survey of India, the true character of the fauna is being elucidated only by returning year after year and month after month to the same hunting-grounds; and it is not only the fauna to which this applies, for we find that the hydrography also must be studied again and again in years of different climatic conditions and at all seasons. The Chilka Lake is only a minute, almost isolated, fragment of the ocean, but in order to obtain a solid basis for the working out of any oceanographic problem recurrence is necessary, not only because conditions change from time to time—and in many parts of the ocean they change, so far as we know, very little—but also because detailed work on results obtained in the field inevitably opens new vistas, suggests unsuspected sources of error, and reveals paths that ought to be followed out.

We would suggest, therefore, the possibility of giving further encouragement to local oceanographic investigations. Such investigations have hitherto been very largely, though by no means exclusively, of a faunistic nature; for example, Dr. Gilchrist's work on the seas of Africa, that of the Australian Fisheries Department, and last, but not least, that of the R.I.M.S. *Investigator* in Indian seas. There is no reason, however, except the lack of physicists, to use the term in a broad sense, why this should be so, and even zoology, not to mention botany, still offers an unlimited scope for oceanographers. War has interfered with the work of the *Investigator*, but we have every reason to hope that her scientific researches will shortly be resumed under conditions more satisfactory than ever before, and that for at least one month every year the work of the ship will be devoted to purely scientific research. The Madras Fisheries Department already possesses a small marine laboratory in the Gulf of Manaar, and we hope that the Zoological Survey of India will shortly be in a position to open a larger one in the Andaman Islands, the seas round which, perhaps, offer as good opportunities for oceanographic investigations of all kinds as any seas in the world. The interest of the Government of India in work of the kind is proved by the fact that the post of Surgeon-Naturalist to the Marine Survey of India has been in existence since 1875. Shortly before the war the trustees of the Indian Museum, with the approval of the Government, consulted the leading marine biologists throughout the world as to the advisability of granting increased facilities to the Surgeon-Naturalist, and the Government accepted the practically unanimous verdict of the experts by voting additional grants, etc. It has only been the war that has interfered with its generous proposals. We are not acquainted with details as to the encouragement given to oceanographic research in the Dominions, but the instances we have already cited are sufficient to prove that it has not entirely lacked sympathy, even if only from a strictly practical point of view.

Would it not, perhaps, be more feasible to approach the different Governments of the British Empire, which abuts on the seas of all the world, to organise, with the aid of the experts in their employment, separate but co-ordinate research rather than to attempt to set on foot a single colossal expedition the cost of which is admitted at present to be prohibitive, while its course could not be permanent, or, indeed, extend for more than a comparatively few years?

N. ANNANDALE,
Director, Zoological Survey of India.
R. B. SEYMOUR SEWELL,
Surgeon-Naturalist to the Marine Survey of India.
Royal Societies' Club, St. James's Street.

The Sound of Distant Gun fire.

WITH reference to the letter of Father Schaffers in NATURE of March 10, it is certainly a fact that sounds from moderate distances are heard most plainly when there is a wind reversal at a moderate height and when the upper wind comes from the same direction as the sound. At this place the sound of firing off the east end of the Isle of Wight is heard best when a south wind is blowing over a light wind from some other quarter. As regards conditions when the sound of gun-fire from the Front was heard in this country, I do not altogether agree with what Father Schaffers writes. He says that sound-waves are bent upwards "when temperatures are diminishing and the strength of a head wind is increasing with altitude. The former is at its maximum efficiency in summer, when there is a steep gradient over the surface of the earth; the other is nearly always a characteristic of air-flows, since, as a rule, friction against the soil retards the lower strata."

Father Schaffers goes on to say that temperature inversions at moderate heights are rare in summer, and that at all seasons a wind between south-west and north-west—that is, a head wind for sounds coming towards this country from Flanders—generally occupies the whole height of the troposphere. But with anticyclonic weather and with easterly surface winds these conditions are not always realised, and I am under the impression that it was chiefly in such weather that the sounds were best heard. There are certainly many occasions when the temperature gradient is very slight in clear, anticyclonic weather; and in an easterly wind there is often a sharp increase of velocity up to 1 km. or 2 km. before any decrease takes place. Moreover, it often happens in summer, and in other seasons, that no westerly wind is met with at any height up to the top of the troposphere.

There are, therefore, it seems to me, many occasions when a sound-wave might be refracted downwards by an easterly wind and reach the surface a considerable way to the west of the source. Sound-waves that went up at a fairly high angle might get through the strongest part of the easterly wind and never reach the surface, but those which went up at a less angle would be refracted and never get through the easterly wind. I am inclined to think that any cause which occurs to make sounds to be heard at great distances must operate fairly low down in the atmosphere; if the waves went to a great height before being bent down the sounds would seem to come from high up, whereas my experience was that they seemed to come from somewhere near the horizon. If this is the experience of others it should rule out the hydrogen-atmosphere theory; a sound-ray which went up to 100 km., say, and was thence refracted down to the surface at a distance of 200 km. from the source would come down at an angle of 45°, and such sounds would have been attributed by ordinary observers during the war to some aerial fighting.

The question of the propagation of sound-waves in the atmosphere has been very fully dealt with by Mr. S. Fujiwhara (Bulletin of the Central Meteorological Observatory of Japan, vol. ii., Nos. 1 and 4). Mr. Fujiwhara maintains that the abnormal propagation of sounds to great distances, silent regions, and regions of double audibility depend on the wind structure of the atmosphere, and that sound-waves may be reflected in certain conditions of a heterogeneous wind structure. He has taken certain cases of wind structure revealed by pilot-balloon ascents at Ditcham, and has calculated theoretically the regions of audibility which should be found under the conditions existing at the time; he finds that these agree fairly well with the size and shape of the areas of audibility of explosions of the volcano of Asamayama. He also maintains that the wind structure of the atmosphere at the time of an explosion may be deduced from the areas of audibility.

C. J. P. CAVE.

Ditcham Park, Petersfield, March 21.

Sound Transmitted through Earth.

THE letters from Mr. C. Carus-Wilson and Dr. Charles Davison in NATURE of March 24 prompt me to give the following experience

In June, 1903, I was trekking towards the Victoria Falls. On the night before arrival we "outspanned" some twelve miles to the south, and on retiring to rest on the bare ground I became aware of a curious, rhythmic sound, quite distinct when my ear was pressed against the soil. I told my two brothers, who found they also could hear the pulsation, and one of them suggested that it must be due to the booming of the distant cataract.

To me the most interesting point is not that the sound was transmitted by the earth, but that it was transformed into rhythmic vibration—very different from the constant roar one hears when close to the Falls. Some process of interference would seem to occur and give rise to this result.

REGINALD G. DURRANT.

Rosetree, Marlborough, March 26.

X-rays and their Physiological Effects.

THE death of my brother, Dr. Ironside Bruce, from a hitherto unsuspected danger in the use of X-rays by medical men for purposes of treatment and diagnosis has an aspect other than its personal or medical one. I only write to NATURE because I feel impelled to address an appeal to workers on the purely physical research problems connected with X-rays. I suggest that there is a need for closer association between the latter and medical men practising radiology. The advance in medical knowledge which the X-ray has rendered possible has been immense, and it is becoming practically indispensable in the diagnosis of disease. But it is now clear that its use by practitioners may be curtailed unless some more effective measures of protection for radiologists can be devised.

On many occasions my late brother expressed to me his difficulty in obtaining precise physical knowledge bearing on the nature of the rays and their effects on human tissues. Not many days before his death he returned to this subject, and said that if he recovered he would devote his life to research on protective measures. If a layman might venture an opinion, it would be that medical men generally cannot be expected to conduct research on the methods of production of the rays, or on the exact nature of the various kinds of rays produced by different forms of apparatus. On the other hand, physicists are not ordinarily competent to investigate the purely biological effects of the rays. Hitherto medical men have been lulled into security by the belief that the only injury to be feared was dermatitis, which they believe is caused by rays of low "penetration," and are probably stopped even by ordinary clothing materials. Again, they believe that protective screens of lead glass afford full protection. We may now doubt whether they do, at any rate in some circumstances.

In the interests, therefore, not only of radiologists, but also of suffering humanity which any curtailment of the facilities for X-ray treatment will affect, I appeal for an organised effort on the part of physicists and biologists *in collaboration* to institute research into the effect of X-rays on living tissues. I have sufficient confidence in science to feel that, as a result, methods will be devised which, while preserving the usefulness of the rays for medical purposes, will guard the devoted band of practitioners against the tragic risk which now stands revealed. I feel that in making this appeal I am discharging a duty imposed upon me by my brother.

March 25.

Since the above was written I have learned that some months ago steps were taken by the Medical Research Council to organise research on the action of radio-active rays on living tissues. With this work prominent physicists will be associated. I am confident that this collaboration will be productive of good results, and I am glad to know that the appeal I ventured to make had already been answered. A. B. BRUCE.

March 29.

Greenland in Europe.

DURING the present month a new light has been thrown upon the Aberdeen kayak (skin-canoe) referred to in NATURE of January 13, p. 648. Fresh information upon this subject is found in a diary of a tour through Scotland in 1760 by the Rev. Francis Gastrell (born 1707; M.A. Oxon. 1728), son of a Bishop of Chester, and owner—by purchase in 1753—of New Place, Stratford-on-Avon. His diary is now preserved in the Shakespeare Museum at Stratford. In a paper read on March 10 before the Edinburgh Bibliographical Society Mr. James Sinton quoted Gastrell's statement that when visiting King's College Chapel, Old Aberdeen, on October 12, 1760, he there saw "a Canoo about seven yards long by two feet wide wh[ich] about thirty-two years since was driven into the Don with a man in it who was all over hairy & spoke a language wh[ich] no person there could interpret; he lived but three days, tho all possible care was taken to recover him." This canoe is now in the anthropological museum at Marischal College, Aberdeen. Its exact length is 17 ft. 9 in., its greatest breadth being scarcely 18 in. and its weight 34 lb. Francis Douglas, who saw it in or about the year 1782, describes it as "a canoe taken at sea, with an Indian man in it, about the beginning of this century. He was brought alive to Aberdeen, but died soon after his arrival, and could give no account of himself."

These two statements do not coincide, but there can be little doubt that they relate to the same individual. The hairiness of which Gastrell speaks suggests a non-Mongolian type, but it might only mean an imperfect recollection of the fur hood, shirt, and breeches worn by kayak-men. A similar canoe, captured in Orkney waters, and preserved in Edinburgh in 1696, had with it "the shirt of the barbarous man that was in the boat." Dr. James Wallace (F.R.S. Lond.), writing in 1700, says that "there is another of their boats in the Church of Burra in Orkney." In the same year the Rev. John Brand states that such canoes and canoe-men were then frequently seen upon the coasts of Orkney, "as one about a year ago on Stronsay, and another within these few months on Westray—a gentleman with many others in the Isle looking on him nigh to the shore,—but when any endeavour to apprehend them they flee away most swiftly." DAVID MACRITCHIE.

4 Archibald Place, Edinburgh, March 21.

The Peltier Effect and Low-temperature Research.

WITH further reference to the suggestions of Mr. Campbell Swinton and Sir Oliver Lodge contained in NATURE of March 10 and 17 that the Peltier effect may disappear at a very low temperature, this appears very improbable from the fact that, as long ago pointed out by myself, there is a continuous transition between metals and non-metals, and this distinction between them does not vanish at low temperatures. Consequently, pairs of elements must always exist with electrothermic differences. The nearly "perfect" metal may become a "perfect" conductor of heat and electricity, and the nearly "perfect" non-metal may become a "perfect" non-conductor at low enough temperatures, but the intermediately graded elements would become neither perfect conductors nor absolute non-conductors, but would behave much like certain elements at ordinary temperatures. The periodic law would enable physicists to predict almost with certainty which elements would exhibit the desired effect best at low temperatures.

It may repay physicists who intend to study these effects to look up papers written by me many years ago, *e.g.* "Some Remarks on the Connection between Metals and Non-Metals," etc., which occur in the *Chemical News* during the years 1903, 1904, and 1905. Also my book "Researches on the Affinities of the Elements and on the Causes of the Chemical Similarity of Elements and Compounds" (1905). I have been hoping for the opportunity of revising the latter and bringing it up to date, but unfortunately have always been overwhelmed with technical work.

GEOFFREY MARTIN.

109 Corporation Street, Manchester,
March 22.

Relativity and the Velocity of Light.

THE great interest of Mr. Jeans's letter on this subject in NATURE of March 10 is, I think, sufficient justification for my letter by which it was evoked.

The argument used by Mr. Jeans to support the proposition that it can be shown that both on the outward and on the inward journey light travels with the same constant velocity is, to me, difficult to follow. Majorana's experiments deal respectively with a source and a reflecting mirror moving relatively to the observer, whereas in the Michelson-Morley experiment both are at rest with the observer. I cannot then see the bearing of Majorana's results upon the question whether β and α remain unchanged in the case given by Mr. Jeans.

I am sorry I misunderstood the words used by Mr. Jeans in his article in NATURE of February 17 to imply a belief in the possibility of measuring the velocity of light in a unidirectional course. It appears to me, however, that the truth of this proposition is involved in the affirmation of the proposition referred to in the paragraph above; for the mean velocity of light on its outward and return journeys after reflection from a mirror can be measured. If also its constancy outwardly and inwardly can be affirmed, does it not follow that the velocity on a unidirectional course becomes known, contrary to the principle of relativity? C. O. BARTRUM.

32 Willoughby Road, Hampstead, March 15.

Stellar Magnitudes and their Determination.

By H. SPENCER JONES, Chief Assistant, The Royal Observatory, Greenwich.

I.—APPARENT MAGNITUDES: (*a*) VISUAL.

THE magnitude of a star, as determined by direct astronomical observation, is a measure of its *apparent* brightness on a scale which has been precisely defined only within recent years. Hipparchus was, so far as is known, the first to assign magnitudes to the stars, and his results have been preserved for us by Ptolemy in the Almagest. The classification of Hipparchus was a crude one, the stars being divided into six classes, all the brightest stars being assigned to the 1st magnitude, and all those only just visible to the naked eye to the 6th. Ptolemy extended the classification by recognising the gradation in brightness between the stars in a given class, this gradation being indicated by the words μείζων and ἐλάσσων, used to denote that a star was brighter or fainter than the average star of its class. Ptolemy's estimations were adopted almost universally until the time of Sir William Herschel, who developed a plan for representing various degrees of difference in brightness between stars by the use of arbitrary symbols, and made observations of the magnitudes of nearly three thousand stars. It was not until Argelander carried out the great project of the "Bonn Durchmusterung" (1852 onwards) that magnitudes were first estimated to tenths, and even in this great work the scale adopted, though made to correspond fairly closely with the then existing scales, was an arbitrary, and not a uniform, one.

Sir John Herschel was the first to attempt to formulate a numerical relationship between the apparent brightnesses of stars of successive magnitudes, and he concluded that the best representation was afforded by a relationship according to which a decrease in light in geometrical progression corresponds to an increase in magnitude in arithmetical progression. He also estimated that the actual ratio of the light of a star of the 1st magnitude to one of the 6th is at least 100 : 1. Herschel's conclusion is in accordance with a psycho-physical law, enunciated by Fechner, that, as a stimulus increases in geometrical progression, the sensation produced by it increases in arithmetical progression, the law being departed from, however, in the case of very intense or very weak stimuli. According to this law, if I_m denotes the apparent brightness of a star of magnitude m, then $I_m : I_{m+\Delta m} = k^{\Delta m}$, where k is a constant, which is called the "light ratio."

Using this relationship, the value of k (or $\log k$) corresponding to various early series of magnitude determinations, after standardisation by various photometric devices, can be found. These show a somewhat wide variation around a mean of about 0·40 for $\log k$. Thus a few values are:—

Herschel	... 0·407	Argelander	... 0·431
Struve	... 0·383	Groombridge	... 0·388

The values are not, in general, constant within any given series. Thus for the "Bonn Durchmusterung" of Argelander we have:—

For magnitudes	3 to 5 ...	0·29
,, ,,	5 to 6 ...	0·30
,, ,,	6 to 7 ...	0·39
,, ,,	7 to 8 ...	0·39
,, ,,	8 to 9 ...	0·44

It was, therefore, suggested by Pogson that the value 0·40 for $\log k$ should be definitely adopted as a basis for accurate photometric determinations of magnitude. This value is in sufficiently close agreement with the values derived from the older series of determinations to ensure that the magnitudes derived on this basis will not deviate greatly from the older estimates. Owing to the convenience of this figure, all modern photometry has been based on this convention, which assigns a value to k of 2·512... The convenience of the figure is due to the facility with which it enables estimates of brightness to be transformed into magnitude differences ($\Delta m = 2{\cdot}5 \log I_m / I_{m+\Delta m}$). In the case of two stars one of which is 100 times as bright as the other, we then have $\Delta m = 5$ magnitudes, exactly in accordance with Sir John Herschel's estimate.

Having adopted this convention, it becomes necessary, before a magnitude can be assigned to any star, to fix the zero from which the magnitudes are to be estimated, it being agreed that the scale shall be continued in both directions, stars brighter than a star of the 1st magnitude being assigned zero or negative magnitudes. The use of the term "negative magnitude" may be misleading to those who are not astronomers, but the conception is a useful one if the scale of magnitude is to be considered—as theoretically it must be considered—capable of infinite extension at each end. It has the further advantage of not causing a break with the old-established convention that the brighter the star the smaller (algebraically) is the quantity denoting its magnitude. It is convenient so to choose the zero that the modern precise photometric magnitudes shall agree as closely as possible with the older values, which we have seen also corresponded closely with a value of 0·4 for the logarithm of the light ratio. In actual practice the zero has been fixed somewhat indirectly; in the extensive visual photometric work carried out at the Harvard Observatory all the stars were compared with the Pole-star, for which a provisional magnitude was assumed. Thus differences of magnitude only were determined. All the magnitudes were finally increased by a quantity so chosen that the mean of the magnitudes deduced for 100 circumpolar stars between the 2nd and 6th magnitudes agreed with the corresponding mean of the values assigned in the "Bonn Durchmusterung." In the photometric *Durchmusterung* of Müller and Kempf at Potsdam the zero was chosen so that the mean magnitude of 144 selected fundamental stars north of the equator, between magnitudes 4 and 7, should agree with the corresponding value in the "Bonn Durchmusterung." The systems of magnitudes derived in these two investigations are not in absolute accordance, as will be seen later.

For the accurate determination of visual magnitudes, some form of photometer is necessary. The two types which have provided the best results are the Zöllner photometer and the meridian photometer of Pickering. The former is illustrated in Fig. 1, the principle of the instrument consisting in the formation of two images in the focal plane of the telescope, one being the image of the star under observation, and the other that of an artificial star the brightness of which can be varied and brought into equality with that of the real

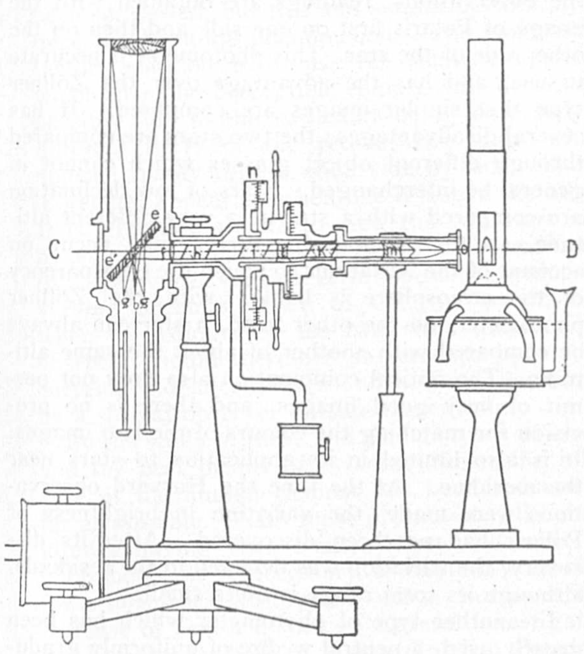

FIG. 1.—The Zöllner Photometer.

star. The light from a standard lamp, giving a constant illumination, passes through a pin-hole in a diaphragm *o*, holes of different sizes being used to simulate stars of different magnitudes. The divergence of the rays passing through the pinhole is increased by a concave lens, *m*, and it then passes successively through a polarising Nicol, *k*, a thin quartz plate, *l*, cut perpendicularly to its optical axis, a second Nicol, *i*, and a third Nicol, *h*. The Nicol *i* and the quartz plate *l* are fixed relatively to one another, but the Nicol *k* can be rotated, so varying the colour of the light falling on the third Nicol. When the colour agrees as nearly as possible with that of the star under observation, *k* is clamped into position. The Nicol *h* acts as an analyser, and the system *k, l, i* is turned as a whole relatively to it in order to vary the brightness of the artificial star and bring it into equality with that of the real star. The light then passes through a lens, *f*, which focusses it in the focal plane of the telescope, after reflection by the plane glass mirror *ee'*, which forms two images of the artificial star of nearly equal brightness by light reflected from its front and back surfaces respectively, the former being somewhat the brighter of the two. There are four positions of the rotating system in which equality can be obtained between the brighter of these images and that of the star under observation, and the reading corresponding to each is observed. Some observers prefer to make the observation by adjusting the brightness of the images of the artificial star so that the real star image is intermediate in brightness between the two images of the artificial star. As differences in brightness only are measured, it is immaterial which procedure is adopted provided it is adhered to throughout. A standard star is then observed in a similar way. If I_1, I_2 are the angles through which the polarising system is turned in the two cases, from the position corresponding to crossed Nicols, then the ratio in brightness of the two stars is $\sin^2 I_1 : \sin^2 I_2$, and therefore their difference in magnitude is $5 \log (\sin I_1/\sin I_2)$. All the Potsdam observations were made with two photometers of this type, though differing in some details from that illustrated here; 144 fundamental stars were chosen, which were combined into 432 pairs, and intercompared in order accurately to determine their magnitudes. Every zone star was then compared with an adjacent fundamental star.

The Zöllner photometer is convenient and accurate in use. The colour compensation reduces the subjective errors of personality which are liable to occur when two images of different colours are compared. The colour match can be made much more accurately, however, for yellow and red stars than for white or yellowish-white stars. The principal objection raised against it is the employment of an artificial star—not on the ground of possible variations in its magnitude, for there are types of standard lamps which give very constant illumination, but owing to the fact that the image of the artificial star may not be exactly similar to that of a real star under all conditions of seeing. It is stated by Müller that the tendency is to make bright stars too bright and faint stars too faint, but, provided that the diaphragm or the aperture of the telescope is so chosen that the magnitude of the artificial star does not differ greatly from that of the star under observation, the errors possible on this account are very small. One of the Potsdam photometers was provided with three object glasses which were used in conjunction with three diaphragms. It was found best to use an aperture of 30–40 mm. for stars of magnitudes 2 to 4, of 60–70 mm. for stars of magnitudes 4 to 6, and of 130–140 mm. for stars of magnitudes 6 to 8.

The meridian photometer, devised by Pickering and used at the Harvard Observatory for the very extensive photometric work carried on there under his direction, is illustrated in Fig. 2. It consists of a horizontal telescope pointing to the west and provided with two similar objectives, A and B, in front of which are placed right-angled prisms, C and D, which reflect the light from two stars into the telescope. The prism D is used only for observing the Pole-star, and can be turned about two perpendicular axes by rods E and F.

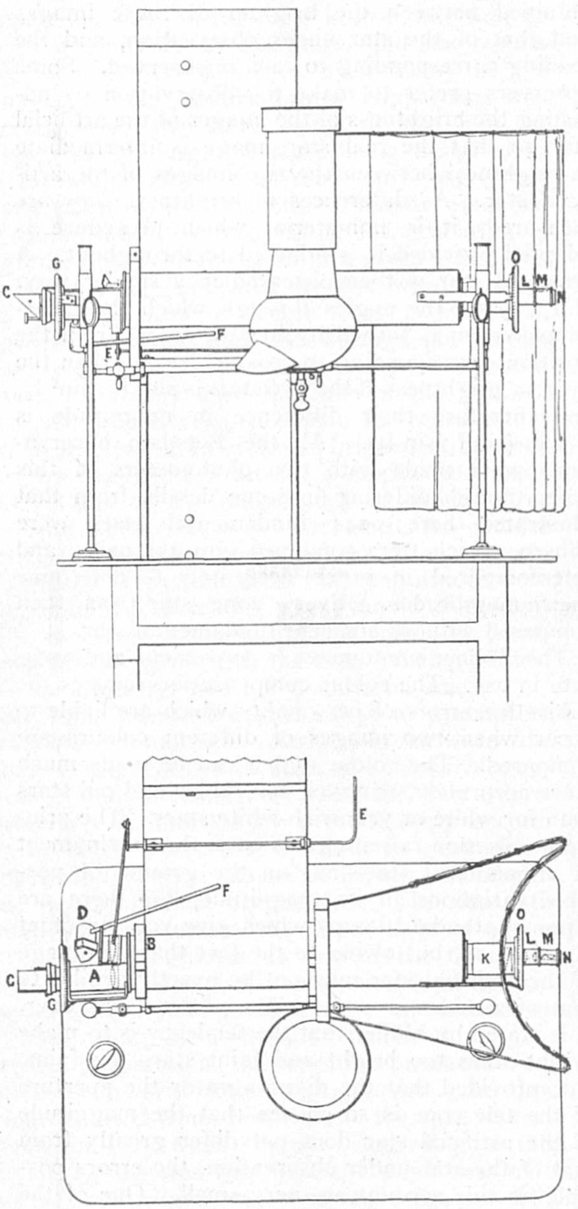

FIG. 2.—The Meridian Photometer.

The prism C can be turned around the axis of the telescope, and its position read by a circle, G, so that a star of any given declination can be observed on the meridian; there is also a slight adjustment for enabling it to be viewed for about one-quarter of an hour before or after meridian passage. A double-image prism, K, made of Iceland spar compensated by glass, is placed near the focus of the objectives, and divides each pencil of light into two; the angles of the spar and glass prism are so adjusted that the two central pencils (one ordinary and one extraordinary pencil) are made to coincide and to pass nearly through the centre of the eyepiece L. In this way errors which might result from having two emergent pupils or from the pencils passing through different parts of the eyepiece are avoided. In front of the eyepiece is placed a Nicol, M, and an eye-stop, N, cuts off the two outside pencils. A graduated circle, O, is attached to the eyepiece and Nicol, and the four positions of the Nicol are observed in which the two images are equal in brightness. Since the beams from the two stars are polarised at right angles, if I is the angle counted from the position where the image of Polaris disappears, then the ratio of the brightness of the star under comparison to that of Polaris is $\tan^2 I$. In taking the observations, readings are obtained with the image of Polaris first on one side and then on the other side of the star. This photometer is accurate in use, and has the advantage over the Zöllner type that similar images are compared. It has several disadvantages; the two stars are compared through different object glasses which cannot in general be interchanged. Stars of low declination are compared with a star at a very different altitude, so that appreciable errors may occur on account of the variations to which the transparency of the atmosphere is liable; with the Zöllner photometer, on the other hand, a star can always be compared with another of about the same altitude. The optical combination also does not permit of very good images, and there is no provision for matching the colours of the two images. It is also limited in its application to stars near the meridian. At the time the Harvard observations were made the variation in brightness of Polaris had not been discovered. After its discovery, the variation was detected in the residuals, although its total range is quite small.

In another type of photometer which has been greatly used, a neutral wedge of uniformly graduated absorption is employed, and the reading is taken of the position of the wedge when the star under observation just becomes invisible. Owing to the strain on the observer's eyes caused by these observations, which are liable to give rise to personal errors of variable amount, and to the impossibility of obtaining an absolutely neutral-tinted wedge, this type of photometer does not give results of the same order of accuracy as the two described above.

Although the theory of the determination of visual magnitudes is very simple, there are many possible causes of error, mainly of a physiological nature, arising from the necessary use of the human eye. Most of these are more important when very faint stars or stars differing much in colour or brightness are observed, though in the Zöllner photometer difference in colour can be compensated to a certain extent. Errors arising from the observation of stars near the threshold of visibility should be avoided by reserving them for an instrument of larger aperture. A few causes of error may be referred to briefly: (i) The Purkinje phenomenon is well known; if two lights of different colours—say, a red and a green—appear equally bright to the eye, then, if the intensity of each is increased in the same ratio, the red will appear the brighter; if reduced in the same ratio, the green will appear the brighter. Thus the relative magnitudes of two stars of different colours depend upon the aperture and power with which they are observed. (ii) Connected with this phenomenon is the difficulty of comparing the brightness of two stars when their colour is different with any type of photometer which does not compensate for colour difference. Some observers will estimate a red star as relatively much brighter than will other observers—errors of half a magnitude on this account are not at all uncommon. The use of a red screen has been suggested, but this and similar devices introduce the Purkinje phenomenon. The most satisfactory solution is to use the smallest aperture which gives no perceptible colour. (iii) Errors are possibly due to the two stars being observed on different parts of the retina; two stars which appear equally bright when side by side will not in general appear so when one is above the other. It is advisable always to view the two stars side by side and then to interchange their positions. (iv) There are various errors possible owing to varying accommodation of the eye, particularly when the colours of the two stars differ. The observer should therefore be screened by a dark curtain, and all readings and settings performed by a second observer outside the curtain.

By the study of these and similar types of errors and the best means of avoiding them, the influence of the human element has been reduced as far as possible. With these precautions, the magnitudes having been finally determined with the photometer, it is necessary to apply a correction for atmospheric absorption, which increases with increase of zenith distance. Careful investigation has been made, both at Harvard and at Potsdam, of the amount of this correction at various altitudes, and the effects of differential atmospheric absorption have been allowed for with relatively small uncertainty. But even after all precautions have been taken it is found that there remain systematic differences between different series of observations, and that these occur not only in the case of series made by different observers and with different instruments, but even between different series made by the same observer with the same instrument. In general, the errors are not large, but they cannot be neglected in comparison with the accidental error deduced from the inner agreement between the observations in any one series. The comparison of the brightness of two images in a photometer is a subjective one, and it seems impossible altogether to eliminate errors. In the observations at Potsdam every star was observed an equal number of times by the two observers in order to make the whole series internally consistent; but another observer observing with the same photometer would probably obtain results differing systematically according to colour. Different results are also obtained from different instruments. Thus Müller and Kempf find, from a comparison of the "Revised Harvard Photometry" with the "Harvard Photometry," in which the observations were made with different photometers, the following relative differences between white and yellow stars in the two series:—

Magnitude	Mean differences (R.H.P.—H.P.) for white stars *minus* differences for yellow stars
m.	*m.*
Brighter than 2·0	−0·23
2·0–3·0	−0·17
3·0–4·0	−0·10
4·0–5·0	−0·10
5·0–6·0	−0·01
6·0–7·0	+0·05
Fainter than 7·0	+0·21

The Potsdam observations made with the different photometers were intercompared, and corrections derived by which all the observations were reduced to a mean system. The differences, in part, were probably due to differences in the absorptions in the several object glasses used.

The comparison between the final Potsdam results and the Harvard results reveals differences which appear surprisingly large in view of the care devoted to the observations themselves. The differences are mainly dependent upon the colours of the stars; to a much less extent they vary with their brightness. The following mean differences in the sense Potsdam *minus* Harvard are found for the Potsdam colour-classes W (white), GW (yellowish-white), WG (whitish-yellow), G (yellow):—

W, +0·25*m*; GW, +0·22*m*; WG, +0·10*m*; G, 0·00*m*.

The differences show continuous variation with brightness for the range 2*m* to 8*m* as follows:—

W, +0·23*m* to +0·37*m*; GW, +0·20*m* to +0·30*m*; WG, +0·12*m* to +0·07*m*; G, +0·07*m* to −0·08*m*.

When it is recalled that a difference in magnitude of 0·1*m* corresponds to an error in apparent brightness of nearly 10 per cent., the magnitude of these errors can better be realised. It is also apparent that there is much scope for improvement in the accuracy of magnitude determinations.

The Potsdam visual *Durchmusterung*, comprising all stars in the "Bonn Durchmusterung" down to a limit of 7·5*m* on the "Bonn Durchmusterung" scale, is probably the most accurate series so far as inner consistency is concerned, the same two observers having observed every star, and instrumental differences having been so far as possible eliminated. If any series of visual photometric observations can be regarded as fundamental, it is this series; but any other fundamental series may be expected to show slight systematic discordances. There is a parallel in the case of meridian observations, in which there are several fundamental systems, and it is customary to reduce any series of observations to one or other of these fundamental systems. If further series of observations are reduced to the Potsdam system, any future revision of this system can easily be extended to all the observations based upon it. At present no series has been generally accepted as a standard, and if two determinations of magnitude of a star agree within one-tenth of a magnitude, astronomers now feel very satisfied.

(*To be continued.*)

The Development and Spread of Civilisation.

By W. J. PERRY, The University, Manchester.

RECENT research suggests that the various forms of human culture are the result of a process of organic growth. Continuity is apparently the key-note of the study of the history of civilisation. But, because it is not possible in each case to supply the missing links, it is incumbent on those who believe in continuity to construct a mechanism of the development and spread of civilisation in all ages and places. The following generalisations suggest how this process has been effected.

It would seem that civilisation—that is to say, the possession of the fundamental arts and crafts necessary for settled corporate life—first appeared in the Near East. There, at some time before 3700 B.C., had apparently been discovered the crafts of agriculture, irrigation, stock-breeding, carpentry, metal-working, stone-working, pottery-making, weaving, and so on. All the rest of the world, so far as can be seen, was at that time peopled only by hunting tribes very low in the scale of culture. These were not long left in possession of their hunting-grounds, for civilisations began to appear in outlying parts of the earth, such as Turkestan, Siberia, China, India, the valley of the Wei in China, the valleys of the Usumacinta and Motagua in Guatemala, Lake Titicaca in Peru, etc. The cultural level of these early centres never exceeded, and rarely approached, that of the Near East. Around these centres appeared later other civilisations, usually progressively lower in cultural level as they became more remote from the centre in space and time. For example, the earliest known civilised settlement of North America was that of the first Maya cities of Guatemala. All the later Maya cities, and the tribes that afterwards occupied the same region, display a definite inferiority of technique in the arts and crafts as compared with these earliest settlements. Northward from Mexico there is a steady drop in the level of culture. Similarly with South America. It is claimed that negro Africa derived practically all its culture, directly or indirectly, from Egypt. As one goes south from Egypt there is, speaking generally, a steady decline in cultural level, the most southerly people of all, the Hottentots and Bushmen, being the lowest. The study of the beginnings of European civilisation reveals a similar condition of affairs. The earliest centre was in the eastern Mediterranean. In no other region of the continent did ancient civilisation attain to so high a level, and the various stages of development of culture appeared later in time in the outlying parts than in those nearer to this region.

It is natural to seek to interpret these and similar facts. In only one region in the world—the Near East—can progressive development of culture be established in ancient times. In that region civilisation probably first appeared, and there it reached the highest level of antiquity. Everywhere in the world outside the area directly and continuously influenced by this region, the story from the beginning is one of uninterrupted degeneration in arts and crafts. In many instances it is possible in these outlying regions to establish direct filiation of culture, and it is invariably found that the process is accompanied by degeneration in the arts and crafts. Since in any one region, such as America, it is found that, wherever direct cultural sequence can be established, the earlier is the more advanced, and that the earliest known culture is the most advanced of all in the technique of the arts and crafts, it is difficult to account for the facts otherwise than by postulating that the earliest civilisation in such a region was derived from one that preceded it in some other part of the world. Carried to its conclusion, this amounts to claiming that everywhere outside the Near East, even in cases where it cannot be established by direct proof, culture exists by reason of direct filiation—in short, it amounts to postulating continuity in culture. In that way it would be claimed that the civilisations surrounding the original culture centres were derived from them, and that the culture centres themselves were derived from those that preceded them on the earth. The chronological argument would thus lead us to derive all the outlying culture centres from the Near East, and the whole process of cultural development would be one of growth outward from the Near East. This solution would satisfy both the spatial and chronological conditions of the problem.

The indication of a motive will tend to facilitate belief in such a world-wide movement of culture in antiquity. The ancient civilisations in different parts of the earth are fundamentally similar—they are all founded on irrigation—and in their economic, social, political, and religious organisation they resemble the civilisations of the Near East. Further, in those early days there was a widespread belief in the efficacy of gold and other substances as "givers of life," and there are historical instances of expeditions setting out to seek for the earthly paradise, where such substances could be found—in America there are traditions of the arrival of highly civilised strangers on such an errand. The early sites of civilisation in the outlying parts of the world are near sources of gold, pearls, and other substances formerly credited with life-giving powers. So there is reason for concluding that there was a great movement of culture, the chief motive for which was the search for the elixir of life.

The ancients have left their traces on most of the goldfields and other similar sources of wealth of the earth, and they were apparently searching for others; but this search was abruptly abandoned. Regions that must have hummed with activity in days long past have, during many centuries, been peopled by tribes indifferent to the wealth at their disposal, so that goldfields worked thousands of years ago have only recently been reopened.

It is necessary to account for the fact that the early civilisation of the world carried within itself the germs of its decay and even destruction.

In the Near East appeared the first ruling class known to us. The kings there were from the first intimately associated with the maintenance of the irrigation systems on which such early communities chiefly depended for their food supply. In the earliest civilisations in the outlying parts of the earth there were ruling families so closely allied in their peculiar culture to those of the Near East that there is reason to believe that they were derived thence, directly or indirectly.

The process is known by which the new communities were formed around the old centres of civilisation. Members of the ruling class went out from their homes and imposed themselves elsewhere as a new ruling class, and this process has gone on until the earth has become covered with a network of States formed of a ruling class dominating people differing from them in culture and often in race. From the beginning, ruling classes have possessed beliefs and practices peculiar to themselves; they universally use heraldic emblems, the lion and the eagle playing a prominent part in connection with the kingship; a claim is often made to descent from an ancestor borne to a god by an earthly mother; in the early States we find the belief in a land of the dead in the sky invariably associated with the ruling class; the kings of the earlier States were supposed to be responsible for the welfare of the community; and there is a widespread association between royalty, the building of pyramids, and the preservation of the dead—all of which goes to support the theory that the ruling class of any country is derived from that of some other country, so that all the ruling classes of the world have originated ultimately by a continuous developing process from one group in the Near East, the place where they can first be detected.

The earliest peoples on the earth used no weapons that we have traces of, and the study of the remains of the Upper Palæolithic and Neolithic ages shows that these peoples were mainly, if not entirely, peaceful. The hunting tribes that live on the earth are all peaceful, and their standard of behaviour and morality is higher than that of civilised communities. War is the accompaniment of ruling classes. In their beginnings in all parts of the earth they did not indulge much in war, except to obtain slaves and victims for sacrifice, but the ruling classes of the daughter States struggled with each other for the possession of power and wealth; and often a military genius arose among them who welded many communities by conquest into an empire that usually fell to pieces on his death or defeat at the hands of some rival. In this way much of the old civilisation of the earth was destroyed, and the arrival of barbarians with ruling classes derived from more advanced peoples can, in a large number of cases, be shown to account for the sudden cessation of the onward march of civilisation into the outlying parts of the earth.

The earliest ruling families claimed to possess the whole realm, and were enabled to divert much of the energies of their subjects to such purposes as the building of temples and palaces, and to the accumulation of the means of upkeep of such establishments. As a result of the combination of the domination of ruling families and their subsequent incessant struggles for power, there has ensued in all parts of the earth the decay and death of civilisations. The domination at home has apparently caused the arts and crafts to decay and become stereotyped, and the warfare engendered by these ruling classes has completed the work of destruction.

It remains to account for the fact that the daughter States were so much more warlike than those that gave rise to them. The explanation suggested by the facts is that the rulers of the original States were chiefly occupied with duties connected with the welfare of the community—for this was the real source of their prestige—and were obliged incessantly to perform ceremonies for that end. They were hide-bound in etiquette, and apparently had but little personal initiative; but the young men who went out to found kingdoms threw over the restraints of their homes, and, with their followers, abandoned themselves to military pursuits, with results that are reflected in the social, economic, and religious life of the communities formed by them. One important consequence of this process was the formation in places of pastoral communities derived from those practising irrigation. These men, with checks and restraints removed, established the most warlike States that the world has known, and these States have ever been distinguished by cruelty beyond any that the world has known. It would seem that the psychological explanation of this phenomenon lies in the possession by these ruling classes of practically unrestrained power, which has caused them to adopt methods of cruelty.

This system of military domination, being inherently unstable, ultimately began to break down, and the peoples of Western Europe, released to some extent from the restraints imposed on mankind for so long by their ruling classes, were enabled to begin once more that progressive conquest of Nature which has so often and so rudely been interrupted in the past.

Obituary.

WE record with much regret the death of DR. W. IRONSIDE BRUCE on March 21 at the early age of forty-four. Dr. Bruce was educated at the University of Aberdeen, obtaining the degrees of M.B. and Ch.B. in 1900, and then served as civil surgeon in the South African Field Force. Here he took much interest in the application of X-rays for the diagnosis of war injuries, and afterwards became assistant to the late Sir J. Mackenzie Davidson at Charing Cross Hospital, and on the death of the latter succeeded as medical officer in charge of the X-ray department. Dr. Bruce was intensely interested in the scientific developments of his subject, of which he acquired a very complete knowledge. He published "A System of Radiography with Atlas of the Normal," and in process of time became president of the section of radiology, Royal Society of Medicine, and took a considerable share in the establishment of the diploma in radiology, now given by the University of Cambridge. Some months ago the condition of his health gave rise to anxiety, and it was later found that he was suffering from a severe type of aplastic anæmia, from which he died. Evidence has accumulated that this condition may be caused by the more penetrating radiations both from X-ray tubes and from radium, and there is little doubt that he succumbed as a result of his continuous work in radiology—another X-ray worker who may be described as a martyr to his science.

Lord Lonsdale has received the following letter from Buckingham Palace: "The King has learnt with much regret of the tragic death of Dr. Ironside Bruce, radiologist to the Charing Cross Hospital, and I am commanded to convey to you and the hospital staff his Majesty's sincere sympathy in the loss of so brilliant a physician, who sacrificed his life in the cause of science and humanity."

SCIENCE and industry alike have suffered a loss by the recent death, at Southall, of MR. S. H. BLICHFELDT, a director of the Maypole Margarine Co. Mr. Blichfeldt was only forty-four years of age. He was of Danish birth, and took up a position as chemist at the Maypole works at Southall in 1906 after having worked for some years at Jörgensen's laboratory in Copenhagen. He was a strong advocate of the application of science to industry, and throughout his work demonstrated the importance of scientific methods in the factory, and the manufacture of margarine in the Maypole Co.'s works was gradually placed upon a really scientific basis as the result of his labours. Mr. Blichfeldt's abilities as a chemist and bacteriologist were widely known to the scientific world, and it is pleasing to note that the Maypole Co. recognised the value of research in industry, and appointed him a director of the company in 1916.

Science for March 11 announces the death on February 2 of PROF. T. MIYAKE, of the Agricultural College of the Imperial University of Tokyo, who was the author of an important work on the entomology of Japan; and on February 24 of DR. F. J. V. SKIFF, director of the Field Museum, at the age of sixty-nine years.

THE death is announced, at eighty-three years of age, of MR. JOHN BURROUGHS, the inspiring American writer on natural history subjects.

Notes.

LECTURING before the Royal Society of Medicine on March 22, Lt.-Col. Nathan Raw gave an account of his work and views on immunity in human tuberculosis. Col. Raw agrees with other investigators that man is attacked by two fundamentally different tuberculous viruses, the human and the bovine. The former is conveyed from person to person by direct infection and mainly attacks the lungs; the other is conveyed by milk from tuberculous cows and develops in the first few years of life. These two types of tubercle bacilli will not live in the body at the same time, and, further, an attack by one virus produces an immunity to the other. The bacilli may be attenuated by cultivating for years outside the body, so that they no longer convey the disease on inoculation into susceptible animals. Vaccines can be prepared from these attenuated cultures, and may be employed for the treatment of tuberculosis in man. Cases of infection with the human bacillus treated with the vaccine of the bovine virus have shown considerable improvement. Animals may be completely immunised against tuberculosis by the use of these attenuated cultures, and Col. Raw expressed the opinion that if all children with a tuberculous family history were vaccinated with the attenuated cultures, an entirely safe procedure, they would be in a much better position to resist infection in after years.

No section of scientific medicine has developed more rapidly in technique than those dealing with vaccines, sera, toxins, antitoxins, and related substances. The real science of these "biologic products" is scarcely a generation old. The use of them in medical practice has spread in recent years with an epidemic acceleration. Vaccines are not yet quite so commonly used as, say, digitalis or strychnine, but they are among the approved medicaments of the "general practitioner." The same is more or less true of salvarsan and its substitutes. The great drug firms have risen to the demand, and the whole medical position is now such that the public service has found it necessary to consider how the best and safest products shall be secured to the consumer. It is these facts that led to the appointment of the Committee "on control of certain therapeutic substances," with Sir Mackenzie Chalmers, K.C.B., as chairman. The terms of reference covered "the legislative and administrative measures to be taken for the effective control of the quality and authenticity of such therapeutic substances offered for sale to the public as cannot be tested adequately by direct chemical means." This carefully exclusive remit left the Committee to deal with three groups of substances: (1) the biologic products already mentioned; (2) potent synthetic remedies like salvarsan; and (3) preparations like digitalis, strophanthus, pituitary gland, etc. The report (Cmd. 1156, *2d.*) deals with all three classes. It makes special recommendations for inspection of the processes of manufacture and testing of the products. The main problem is standardisation. This is supremely difficult for delicately varying biological substances like vaccines or toxins. Recommendations, however, make full provision for the activities of private enterprise. There is an outline of a draft Bill, which no doubt is prepared first for discussion. From the evidence quoted the leading British firms are in favour of more effective control.

IT is reported from Rome that a "thunderbolt" fell there on Sunday, March 27, and slightly damaged the base of the Obelisk in the Piazza di San Pietro, but no mention is made of any fragments of the meteorite having been found. The excellent "Introduction to the Study of Meteorites," published by the British Museum (Natural History), refers as follows to several early historical accounts of meteorites associated with Rome:—"A stone, famous through long ages, fell in Phrygia, and was preserved there for many generations. About 204 B.C. it was demanded by King Attalus, and taken with great ceremony to Rome. It is described as 'a black stone in the figure of a cone, circular below and ending in an apex above.' In his History of Rome Livy tells of a shower of stones on the Alban Mount about 652 B.C. which so impressed the Senate that a nine days' solemn festival was decreed. Other instances of the 'rain of stones' in Italy are mentioned by the same author."

THE next ordinary scientific meeting of the Chemical Society will be held at the Institution of Mechanical Engineers on April 7 at 8 p.m., when Dr. F. W. Aston will deliver a lecture entitled "Mass Spectra and Atomic Weights."

IN connection with the London Branch of the National Union of Scientific Workers a meeting will be held at 7.30 o'clock on Thursday, April 14, at 52 St. Martin's Lane, W.C.2, when an address will be given by Mr. H. E. Potts on "The Position of Employer and Scientific Worker in Relation to Patent Law."

ON Tuesday next, April 5, at 3 o'clock, Prof. R. A. Sampson, Astronomer-Royal for Scotland, will deliver the first of two lectures at the Royal Institution on (1) Present Position of the Nebular Hypothesis and (2) Measurement of Starlight. The Tyndall lectures will be delivered by Mr. C. T. R. Wilson on Thunderstorms, beginning on Thursday, April 7; and on Saturday, April 9, Dr. H. H. Dale begins a course of two lectures on Poisons and Antidotes. The Friday evening discourse on April 8 will be delivered by Dr. R. H. A. Plimmer on Quality of Protein in Nutrition.

THE officers elected by the Institution of Petroleum Technologists for the session 1921–22 are as follows:—*President:* Prof. J. S. S. Brame. *Vice-Presidents:* Mr. H. Barringer, Sir George Beilby, Sir John Cargill, Bart., the Right Hon. Viscount Cowdray of Cowdray, Mr. A. W. Eastlake, and Sir Thomas H. Holland. *Council:* Mr. A. C. Adams, Mr. H. Allen, Major R. W. Barnett, M.P., Mr. A. Campbell, Mr. E. H. Cunningham Craig, Mr. A. Duckham, Dr. A. E. Dunstan, Mr. J. Kewley, Dr. W. R. Ormandy, Mr. T. C. Palmer, Dr. F. Mollwo Perkin, Mr. R. Redwood, Mr. J. S. Smith, and Prof. W. W. Watts.

THE Joint Committee on British Petrographic Nomenclature appointed by the Geological Society of London and the Mineralogical Society has published a report in the current issue of the *Mineralogical Magazine.* The report deals with ninety rock-names hitherto used with various meanings. Some synonymous terms are considered and seven general recommendations for the formation of rock-names are made. The Geological Society has issued one copy of the report to each of its fellows. A limited number of copies are still available for distribution. Application for copies may be made to Mr. Campbell Smith, British Museum (Natural History), Cromwell Road, S.W.7. The committee is still in being, and it is expected that further meetings will be held.

WE have received the first issue of *Atti della Società Agronomica Italiana,* the purpose of which is to coordinate and initiate scientific work in agriculture in Italy, it being considered that the existing agencies are not sufficiently strong. An advisory committee has therefore been formed under the presidency of Senator Grassi, and including Profs. Baglioni, Bonzi, Cuboni, and Pirotta. A programme has been drawn up comprising five sections:—(1) Investigations of the best means of utilising poor and arid land, special attention being paid to the phenomena of drought resistance of crops. (2) The study of the yield capacity of wheat in the south of Italy, especially in relation to the physical features of the country and the meteorological data. (3) The control of the insect pests of the olive. (4) The possibility of obtaining potash manures from leucite deposits. (5) The study of the root-rot of the Sicilian citrus-tree. The new organisation will be watched with much interest by agriculturists everywhere, who will heartily wish it success in the study of these important problems.

DR. R. KARSTEN contributes to *Acta Academiae Aboensis,* part i., an elaborate monograph entitled "Contributions to the Sociology of the Indian Tribes of Ecuador," divided into three parts, dealing with agriculture, hunting and fishing, and birth customs respectively. The last includes an account of the magical practices intended to promote the growth of the crops and modes of attracting animals and fish. Many curious details are given regarding birth customs. These are closely connected with peculiar, but vague, ideas of conception and supernatural birth. They do not, like the Arunta of Australia, believe that conception is entirely due to spirit influence, but they think that the influence of the new moon is a potent cause. Monstrous or defective children are the direct result of demoniacal operation, and the same belief extends to the birth of twins, even where there is nothing abnormal in their outer appearance.

IF the theory explained in a paper entitled "Buddha's Diadem" by the eminent scholar Dr. L. A. Waddell, and published in *Ostasiatische Zeitschrift* (iii., 2), be accepted, the current views of the development of early Buddhism must be modified. The popular view is that the deification of Buddha, unknown to the orthodox primitive school, did not prevail among the "Northern" school until the age of Kanishka (1st century B.C. to 2nd century A.D.). It is now shown that as early as the 4th or 3rd century B.C. Buddha was invested with the attributes of the supreme Brahman god Náráyana—Vishnu. One of the two chief conventional symbols of this god was the supernatural diadem, now represented by the curious protuberance of the skull in images of Buddha, the prototype of which is the serpent-hood of Varuna, the Vedic god of the firmament. By the artists of the Gandhára school Buddha was identified with Apollo, and the skull protuberance became a symbol of divine wisdom, emitting flames which become divine messengers. It was at a later time conceived by Buddhists as the seat of the Dharani, or magical protective spells. In short, the diadem is the lineal descendant of a primeval cosmic ideograph imported into ancient India from the West long before the rise of Buddhism, expressing the divinity in Nature's order, or Law. The paper is attractively written, and forms an important contribution to the study of early Buddhism.

TWO recently published maps show some important aspects of the distribution of population in Siberia. They accompany an article in *Petermanns Mitteilungen* for December, 1920, by Dr. A. Schultz entitled "Die Verteilung des Landbesitzes in Sibirien." Of most interest is the location of the colonies of free settlers from European Russia and the colonies of Cossacks. The maps show clearly the small hold in real settlement that Russia has on the rich lands of eastern Siberia, especially the Amur and Ussuri valleys. They illustrate also the strong predominance of Cossacks and native Siberiaks around the head-waters of the Amur system and Chita and Transbaikalia generally. In western Siberia Russian settlers predominate north of the steppe provinces and south of the marsh and forest lands. The statistics on which the maps are based date from 1913, or even earlier in some cases, but this is unavoidable; even under the old *régime* Russian statistics were very slow to appear, and now they are unobtainable.

IN an address on "International Organisation and Public Health," read before the Society of Medical Officers of Health on February 18, Dr. G. S. Buchanan reviewed the International Health Organisation which will shortly come into being as a result of a series of detailed resolutions which were passed by the Assembly of the League of Nations at Geneva last December (*Lancet,* February 26). By the Covenant of the League of Nations the members of the League pledge themselves to take steps in matters of international concern for the prevention and control of disease. These include (1) advising the League in matters affecting health, (2) co-ordination of administrative health authorities in different countries, (3) organisation of means for the more rapid interchange of information on matters such as epidemics where precautionary measures may be required, (4) the revision of international agreements affecting the public health, (5) assisting international labour organisations in securing protection for the worker against sickness, injury, and disease arising out of his employment, and (6) the organisation of missions in connection with matters of health at the request of the League of Nations.

WE have received a brochure entitled "Approved Technique of the Rideal-Walker Test," by Dr. S. Rideal and Mr. Ainslie Walker (H. K. Lewis and Co., 1*s*. net). It contains a clear and full account of this test, which is employed for estimating the germicidal value of disinfectants, comparing the particular disinfectant with a standard carbolic acid solution under stated conditions. The test was originally devised about 1902, and the present description introduces some modifications of detail, though not of principle. The term "approved" which appears in the title may mislead, as it here means "recommended by the authors," and not a statutory or general approval.

MR. HECTOR COLWELL continues his "History of Electrotherapy" in the *Archives of Radiology and Electrotherapy* for February (No. 247). The work of Duchenne (1806–75) particularly is dealt with. Duchenne was the first to discover that individual muscles can be stimulated electrically by the application of suitable moistened electrodes to the overlying skin, and he is regarded by Mr. Colwell as the founder of modern electro-therapeutics.

THE attention of workers on water-mites (Hydracarina) is directed to the account by Messrs. C. D. Soar and W. Williamson (Journal of the Quekett Microscopical Club, vol. xiv., November, 1920) of the twenty-two species of Eylais which occur in Britain.

MR. E. AVERY RICHMOND has published (Bull. Amer. Mus. Nat. Hist., vol. xlii., 1920) some interesting studies on the life-history and biology of water-beetles of the family Hydrophilidæ, especially on those occurring in the vicinity of Ithaca. Some eighteen genera—examples of all of which have been reared by the author—are dealt with, and keys are given for the determination of the egg-cases, larvæ, and pupæ (so far as they are known) of this family.

AMONG the investigations carried out at the Millport Marine Laboratory, which are recorded in the recently issued annual report for 1919 of the Scottish Marine Biological Association, is one by Mr. R. Elmhirst and Dr. J. H. Paul on the distribution of copper in the blood and "liver" of the Decapod Crustacea during the moulting cycle. It has been found that as moulting approaches the animal accumulates a considerable amount of copper in the "liver," and that this is released into the general circulation when the shell is cast. The amount of copper present varies; in the Macrura it may represent 5 per cent. of the ash of the liver; in the Brachyura only traces are present; in Lithodes—the position of which is regarded as intermediate—the maximum amount is about 2½ per cent. Mr. Elmhirst notes the great abundance in the Laminarian zone of the polyzoon *Membranipora membranacea*, and that animals of various phyla browse on Membranipora, *e.g.* sea-urchins, starfish and brittle stars, lobsters, crabs, and several molluscs, all of which require lime for building their skeletons or shells. Estimations by Mr. Elmhirst and Mr. J. S. Sharpe show that round the shores of Cumbrae the quantity of lime available in the Membranipora in August was equivalent to some 3½ tons of metallic calcium. At that season members of the larger crustacea moult inshore among the Laminaria, and it is significant also that analyses of the ash of Membranipora reveal traces of copper.

IN the Transactions of the New Zealand Institute (lii., pp. 193–239, 1920), Dr. J. E. Holloway continues his studies of the New Zealand species of the genus Lycopodium with an account of the structure of the prothallus in five species, belonging to the sections Phlegmaria and Cernua. The structure, which shows considerable variety, is described in detail, together with the relation of the young plant to the prothallus and the form and distribution of the symbiotic fungus which is universally present, at any rate in later stages of development. The author regards the fungal symbiont as of great importance. He concludes, from a comparative study of the general form and structure of the different Lycopodium prothalli, that they are all more or less modified from some primitive type of structure, and that the chief factor in this modification has been the presence of the symbiotic fungus. This primitive type was probably a bulky filament of radial build living at the surface of the ground and containing chlorophyll. The adoption of a fungal habit opened the door to possibilities of modification of this simple type of structure, and the prothallus was able to establish itself in new positions and soils, the different types of habitat resulting in different types of modification of the original structure. When the fungal habit was thoroughly adopted, the early filamentous stage became lost, but in all its forms the Lycopodium prothallus has never departed from its radial build. It is suggested as possible that the varied aspects of the genus as it exists to-day, in the form and structure of the mature plant, have arisen as a natural consequence from the spread of the prothallus to different stations and soils.

WE have received the annual report of the Director of the United States Geological Survey for the year ending June 30, 1918. During the year under review practically all the activities of the Survey were directed to the prosecution of the war and to problems arising from the war; research of a purely scientific nature was in abeyance. Much attention was devoted to the search for minerals, the examination of deposits, and the estimate of available reserves. In the effort to meet the urgent demand for essential minerals, Survey geologists visited not only the mining districts of the United States, but also deposits of potash, nitrate, chrome, and manganese in Central and South America and the West Indies. As a further contribution to the problems of the day, much consideration was paid to the extent to which water-power could, if necessary, replace steam-power. A natural extension of these investigations was the study of the mineral and power resources of the world in general. A number of ingenious diagrams show the work of the various departments of the Survey in relation to the War Departments to which they contributed.

SINCE the memorable work of J. W. Judd on the Mesozoic rocks of Scotland the Geological Survey has been able to add many important details, and the discovery of iron-ore in the Upper Lias of Raasay by H. B. Woodward in 1893 has led to a considerable industry. Dr. G. W. Lee now describes ("The Mesozoic Rocks of Applecross, Raasay, and North-East Skye," Mem. Geol. Surv. Scotland, 1920, 6s.) the western zones in detail, with an interesting series of comparative vertical sections and a geological map of the southern end of Raasay. The iron-ore is oolitic, and passes laterally into siderite. Its composition is held to ally it with chamosite, the green chloritic silicate described in 1820 from Chamoson, west of Sion, in the Rhône vale. Berthier's original analysis, it may be remarked, has been replaced by those of Groth, which bring the composition of chamosite into agreement with the ore of Raasay. Mr. S. S. Buckman concludes from the ammonite fauna that a long interval occurred between the deposition of the oolitic beds and the overlying shales, and Dr. Lee suggests that the mineral change in the former took place during this stratigraphical episode. The presence of green silicates in the oolitic iron-ores of Arenig age in North Wales, which have been ascribed to the alteration of limestone, renders further research into the origin of the Raasay ore desirable.

ALL previous attempts at tabulating chemical analyses of rocks are dwarfed by Professional Paper 99, 1917, United States Geological Survey ("Chemical Analyses of Igneous Rocks," by Dr. H. S. Washington). It is a revised and enlarged edition of Professional Paper 14 (1903), which contained 2881 analyses published between 1884 and 1900. The present volume contains 8602 analyses of igneous rocks published between 1884 and 1913, which have been carefully scrutinised and graded according to their completeness, accuracy, and the freshness of the material analysed. They are divided into four parts:—(1) Superior analyses of fresh rocks; (2) incomplete analyses of fresh rocks; (3) superior analyses of altered rocks and tuffs; and (4) inferior analyses. Part 1, including 4980 analyses, constitutes the most complete statement yet published of the distribution of rocks in the subdivisions of the quantitative classification of igneous rocks of Cross, Iddings, Pirsson, and Washington (1903), an explanation of which is given in appendix i. The analyses in the other three parts are arranged under their published rock-names. A valuable feature of the arrangement is the geographical grouping of analyses in each subdivision; this brings out the extreme scarcity of trustworthy analyses of rocks of some of the most important petrological areas. In this connection it may be noted that for rocks of the British Isles there are only 264 analyses recorded in the whole book, distributed as follows: 77 in part 1, 9 in part 2, 90 in part 3, and 88 "inferior" analyses in part 4. Dr. Washington's work will be of inestimable value. The complete record of analyses here presented and their arrangement by the quantitative system will facilitate the reviewing of our current nomenclature in the light of the chemical composition of rocks.

DR. C. E. ADAMS, Government Astronomer and Seismologist in New Zealand, and Prof. E. Marsden have recently visited the geophysical observatory at Apia founded in 1902 by the Society of Sciences of Göttingen. Their report appears in the *New Zealand Journal of Science and Technology* (vol. iii., 1920, pp. 157–61). The observatory is the most complete of its kind in the Pacific. The magnetic department provides for the continuous registration of the horizontal component, the vertical component, and the declination. The seismological observatory contains Wiechert seismographs for both horizontal and vertical components of the motion. A recording tide-gauge is maintained in the adjoining harbour. In addition to the usual astronomical and meteorological observations, arrangements have been made for the investigation of the upper atmosphere by means of hand-hauled kites and free balloons. New Zealand having accepted the mandate over Samoa, the authors urge the desirability, with which all will agree, of maintaining the observatory, which is well-equipped and situated, at its full pre-war efficiency.

ONE of the most serious difficulties with which inventors of apparatus for use on aeroplanes during the war had to contend was the absence of any information as to the special circumstances in which the apparatus had to operate and the arrangements which had been made to enable it to function properly in those circumstances. Even now it is not easy for an inventor not engaged in aeroplane construction or design to get to know what apparatus is actually used and in what respects it falls short of the requirements of the service. To all who are interested in the subject an article on aeronautical instruments in the January issue of the Journal of the Franklin Institute by Prof. C. E. Mendenhall will be welcome. It divides them into four groups concerned respectively with the engine, the aeroplane, navigation, and military purposes, and in each group the instruments used and the special difficulties with which they have to contend are described. The article is well illustrated, and gives much valuable information in a compact and readable form.

THE "British Meteorological and Magnetic Year Book," 1917, part 4, has recently been published by the Meteorological Office. It comprises hourly readings of terrestrial magnetism at Eskdalemuir Observatory and summaries of the results obtained in terrestrial magnetism, meteorology, and atmospheric electricity, chiefly from self-recording instruments at the observatories of the Meteorological Office. The work consists mainly of tabular matter. The mean daily variation of the various meteorological elements is given for each month and for the year for the five observatories, Aberdeen, Eskdalemuir, Cahirciveen (Valencia), Richmond (Kew), and Falmouth. C.G.S. units are used for meteorological data, with temperature in absolute degrees. The normal constant for absolute temperature given is 200°. With a normal constant of 273° the resulting values would be in ordinary degrees Centigrade, a system adopted by many meteorologists on the Continent and by some at home. To the uninitiated it gives a reading more easily comprehended, although in the British Isles very occasionally some of the values would be given with the negative sign. For terrestrial magnetism hourly observations are given for each month, with notes of the special features of the disturbances experienced. Notes are given at the end of the volume on the management of the magnetic and electrical instruments and on results of interest, showing the method of observation and the treatment in discussion.

IN two papers communicated to the Rumanian Academy of Sciences for 1920, G. G. Longinescu with G. P. Teodorescu and G. Chaborski respectively describes modified methods for the separation of the metals of the second group in qualitative analysis and of hydrochloric acid in the presence of hydrobromic and hydriodic acids. In the first, ammonium carbonate is used in the separation of the metals of the sub-group instead of ammonium sulphide. Caustic soda is used in the separation of the remaining metals. The separation of a bromide from the mixture with a chloride and iodide is effected by heating with alcohol and sulphuric acid. Hydrochloric acid is evolved, the hydrobromic acid decomposes into bromine which forms ethylene bromide, and the iodine remains principally in the liquid.

THE economics of ship propulsion are dealt with in a paper entitled "Coal, Oil, or Wind," read on December 14 before the Institution of Engineers and Shipbuilders in Scotland by Mr. C. O. Liljegren. So far as ships are concerned, wind only can be used to save fuel. Properly applied, this method of propulsion would mean an enormous saving in fuel and a reduction in the cost of carrying both passengers and freight. Sailing ships can be run at less cost per ton-year than any machine-driven vessel, whatever the price of fuel. The author has studied Sauerbeck's index, giving prices of forty-five commodities since 1800, together with the records of the prices of French wheat since 1250, and constructs some interesting curves. He is thus led to predict that all fuel will be too high in price for the profitable working of vessels for at least thirty years to come. The motor clipper appears to be the type of the immediate future, in which the auxiliary propulsion machinery would be used in calms only. The following figures are for the year 1913–14, and give the percentage earnings on investments with freight at 20*s.*:—Motor-ship, two-cycle, 26·0; motor-ship, four-cycle, 36·2; steamship, superheat, 38·5; and motor clipper, auxiliary sailing vessel, 70·2. Comparative figures for the year 1920 with freight at 55*s.* are as follows:—Motor-ship, four-cycle, 28·5; steamship, superheat, 25·5; motor clipper, 7150 tons, 56·0; and motor clipper, 11,600 tons, 63·0.

AMONG the forthcoming books announced by the Cambridge University Press we notice "Scientific Papers of Henry Cavendish," in 2 vols. Vol. i. (The Electrical Researches) is a reprint of the volume edited by Clerk Maxwell (1874–79), with additional notes by Sir Joseph Larmor. Some changes have been made in the arrangement of headlines, etc., and it is hoped that the revised volume will bring out more clearly both the extraordinary range and value of Cavendish's work and the magnitude and importance of the task which Clerk Maxwell accomplished in the last five years of his life. The volume also includes a reprint of the biographical sketch of Cavendish which Dr. T. Young contributed to the "Encyclopædia Britannica." Vol. ii. (Chemical and Dynamical), edited by Sir Edward Thorpe, includes the papers published in the Philosophical Transactions and much unpublished material from the papers in the possession of the Duke of Devonshire. It also contains an account of the researches in dynamics, astronomy, geology, and magnetism, in arranging which the editor has been assisted by Sir Joseph Larmor, Sir Archibald Geikie, Sir Frank Dyson, and Dr. C. Chree.

Our Astronomical Column.

PONS-WINNECKE'S COMET.—The failure to find this comet up to the present suggests that the date of perihelion may be later than those assumed. Ephemerides for April have therefore been prepared with the addition of a third assumed date, June 29·5. They are for Greenwich midnight:

T assumed June 13·5.

Date		R.A. h. m. s.	N. Decl. ° ′	Log *r*	Log Δ
March	31	15 30 23	34 51	0·1519	9·7731
April	8	15 46 15	38 13	0·1306	9·7181
	16	16 4 49	41 27	0·1091	9·6600
	24	16 26 52	44 39	0·0879	9·5971
May	2	16 54 36	47 40	0·0670	9·5270

T assumed June 21·5.

Date		R.A. h. m. s.	N. Decl. ° ′	Log *r*	Log Δ
March	31	14 32 23	39 26	0·1729	9·8064
April	8	14 35 18	42 57	0·1519	9·7602
	16	14 36 45	46 20	0·1306	9·7135
	24	14 37 40	49 21	0·1091	9·6641
May	2	14 37 12	52 3	0·0879	9·6100

T assumed June 29·5.

Date		R.A. h. m. s.	N. Decl. ° ′	Log *r*	Log Δ
March	31	13 39 1	42 1	0·1932	9·8483
April	8	13 33 41	45 1	0·1729	9·8130
	16	13 24 58	47 28	0·1519	9·7789
	24	13 14 44	49 15	0·1306	9·7452
May	2	13 4 28	50 11	0 1091	9·7092

These three ephemerides define curves near which the comet should be found. Owing to its high north declination it is observable throughout the night.

COMET REID 1921*a*.—A third observation of this comet was obtained at Algiers on March 25. The following is the orbit deduced from this, combined with those of March 14 and 18:

$$T = 1921 \text{ May } 10{\cdot}297 \text{ G.M.T.}$$
$$\omega = 64^\circ\ 25'\ 24''$$
$$\Omega = 268^\circ\ 28'\ 53''$$
$$i = 131^\circ\ 36'\ 42''$$
$$\log q = 0{\cdot}00582$$

Ephemeris of Greenwich Midnight.

		R.A. h. m. s.	Decl. ° ′	Log *r*	Log Δ
March	31	20 24 4	7 1 S.	0·0843	0·0928
April	8	20 28 51	2 23 N.	0·0596	0·0012
	16	20 34 40	17 2	0·0379	9·9007
	24	20 44 29	39 37	0·0206	9·8190
May	2	21 12 30	67 28 N.	0·0095	9·8127

The comet was observed on March 25 in bright moonlight. There is reason to expect that it will attain at least faint naked-eye visibility. The elements do not closely resemble those of any known comet.

LARGE DETONATING FIREBALL.—Mr. Denning writes:—"On March 16, 8h. 33m. G.M.T., a magnificent meteor was observed from Scotland and the north of England. It occasioned a brilliant illumination of sky and landscape, and was followed several minutes afterwards by loud detonations, which some of the observers likened to the bursting of high explosive shells. At Edinburgh the sound came in about 4 minutes after the meteor had passed, at Duns the interval was 2½ minutes, at Kelso 80 seconds, while at Berwick-on-Tweed the fireball's flash and sound of disruptive explosions were almost simultaneous. There seems to have been little doubt that the meteor may have fallen in or near the latter town, or in that part of the North Sea contiguous to it.

"A large number of observations were made of the object, but they are mostly of the popular type. It appears highly probable, however, that the meteor moved in a direction from south-west by west to north-east by east, and that its flight was from over Moffat to Berwick-on-Tweed. Its height was about 71 miles at the outset of its luminous career, and after traversing about 75 miles of its path it seems to have been about 24 miles high between Kelso and Coldstream, while at Berwick the meteor gave evidence of very near approach to the earth's surface. The fireball was a late Taurid from a radiant at 80°+22°, but it is rather difficult to fix with accuracy and certainty the point of radiation. The duration of the meteor's flight was about 6 seconds, and this would give a velocity of about 14 miles per second. Up to the time of writing no fragments of the meteor have been found, but they might easily have fallen into the sea unperceived."

The Origin of the South-west Monsoon.[1]

By Dr. G. C. Simpson, F.R.S.

It has generally been held that the south-west monsoon owes its origin to the great difference of temperature which exists during the summer months between the heated land surface of India and the surrounding oceans, the general idea being that the warm air over the land rises, and damp air from the sea flows into India to take its place, thus resulting in the strong south-west winds, the rainfall itself being due to the cooling of the air as it rises over India.

This theory has to face the difficulties that the temperature over India is much higher in May, before the monsoon sets in, than it is during the monsoon itself; that the temperature is higher in years of bad monsoon than in years of good monsoon; and that the part of India which has the highest temperature and the lowest pressure, and where ascending currents should be the greatest, is a region of practically no rainfall throughout the monsoon.

The true explanation of the south-west monsoon can be obtained only by taking a wide view of the weather conditions over large parts of the earth's surface during the summer months in the northern hemisphere. It is then seen that the south-west winds are not due to the temperature in India, but are a relatively small part of a general circulation of the atmosphere caused by a region of high pressure over the South Indian Ocean and a region of low pressure which extends over the whole of Central Asia. Air passes northwards from the region of high pressure as the south-west trade winds so far as the equator, where it gets caught up in the circulation around the low pressure over Asia. On account of the particular arrangement of sea and land, combined with deflection of wind currents due to the earth's rotation, this air travels for 4000 miles over the sea before it reaches India, where it arrives in a very warm and exceedingly humid condition. This air, however, would probably sweep right across India to its goal in Central Asia without producing much rainfall if it were not for the unique distribution of mountains around India. From the north of the Mokran coast, right round India, following the line of Afghanistan, the Himalayas, and the mountains of Burma, there extends an unbroken wall of mountains, nowhere lower than 5000 ft., standing directly athwart the air-currents. The mountains catch the air, which is being driven by a pressure distribution extending from the Southern Indian Ocean to the centre of Asia, in a kind of trap, out of which there is no escape except by ascension. The damp, humid air, which begins to rain as soon as it rises 500 ft., is forced to rise between 10,000 ft. and 20,000 ft., and, in consequence, large masses of water are precipitated over the greater part of the Indian area.

[1] Abstract of a paper entitled "The South-west Monsoon," read to the Royal Meteorological Society on Wednesday, March 16.

The Finsbury School of Chemistry.

By Prof. G. T. Morgan, F.R.S.

The widespread feeling among scientific workers that the threatened closing of the Finsbury Technical College would be a calamity of national importance has found expression in a petition recently presented to the council of the City and Guilds of London Institute. In this appeal, which is supported by a long list of eminent names representative of every branch of art, science, and technology, the members of the Finsbury Technical College Defence Committee, many of whom are former students of the college, testify to their grateful appreciation of the long-continued benefactions made by the institute to the college, and urge the council to take into consideration all possible sources of assistance in the responsible task of keeping the college open as an institution for higher technical education.

The salving of Finsbury cannot be regarded otherwise than as a prudent step in the conservation of our educational resources at a time when public expenditure on new institutes embodying untried schemes is scarcely likely to meet with popular approval. This anticipated continuance of the college involves, however, a retention in its entirety of the unique system of scientific education given at Finsbury, so that the future of this institution may be a logical and evolutionary development of its former activities. The policy consistently adopted in the past by the City and Guilds of London Institute was to place implicit trust in the judgment of the scientific men appointed to the professoriate of the college. These professors were not tied down by formal curricula, and were allowed complete liberty to teach their respective subjects in their own way.

It is largely this freedom from prescribed courses and examinational restraints which has given to the Finsbury School of Chemistry, founded by Prof. H. E. Armstrong in 1879, its outstanding and distinctive features. From the first its laboratories were a centre of unceasing chemical activity, for they were open to day and evening students, who found unfailing assistance in their preparatory studies and inspiration in research from the hard-working staff whom the professor gathered round him. Among the more salient investigations of the early Finsbury School of Chemistry, which inaugurated a new era in the teaching of this science, were the researches on the laws of substitution among aromatic compounds and on the relationship between colour and chemical constitution, and the important discovery by Armstrong and Miller of the purification of coal-tar hydrocarbons through their sulphonic acids.

With Prof. Meldola's arrival in 1885 the chemical department was brought into even closer association with the synthetic colour industry. The new professor had recently discovered the oxazine blue which still bears his name, and had also made in the works several notable discoveries which afterwards bore fruit either in this country or abroad. The investigations then initiated at Finsbury showed the influence of the earlier industrial experience of its director. The course of substitution in the naphthalene series was the subject of several memoirs, and the researches on azo-compounds originally commenced in the works laboratory were continued throughout the remainder of the professor's lifetime. In collaboration with Mr. F. W. Streatfeild, Meldola instituted an inquiry into the constitution of diazoamino-compounds and amino-amidines which brought to light unexpected instances of isomerism. In 1000 he discovered the first recorded instance of the replacement of a nitro-group by hydroxyl during diazotisation. Numerous cases of this substitution have since been noticed and shown to be capable of industrial application in the production of useful mordant dyes.

During the greater part of their joint career at Finsbury, Meldola and Streatfeild had as research assistants at any given time only one or two senior students chosen to work for one session in the professor's laboratory. Streatfeild, however, had a wonderful faculty for dovetailing together instruction and research, and Meldola had the happy knack of furnishing his youthful collaborators with an "Arbeit" which generally blossomed into a contribution to the Chemical Society's Transactions within this annual period of apprenticeship. From 1908 onwards the council of the college provided the professor with a whole-time research assistant, who generally held this coveted post for about three years. The senior students who were fortunate in receiving this more prolonged experience in research have justified their training by gaining responsible industrial appointments within a short time of leaving college.

When the writer succeeded his former teacher in 1916 the work of the Finsbury laboratories was dominated by the exigencies of the war, then entering on its critical stages. The Trench Warfare Department employed in the Finsbury laboratory of applied chemistry a small works plant for smoke-bombs and other munitions, which was not at that critical time to be found in any other London college. In 1917 the institute sanctioned an extension of the chemical department, and the additional facilities thus provided were promptly made use of by the Chemical Warfare Department, which maintained a staff of research workers at the college until after the armistice. At the same time the chemical school remained in touch with the synthetic colour industry, inasmuch as the new research laboratories afforded accommodation to a group of chemists sent by the British Dyestuffs Corporation to extend their experience of organic synthesis. Other firms also took advantage of the research equipment for applied chemistry which was now being made in the chemical workshop, and several experienced chemists were allotted laboratory facilities for their researches in various branches of chemical technology. The materials required by these research workers were in certain instances prepared by senior students of the chemical department, who thus benefited by being brought at an early stage into contact with the actualities of industrial practice.

With a high tradition of practical laboratory instruction extending over a period of forty years it is not surprising to find that the senior *alumni* of the Finsbury chemistry department now occupy responsible positions in every centre of chemical activity in the British Empire. It is, moreover, a noteworthy consequence of the close association of the college with the industrial life of the country that several important chemical firms are taking an active interest in the Finsbury defence movement, thus showing in a practical manner their appreciation of the training afforded in this historic school of chemistry.

Bacterial Diseases of Farm Crops.

IN certain seasons some of the bacterial diseases which attack farm crops do sufficient damage to become serious economic factors. An instance of this was provided in 1918 by the "halo-blight" of oats which caused much trouble throughout Wisconsin and other parts of the United States (C. Elliott, *Journ. Agric. Research*, 1920, vol. xix., No. 4). The blight appears to be present in oat-fields every season, but attracts attention only when it develops strongly and does serious damage under particularly favourable weather conditions. The epidemics disappear if the weather changes to a type more favourable to the development of the plant.

The halo-blight usually appears as lesions on the leaves, but may occur on the leaf-sheaths and glumes; infected areas show a centre of dead tissue surrounded by a halo-like margin of chlorotic tissue, and they gradually spread and often coalesce until large areas are involved and the whole leaf becomes dry and brown. A typical white organism has been isolated from these lesions, for which the name *Bacterium coronafaciens*, n.sp., is proposed. The organism is a motile rod with rounded ends, sometimes occurring singly or in pairs, but usually in short to long chains. One to several polar flagella have been made out, but no spores have been observed. The bacteria live through winter on the seed, produce primary lesions on the first leaves of seedlings, and are carried to other leaves by wind and rain. Natural infections of halo-blight have been observed only on oats and rye, though artificial inoculations indicate that the organism may be slightly pathogenic on wheat and barley also. Infection takes place more readily on injured than on uninjured parts of the plants. In normal circumstances different varieties of oats show differences in susceptibility to the disease.

Though halo-blight is known to be seed-borne, no practical method of seed treatment has yet been found which will entirely control the disease. Treatment with 1 in 320 formalin, as is used for smut, keeps the blight in check, but is not entirely effective. Heating the seed in a hot-air oven for thirty hours at 100° C. completely checks the disease, but the commercial application of the treatment has not yet been worked out.

An unrecorded bacterial disease, basal glume-rot of wheat, was discovered in 1917 by L. McCulloch (*Journ. Agric. Research*, 1920, vol. xviii., No. 10) on plants obtained from various localities in Canada and the United States. The leaf, head, and grain of wheat are all affected, the diseased portions being discoloured and blackish, and the basal ends of the grains often appear charred. The development of the grain is hindered when the disease appears early in life, but it is possible for the plants to be attacked when the ears are well filled out. Bacteria are abundant in all the discoloured tissues, and are fairly resistant to desiccation, as the organism has been isolated from dry wheat-kernels kept at room-temperature for seventeen months. The organism, for which the name *Bacterium atrofaciens* is proposed, is a white, polar-flagellated rod, producing a green fluorescence in the ordinary culture media. It attacks starch, and will tolerate sodium chloride up to a strength of 5 per cent., above which no growth occurs. Many tests of the reaction of the bacteria have been made, and the optimum growth-temperature appears to be between 25° and 28° C., the thermal death-point being about 48° or 49° C. Ten minutes' exposure to sunlight or forty-four hours' freezing was also found to kill most of the bacteria. No method of controlling the disease is suggested.

W. E. B.

Fatigue and Efficiency in the Iron and Steel Industry.

IN Report No. 5 of the Industrial Fatigue Research Board Dr. H. M. Vernon describes the results of a series of investigations carried out at most of the chief iron and steel centres in the United Kingdom. He points out that there are tremendous variations in the mechanical efficiency of the plant employed in various works and in the efficiency with which human labour is utilised. In most districts the blast furnaces are charged by hand, though four to eight times more men are required than for mechanical charging, and the work is of a much heavier character. In the most efficiently run open-hearth steel furnaces two to three times more charges of steel are worked per week than in the least efficient, whilst the efficiency of rolling mills varies in similar proportion.

The steel-melters, when engaged in mending their furnaces, which they usually do immediately after the molten steel has been drawn off and whilst they are still white-hot, have to undertake one of the most arduous forms of labour known in any industry. Much might be done to lighten this labour, for at some works the average time required for mending is seven times longer than at others; also, owing to the fact that all the furnaces are started at about the same time, they tend to require mending at the same time, so the men frequently cannot relieve one another. This could be remedied by arranging that mending was more evenly spread over the week. Many of the steel furnaces are still charged by hand, in spite of the tremendous labour and delay involved.

The effect of fatigue on health and longevity was studied by Dr. Vernon (in conjunction with Mr. E. A. Rusher) by tabulating the sickness and mortality data of 24,000 iron and steel workers for a six-year period. These data, which had accrued under the National Health Insurance Act, showed that there is a definite relationship between the amount of sickness experienced by the workers and the nature of their occupation. Steel-melters headed the list, and showed 23 per cent. more sickness than the average and 26 per cent. greater mortality. The puddlers of wrought-iron showed a 20 per cent. excess of sickness, the whole of this excess being due to respiratory diseases and rheumatism. Presumably this was because the puddlers usually work alternate 20-minute periods of very hot and heavy work followed by light work or complete rest, during which they tend to catch chills. Other workers at hot and heavy work likewise showed an excess of sickness, whilst workers at ordinary temperatures, such as cranemen and general labourers, showed 9 per cent. less sickness than the average.

University and Educational Intelligence.

MR. JAMES W. LOW, assistant in the natural history department of University College, Dundee, has been appointed lecturer in zoology at Birkbeck College, London.

THE Manchester Education Committee has appointed Prof. B. M. Jones to be principal of the Manchester College of Technology in succession to Principal Garnett. Prof. Jones, who was educated at Oxford, was for some time professor of chemistry at the Government College, Lahore, and more recently professor of chemistry at, and director of, the Edward Davies Chemical Laboratories, Aberystwyth.

Science for February 25 announces that Prof. J. R. Angell was elected president of Yale University at a meeting of the University Corporation on February 20; the new president will take up his duties at the close of the university year. Prof. Angell is a graduate of the University of Michigan, and has been professor of psychology, dean, and acting president of Chicago University. He has also shown ability as an administrator and a leader of education while acting as chairman of the National Research Council and as president of the Carnegie Corporation.

A LIST of the students and teachers from the Dominions overseas and from foreign countries at present in our universities, which supplements that issued in December last and referred to in NATURE of December 30, p. 585, has been issued by the Universities Bureau of the British Empire. Although the information is not yet quite complete, an interesting summary has been compiled showing the numbers which are contributed by each of the continents. Africa sends 1046; America and the West Indies, 676; Asia, 1228, of whom 974 are from India, Burma, and Ceylon; Europe, 703; and Australasia, 282. The grand total to date is thus 3935, of whom about two-thirds are from our overseas Dominions.

THE Carnegie Corporation of New York has entered into an agreement with the Leland Stanford University of California by which it will give large financial support to a research institute which the University is about to establish for the intensive study of the problems of the production, distribution, and consumption of food. The need for such research was first brought to the attention of the Corporation by Mr. Herbert C. Hoover, and it is proposed that the institute shall bear his name. The selection of the University as its home is partly due to the fact that Mr. Hoover has deposited there the documentary material he has collected relative to the economic side of the war. The work of research, for which the laboratories of the University will be made available, is to begin on July 1.

THE *Pioneer Mail* for February 18 publishes extracts from the presidential address delivered by Lt.-Col. J. W. D. Megaw to the Medical Research Section of the Indian Science Congress. Col. Megaw states that of late persistent rumours have been circulated that the Government of India is not prepared to undertake the full responsibility for the School of Tropical Medicine and Hygiene of Calcutta and Bombay because all its funds are wanted for the establishment of a new Imperial Institute of Medical Research in Delhi. The school was established largely through the initiative of Sir Leonard Rogers with funds subscribed by the public and grants from the Government. Col. Megaw alludes to the valuable work done by the school, and pleads earnestly for its proper support, suggesting that the programmes of medical research in India should be considered by an authoritative committee of experts.

La Nature for March 19 gives some extracts from the statistics of attendance at the University of Paris which have been published in *L'Université de Paris*. Before the outbreak of war the total number of students in the University was 17,308; in the succeeding four years there was naturally a big drop, while in 1918 the numbers had risen again to 11,026, a figure only about a thousand short of the 1910 total. In 1919 there was a big influx of students, much as our own universities experienced, and the total rose to 17,761; but surprising figures are given for 1920, from which it appears that only 11,214 students were in attendance. The distribution of the totals among Frenchmen and others and among men and women also reveal some strange facts. The figures for the men classed as "étrangers" for 1920 show a decrease of about one-fifth of the 1913 total, while for women the decrease for the same period is fully two-thirds. The numbers of Frenchmen attending the University have decreased almost by one-half, while the numbers of French women students increased by a similar amount. In another table are shown the numbers of students who attended at the faculties of law, medicine, science, arts, and pharmacy for the various years. From these it appears that the faculty of science is alone in claiming an increase on previous years in the numbers of its students, the figures given being 1175 for 1913, 1999 for 1919, and 1558 for 1920.

THE seventh annual report of the Carnegie United Kingdom Trust gives an account of the activities of the Trust during 1920. The high cost of materials and labour made it impossible to erect buildings even when the plans had been already approved; indeed, the trustees felt that they ought not to divert labour and material from the urgent needs of housing. Meanwhile, a special reserve of 414,765*l*. has accumulated to meet the claims of those who had been promised building grants. Unfortunately, this sum will be quite inadequate to carry out the work proposed unless there should be a heavy fall in the cost of building. For the quinquennium 1921–25 the trustees allot provisionally 250,000*l*. for library grants of all kinds. They had already promised, in the event of statutory powers being granted to county authorities enabling them to maintain county library schemes, to provide the capital outlay for every county in Great Britain which had not yet adopted a pioneer scheme under the auspices of the trustees. These powers were granted by the Public Libraries Act of 1919, and the trustees will now fulfil their promise. The Trust has continued its support to the Central Library for Students, and now proposes to help the rural libraries to lend to genuine students who may live far from any public library the more expensive books necessary for their studies. Among other grants made during 1920 we notice 4000*l*. to the London School of Economics in connection with the very large extension of its premises, 1000*l*. towards the initial expenses of a library to provide merchant seamen with books while at sea, and 1000*l*. to the National Institute of Psychology. An important function of this institute will be to advise manufacturers as to factory conditions and economy of labour.

DURING the summer term at King's College, Strand, Mr. J. H. Jeans will give four lectures on "Cosmogony and Stellar Evolution" on May 3, 10, 17, and 24 at 5 p.m. The first lecture will deal with observation evidence, the second with the effect of rotation on gaseous masses, the third with the effect of rotation on liquid or semi-liquid masses, and the last with the effect of tidal encounters. Mr. Jeans's intention is to give an account of recent observational and theoretical research in non-technical form so as to be intelligible not only to astronomers and mathematicians, but also to geologists and all acquainted with simple scientific terminology. On May 9, 11, and 13, at 5 p.m. in King's College, Prof. N. Bohr will lecture on "The Quantum Theory of Radiation and the Constitution of the Atom." At University College a course of three lectures on "Oceanography, with Special Reference to the British Isles," will be delivered by Prof. H. N. Dickson on June 17 and 24 and July 1 at 5.30 p.m. It is also announced that the course of lectures entitled "A Historical Review of Meteorological Theory," by Sir Napier Shaw, has been postponed; it will commence on April 29, and one lecture will be given each week until June 10. All the lectures mentioned are intended for advanced students of the University and others interested in such subjects; admission is in all cases free and, with the exception of Sir Napier Shaw's lectures, without ticket. Tickets for Sir Napier Shaw's lectures can be obtained from the Meteorological Office, South Kensington, S.W.7.

Calendar of Scientific Pioneers.

April 1, 1863. Jacob Steiner died.—Referred to as "the greatest geometrical genius since the time of Apollonius," Steiner treated geometry synthetically. A chair of geometry was created especially for him at Berlin.

April 1, 1900. St. George Jackson Mivart died.—Originally a barrister, Mivart took up medical and biological studies, and became well known by his writings. For short periods he held professorships at the Roman Catholic University in London, and also at Louvain.

April 1, 1901. François Marie Raoult died.—From 1870 until his death, Raoult was professor of chemistry at Grenoble. His work on solutions, begun in 1878, had a profound influence on the development of both chemistry and physics. He was awarded the Davy medal in 1892.

April 2, 1872. Samuel Finlay Breese Morse died.—An artist by profession, Morse first transmitted messages by electricity in 1835, exhibited his apparatus in New York in 1837, and in 1844 connected Baltimore and Washington by telegraph. His well-known alphabet was invented during a voyage in 1832.

April 3, 1879. Heinrich Wilhelm Dove died.—A professor of natural philosophy in the University of Berlin, Dove added much to the science of meteorology.

April 3, 1900. Joseph Louis François Bertrand died.—Secretary of the Paris Academy of Sciences and a professor in the Ecole Polytechnique, Bertrand for fifty years was a prominent member of the French mathematical world.

April 4, 1617. John Napier died.—A man of many interests, Napier first published his invention of logarithms in 1614 when sixty-four years of age. His work has been described as one which in the history of British science can be placed as second only to Newton's "Principia."

April 4, 1827. Ernst Florens Friedrich Chladni died.—One of the founders of the science of acoustics, Chladni was of Hungarian extraction, and for some time held the chair of jurisprudence at Leipzig.

April 4, 1870. Heinrich Gustav Magnus died.—A physicist of Berlin, Magnus was an inspiring teacher, and was known for his researches on heat and other subjects.

April 4, 1919. Sir William Crookes died.—Trained as a chemist by Hofmann, Crookes at an early age attained high rank as an investigator. His discovery and study of thallium, invention of the radiometer, study of electric discharges in high vacua, experiments on the rare earths and on glasses, and investigation of psychic phenomena were but a few of the subjects with which he dealt. His work, moreover, in many cases was a starting-point of important modern developments. Knighted in 1897, he received the Order of Merit in 1910, and during 1913–14 served as president of the Royal Society.

April 6, 1829. Niels Henrick Abel died.—Still under twenty-seven years of age when he died, Abel held a place among the greatest mathematicians of his day. His main work related to the theory of elliptical functions.

April 6, 1913. Adolf C. H. Slaby died.—The inventor with Count Arco of a system of wireless telegraphy, Slaby made his first successful experiments in 1897 in the Royal Gardens on the Havel.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, March 17.—Prof. C. S. Sherrington, president, in the chair.—Lord **Rayleigh**: The colour of the light from the night sky. Photographic exposures were made under coloured media selected for isolating various parts of the spectrum. Comparison with direct sunlight or moonlight showed that the night sky was of the same quality as these. Visual comparisons through coloured films showed that a blue film, which was equally bright with a yellow one against the night sky, was brighter against the twilight sky. These comparisons were not embarrassed by colour differences, because the light was so faint as to give purely monochromatic vision. The requirements as regards colour and polarisation of the light would be satisfied if we regarded it as coming from an unresolved background of stars. They would equally be satisfied if we regarded it as due to sunlight scattered by meteoric matter.—R. O. **Street**: The dissipation of energy in permanent ocean currents, with some relations between salinities, temperatures, and currents. On the assumption of slow, non-turbulent motion a formula for the mean rate of energy dissipation in permanent ocean currents is obtained which, when integrated over the whole of the oceans, gives a dissipation at the mean rate of approximately 3×10^{18} ergs per second. Simple relations between the strength of the current, the salinity, and the temperature of the water are also found; satisfactory estimates of the currents in mid-ocean can thus be made.—S. **Datta**: The vacuum arc spectra of sodium and potassium. Definite improvements in the measures for the spectra of sodium and potassium have been obtained by the use of sodium and potassium vapour lamps as sources. With potassium an interesting combination pair indicating satellites to the diffuse series has been observed. The presence of potassium in the sun has been established, and some additional sodium lines have been identified with solar lines.—W. E. **Garner** and C. L. **Abernethy**: Heats of combustion and formation of nitro-compounds. Part i.: Benzene, toluene, phenol, and methylaniline series. In this paper the heats of combustion of all the isomerides of the mono-, di-, and tri-nitro-toluenes and -benzenes, together with a number of nitro-derivatives of phenol and methylaniline, have been determined, and the heats of formation and nitration calculated. The heats of formation and nitration of the isomerides of the di- and tri-nitro-toluenes and -benzenes show considerable variation, the values tending to a minimum when the nitro-groups are adjacent to one another or to a methyl group. The heats of formation in any series increase to a maximum value with the introduction of the nitro-groups, which is reached in the toluene, phenol, and methylaniline series (when symmetrical substitution takes place) at the dinitro-derivative. The introduction of the methyl group into benzene modifies only slightly the shape of the curves showing the heats of formation of the derivatives, but the hydroxyl or methylaniline group has a much greater effect.—E. K. **Rideal**: The catalytic dehydrogenation of alcohols. Application of the approximation formula of the Nernst heat theorem to the equilibria:

$$C_2H_5{\cdot}OH \rightleftharpoons CH_3{\cdot}CHO + H_2$$

and

$$(CH_3)_2CH{\cdot}OH \rightleftharpoons (CH_3)_2CO + H_2.$$

The variation of the dissociation constants with the temperature was determined by means of a constant-volume gas thermometer containing reduced copper as catalytic material. The velocity of decomposition of the alcohol at the surface of the solid catalyst was found to be much more rapid than the reverse bimolecular reaction. Concordant values for the equilibrium constants at various temperatures could be obtained only at low pressures.

Geological Society, March 9.—Mr. R. D. Oldham, president, in the chair.—W. B. R. **King**: The surface of the marls of the Middle Chalk in the Somme Valley and the neighbouring districts, and the effect on the hydrology. Chalk forms the main deposit of the area; water was obtained for troops largely from boreholes made by the percussion method. The great number of bores enables one to construct a map of the contours of the marl-surface. These curves show that (1) the main anticlinal crest (axis of Artois) is not continuous, but consists of a series of curved axes arranged *en échelon*; (2) the close relationship of the river-systems to the tectonic axes; and (3) the capacity of the Chalk to yield water for boreholes measuring about 6 in. in diameter depends more on the topography of the neighbourhood than on the larger tectonic features, provided about 50 ft. of chalk occurs between the marl-surface and the surface of the water-table in the Chalk.—Dr. Gertrude L. **Elles**: The Bala country: its structure and rock-succession. The detailed mapping of the beds, as now classified, has brought out the structure of the country, and a modification of views previously held with regard to the Bala fault seems to be necessary. It appears to be one of a series of compressional faults affecting the whole of the country south-east of Bala Lake. The initiating structural factor was probably compression of the rocks as a whole against the Harlech Dome, controlled by the resistance offered by the Ordovician volcanic mass to the compressional force. The country was first folded, and then affected by thrust-movements. The six main structural lines of displacement are given. Combined with these major displacements there has been much differential minor thrusting (tears), which is most conspicuous above the Llangower thrust. Comparison is made between the succession here seen and that of other areas in Great Britain, and the faunal features are noted and tabulated.

Zoological Society, March 8.—Sir S. F. Harmer, vice-president, in the chair.—E. G. **Boulenger**: Experiments on colour-changes of the spotted salamander (*Salamandra maculosa*) conducted in the society's Gardens.—Miss Joan B. **Procter**: The variation of the scapula in the Batrachian groups Aglossa and Arcifera.—Dr. W. T. **Calman**: Notes on marine wood-boring animals. II.: Crustacea.—Dr. A. A. **Christie-Linde**: The reproductive organs of the Ascidian *Kükenthalia borealis*, Gottschaldt.—B. P. **Uvarov**: The geographical distribution of Orthopterous insects in the Caucasus and in Western Asia.

PARIS.

Academy of Sciences, March 7.—M. Georges Lemoine in the chair.—G. **Lippmann**: The determination of the axis of rotation and the velocity of rotation of a solid body, and the realisation of a solid body without rotation.—M. **de Sparre**: The maximum yield of turbines.—G. **Julia**: The variation of the function which furnishes the conformal representation of an area on a circle when the contour of the area varies.—B. **Gambier**: Articulate deformable systems and couples of surfaces deduced from them.—A. **Talon**: The reversal of the stresses in bridge lattice bars.—R. **Feret**: The law of equilibrium of solid grains in a vertical ascending current of water. Experiments on the relation between the linear dimensions of solid particles and the velocity of currents of water maintaining the particles in suspension. Six different minerals were used, and it was found that when the section of the particles was small compared with that of the tube, Stokes's law was applicable.—A. **Perot**: Measurement of the pressure of the solar atmosphere in the magnesium layer and the verification of the principle of relativity.—H. **Soulan**: The influence of light on the conductivity of fluorescent liquids.—P. L. **Mercanton**: The application of stereoscopic vision to the control of glacial variations. The application of stereoscopic vision to two photographs taken with the same camera and from the same spot at an interval of a year showed clearly the changes in the Orny glacier.—M. **Pauthenier**: New applications of the method of charges of very short duration and instantaneous lighting.—F. **Michaud**: Study of the energy of a system of currents.—H. **Chipart**: The apparent mutual actions of magnets and currents plunged in a magnetic liquid.—J. **Barbaudy**: The properties of diagrams. Curves representing the displacement of equilibrium of chemical systems.—P. **Chevenard**: The action of additions on the expansion anomaly of the ferro-nickels; application to the iron-nickel-chromium alloys. The hypothesis of the formation of the compound $Ni_2.Cr_3$ serves to explain the marked effect exerted by chromium on the expansion anomaly of the ferro-nickels.—S. **Posternak**: The systematic nomenclature of the molybdates. A criticism of a recent communication by Forsén on the same subject.—E. **Toporescu**: The removal of lime and magnesia from solution by precipitates of chromium hydroxide. The limiting quantities removed are those corresponding to the formation of $3CaO.Cr_2O_3$ and $3MgO.Cr_2O_3$. Both the lime and magnesia can be removed by washing the precipitate with boiling 5 per cent. solution of ammonium nitrate.—M. **Legrand**: The estimation of maltose and lactose in presence of other reducing sugars. Use of Barfoed's solution. Details of the method are given, with examples of its application to the study of the products of the germination of seeds and to the analysis of milk.—R. **Chudeau**: The changes in the climate of the Sahara during the Quaternary period.—R. **de Litardière**: The dimorphism of the chromosome elements in *Polypodium Schneideri* during the telophase and interphase periods.—H. **Coupin**: A stem with horizontal geotropism. With certain species of lentil cultivated in the dark the stems grow in the horizontal direction. If, after the stem has commenced to grow, it is placed vertical, fresh growth is still horizontal. If the seeds germinate in daylight the stem grows vertically.—L. **Daniel**: Grafts of the sunflower on the Jerusalem artichoke.—J. **Dufrenoy**: The influence of the temperature of the thermal waters of Luchon on their flora. Only the thiobacteria of very small diameter can live in the hottest springs (50° to 62° C.). The formation of sulphur is especially marked between 40° and 50° C.—E. **Chemin**: The action of a parasitic fungus on *Dilsea edulis*.—L. **Bordas**: The general morphology and structure of the digestive apparatus of the Lepidoptera.—L. **Fage**: Some spiders without pulmonary sacs. A description of the spider *Telema tenella*, found in the St. Mary Cave, near La Preste, in the eastern Pyrenees. This spider is blind, and the lungs are replaced by trachean stigmata. The author in 1913 put forward the view that *T. tenella* was the survivor of an extinct fauna, and this is confirmed by the discovery by MM. Alluaud and Jeannel in eastern Africa of a new form, Apneumonella.—L. **Bertin**: Preliminary note on the idea of species and variability in the sticklebat.—A. **Peyron**: Tumours of the interstitial gland of the testicle of the horse.

Books Received.

Imperial Mineral Resources Bureau. The Mineral Industry of the British Empire and Foreign Countries (War Period): Zinc. (1913–1919.) Pp. 112. (London: H.M. Stationery Office.) 3*s*. 6*d*. net.

The Great Riddle; or, The Action and Effects of Natural Forces and Conditions in the Creation. By Frank Horridge. Pp. vii+99. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co.) 3*s*. 6*d*. net.

The Soils and Agriculture of the Southern States. By Hugh H. Bennett. Pp. xviii+399+plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 18*s*. net.

Camping and Woodcraft: A Handbook for Vacation Campers and for Travelers in the Wilderness. By Horace Kephart. Vol. i.: Camping. Pp. 405. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 14*s*. net.

Elementary Calculus. By Prof. William F. Osgood. Pp. ix+224. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 12*s*. 6*d*. net.

Yarn and Cloth Making: An Economic Study. By Mary L. Kissell. Pp. xxvii+252. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 10*s*. net.

When Buffalo Ran. By George B. Grinnell. Pp. 114. (New Haven: Yale University Press; London: Oxford University Press.) 10*s*. 6*d*. net.

A First Grammar of the Adamawa Dialect of the Fulani Language (Fulfulde). By F. W. Taylor. Pp. 135. (Oxford: Clarendon Press.) 10*s*. 6*d*. net.

Three Lectures on Fermat's Last Theorem. By L. J. Mordell. Pp. vii+31. (Cambridge: At the University Press.) 4*s*. net.

Set of Cards for Teaching Chemical Formulæ and Equations. Devised by Mrs. M. Partington. (London: Baird and Tatlock, Ltd.) 1*s*. 4*d*.

Imperial Department of Agriculture for the West Indies. Sugar-cane Experiments in the Leeward Islands. Report on Experiments Conducted in Antigua and St. Kitts-Nevis in the Season 1918–19. Part i.: Experiments with Varieties of Sugar-cane. Part ii.: Manurial Experiments with Sugar-cane. Pp. 62. (Barbados: Imperial Commissioner of Agriculture.) 1*s*.

Air Ministry: Meteorological Office. Report of Proceedings of the Third Meeting of the Commission for Weather Telegraphy, held at the Air Ministry, London, November 22–27, 1920. (M.O. 242.) Pp. 116. (London: H.M. Stationery Office.)

Gesammelte Arbeiten von Rudolf Mewes. I. Abteilung: Raumzeitlehre oder Relativitätstheorie in Geistes- und Naturwissenschaft und Werkkunst. Heft 1: Wissenschaftliche Begründung der Raumzeitlehre oder Relativitätstheorie (1884–94) mit einem geschichtlichen Anhang. By R. Mewes. Pp. 110. 18 marks. Heft 3: Anwendung auf Mechanik und Thermodynamik (Wärmeleitung und Relative Bewegung) 1884–85 nebst Anhang. I. Teil. By R. Mewes. Pp. 64. 8 marks. Heft 4: Anwendung auf die Physik des Aethers (Kraft und Masse) Neuausgabe der Schrift vom Jahre 1892. I. Teil. By R. Mewes. Pp. 134. 18 marks. Heft 5: Anwendung auf die Physik des Aethers (Kraft und Masse) Neuausgabe der Schrift vom Jahre 1894. II. Teil. By R. Mewes. Pp. 160. 20 marks. Heft 7: Anwendung auf Mechanik und Thermodynamik (Fortpflanzungs-Geschwindigkeit der Schwerkraftstrahlen) Neuausgabe der Schrift vom Jahre 1896. II. Teil. By R. Mewes. Pp. 95. 8 marks. (Berlin: Rudolf Mewes.)

Diary of Societies.

THURSDAY, MARCH 31.

INSTITUTE OF METALS (at Shaftesbury Hotel, Great St. Andrew Street, W.C.2), at 8.—S. L. Archbutt: Aluminium Alloys.

FRIDAY, APRIL 1.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.45.
ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. R. L. M. Wallis and Dr. C. L. Hewer: A New General Anæsthetic: Its Theory and Practice.

SATURDAY, APRIL 2.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Sir David Prain: Natural History (Presidential Address).

MONDAY, APRIL 4.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—W. Hoste: Fetichism in Central Africa and Elsewhere.
SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—Lieut. J. C. Ferguson: The Motor-car Pneumatic Tyre.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Sir Lawrence Weaver: The Land Settlement Building Work of the Ministry of Agriculture and Fisheries.
ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—Prof. J. Laird, Dr. G. E. Moore, Prof. C. D. Broad, and Prof. G. Dawes Hicks: Symposium on The Character of Cognitive Acts.
SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—A. W. Gomme: The Scenery of Greece.
ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section), at 8.30.—Dr. W. B. Alcock: Laboratory Observations on Pensioners who Contracted Malaria in the Late War.—Dr. H. C. Lucey: Observations Bearing on the Reliability of the Large Mono-nuclear Leucocyte Count as an Aid to the Diagnosis of Malaria.

TUESDAY, APRIL 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. R. A. Sampson: Present Position of the Nebular Hypothesis.
ROYAL HORTICULTURAL SOCIETY, at 5.—Informal Conference on Plants in Flower at the Time.
INSTITUTION OF CIVIL ENGINEERS, at 5.30.—L. H. Larmuth: Airship Sheds and their Erection.
ROYAL SOCIETY OF MEDICINE (Surgery: Sub-section of Orthopædics), at 5.30.
ZOOLOGICAL SOCIETY OF LONDON, at 5.30.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—C. M. Thomas: Chemical Methods in Photography.
ROYAL SOCIETY OF MEDICINE (Pathology Section) (at Institute of Pathology, Charing Cross Hospital Medical School), at 8.30.—W. S. Cole and Dr. W. J. Adie: The Quantitative Analysis of the Gastric Contents.—W. S. Cole and Miss J. Aynton: Observations on Post-operative Ketosis.—J. E. Barnard: A Method of Demonstrating the Structure of Bacteria.—Dr. A. B. Rosher: The Agglutinins Present in Normal Sera for B. Enteriditis (Gaertner) and for Bacilli of the B. Suipestifer Group.—Dr. G. S. Wilson: Some Points in the Technique of Counting Viable Bacteria.—Dr. H. B. Weir and Dr. W. J. Adie: (*a*) Infarct of Spleen, followed by Rupture and Hæmorrhage; (*b*) Gumma of Heart, with Hæmorrhage Causing Acute Heart-Block.—Dr. W. W. C. Topley, J. E. Barnard, and Dr. G. S. Wilson: A New Technique for Obtaining Bacterial Cultures from a Single Cell.—Dr. W. W. C. Topley and Dr. H. B. Weir: Demonstration of the Lesions found in Some Epidemic Diseases of Mice.—Dr. W. W. C. Topley: The Relation of B. Enteriditis (Gaertner) to Bacilli of the B. Suipestifer Group.

WEDNESDAY, APRIL 6.

FARADAY SOCIETY, IRON AND STEEL INSTITUTE, INSTITUTION OF MECHANICAL ENGINEERS, AND INSTITUTE OF METALS, ETC. (at Institution of Mechanical Engineers), at 2.30, 5, and 8.—Joint General Discussion on Failure of Metals under Internal and Prolonged Stress.—Dr. W. Rosenhain: Introductory Address.—Prof. C. H. Desch: Chemical Influences in the Failure of Metals under Stress.—L. Archbutt: Failure of the Lead Sheathing of Telegraph Cables.—Dr. W. H. Hatfield: Mechanism of Failure in Metals from Internal Stress.—J. C. W. Humfrey: Internal Stresses in Relation to Micro-structure.—R. H. N. Vaudrey and W. E. Ballard: Internal Stresses in Brass Tubes.—Dr. F. Rogers: Effects of Prolonged Stress on Metals at High Temperatures.—R. W. Woodward: Corrosion-cracking of Non-Ferrous Materials.—Sir Henry Fowler: Notes on Fractures in Locomotive Boiler Tubes.—D. Hanson: Intercrystalline Failure in Steel.—J. A. Jones: Intercrystalline Cracking of Mild Steel in Salt Solution.—H. S. Rawdon: The Presence of Internal Fractures in Steel Rails and their Relation to the Behaviour of the Material under Service Stresses.—H. Moore: The Season-cracking of Brass: Digest of Published Information.—H. Moore and S. Beckinsdale: The Removal of Internal Stress in Brass.—O. W. Ellis: Experiences of Season-cracking during the War.—Dr. F. Rogers: Stress and Season-cracking in Cold Worked Brass Articles.—W. C. Hothersall: The Spontaneous Cracking of Necks of Small Arm Cartridge Cases.—J. Arnott: Note on Phosphor Bronze Bars.
ENTOMOLOGICAL SOCIETY OF LONDON, at 8.
SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—F. G. H. Tate and J. W. Pooley: Detection and Estimation of Illipé Nut Fat used as a Substitute for Cocoa Butter.—T. F. Harvey and S. Back: The Estimation of Strychnine in Scale Preparations containing Quinine and other Cinchona Alkaloids.—Dr. S. Mallaneh: A Colour Reaction for Aconite.—J. L. Lizius: A Method for the Determination of the Acidity of Coloured Solutions.
ROYAL SOCIETY OF ARTS, at 8.—Prof. A. Barr: The Optophone: An Instrument for enabling the Blind to Read Ordinary Print.

THURSDAY, APRIL 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—C. T. R. Wilson: Thunderstorms (Tyndall Lectures).
LINNEAN SOCIETY, at 5.—Reginald A. Malby: A Miniature Alpine Garden from January to December.—H. W. Monckton: Exhibition of Various Forms of *Taraxacum erythrospermum*, Andrz.
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—M. Dainow: Original Research in Vocational Tests.
INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—K. Baumann: Some Recent Developments in Steam Turbine Practice.
CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Dr. F. W. Aston: Mass Spectra and Atomic Weights.

FRIDAY, APRIL 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Dr. W. J. H. Moll: A New Registering Microphotometer, University of Utrecht.—Sir William Bragg: The Examination of the Structure of Crystals in the Form of Powder by Means of the Ionisation Spectrometer.—H. Parry: A Balance Method of Using the Quadrant Electrometer for the Measurement of Power.
ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Dr. Ivor Davies: Hair Ball or Hair Cast of the Stomach and Gastro-Intestinal Tract. A Report of Two Cases with Specimens, and an Abstract of 108 Cases from the Literature.—Dr. M. Cassidy: Report *re* Case of Neoplasm of Lung.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. R. H. A. Plimmer: Quality of Protein in Nutrition.

SATURDAY, APRIL 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. H. H. Dale: Poisons and Antidotes.

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