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Taxonomy in Biology.

WHEN Peter Camper, the great Dutch anatomist, was proposed for election as a foreign member of the Linnean Society of London in 1788, he wrote refusing in very emphatic terms to be associated with a society which bore the name of the founder of modern systematic biology. The incident is typical of an attitude towards the systematist on the part of those cultivating some of the other branches of biology which did not begin with Linnæus, and has by no means ended to-day. There is, however, one branch of biological research the dependence of which on the work of the systematist cannot be overlooked. The economic biologist, at any rate, must begin by finding out the names of the species of animals or plants with which he is dealing. Without their names he cannot profit by the experience of the past, nor can he transmit his results for the benefit of the future.

It is not surprising, therefore, to find that in a recent discussion before the Association of Economic Biologists on "The Place of the Systematist in Applied Biological Work," [1] all the speakers emphasised the fundamental importance of systematics. Dr. James Waterston, in opening the discussion, gave a description of the work of the systematist which deserves to be thought over. "He finds in nature communities or groups of similar individual organisms which he calls species, and he makes it his business to arrange these and to summarise the salient facts about them in the simplest and most intelligible form." While the basis of his arrangement must be morphological, neglecting neither external form nor internal anatomy, he may also get help from other fields of work and take account of the results of the geneticist or the physiologist.

This is excellent if not quite exhaustive, but some of the later speakers in the discussion seemed to imply that the only help the economic biologist could get from the systematist was an answer to the question 'What is the name of this?' This estimate of the value of the systematist's work is widely held if it is not often frankly expressed. A distinguished biologist once told the present writer that the search for a natural classification was no part of a systematist's business. His job was identification, not classification, and he had only to devise some kind of key or card index which would enable the organisms to be quickly and easily sorted into species. If he cared he might amuse his leisure by speculating on the affinities of these species, but, so far as the really scientific branches of biology were concerned, an artificial classification was as good as, and might even be better than, any other.

[1] *Annals of Applied Biology*, vol. 13, No. 3, August 1926.

The idea underlying the view thus drastically expressed would seem to be that since the categories of the physiologist, the ecologist, the geneticist, and so on, often cut across the divisions of the most natural (that is, phylogenetic) classification we can devise, taxonomy is without interest or importance for workers in these other fields. It would not be difficult to show that this conclusion is far from being justified for any branch of biology. For the present, however, it is enough to point out that the economic biologist, although identification is his primary need, cannot afford to neglect the help that he may get from the improvement of classification.

In the course of the discussion mentioned above, Mr. J. C. F. Fryer pointed out that "the ability to place an organism in its correct group would often yield invaluable clues as to its biology and the part it might be playing in the problem in hand." In other words, the chances are that an organism will approach, in its habits and reactions, those that come nearest to it in morphological characters. A parrot may have the feeding habits of a hawk and a kingfisher may live in a waterless country and feed on lizards, but these exceptions must not obscure the fact that in defining the systematic groups of parrots or of kingfishers we are also defining, although somewhat less strictly, bionomic groups. A crab may live on land or have a direct development, but as a rule an animal with the morphological characters of the Brachyura may be expected to have aquatic habits and to hatch as a zoea larva. On merely practical grounds, therefore, the card index idea of biological systematics is inadequate.

On the other hand, the systematist, if he is to deserve the consideration of his scientific colleagues, must not allow himself to become immersed exclusively in the minor problems of specific distinction, although these may often be as fascinating as any crossword puzzle. The natural system of classification may seem, for some groups of organisms, to defy discovery, but each step towards it holds the promise of added usefulness in possibly remote fields of research.

We may close, as we began, with a story, but it is to be hoped that this one is apocryphal. Once upon a time, it is said, a young zoologist wrote a paper, which he sent to the Royal Society. The title of the paper ran somewhat thus, "On the development of a certain system of organs and its bearing on the classification of the group of animals in which it occurs." In due course the author received notice that the paper had been reported on favourably and would be accepted for publication provided that he removed from the title the reference to classification!

W. T. C.

Biological Synthesis: Hopes and Obstacles.

The Physiology of the Continuity of Life. By Prof. D. Noël Paton. Pp. x+226. (London: Macmillan and Co., Ltd., 1926.) 12*s.* net.

THERE never was a greater opportunity for successful and fruitful synthesis in science than exists now in respect of general biology. At last we know the main outlines of the laws of most vital phenomena—comparative morphology, physiology, embryology, *Entwicklungsmechanik*, cytology, heredity, evolution, ecology. Never in the past has there existed the possibility which exists to-day—the possibility of erecting a unified science of biology, in the same sense in which there has existed for some time a unified science of physics, in which each advance in each separate branch means an advance in the whole, and not merely another step down an isolated track.

When I saw the title of Prof. Noël Paton's book I hoped that he would give us a valuable synthesis in that broad field of biology concerned with reproduction. But I must at the outset confess that those hopes are far from being realised. Indeed, the book is in many ways a step in the wrong direction. In other fields than the author's special one, notably in regard to heredity, it attempts to destroy those principles which have already been established, and betrays an unfortunate lack of acquaintance with the essentials of many of the problems involved. On the other hand, within his own special field, and notably in dealing with the interrelations of the endocrine organs and their effects on reproduction, we feel all the time that general principles are lurking in the background, but that for some reason the author has not made them evident.

The major part of the book is 'biological,' in the current sense, as against physiological *sensu restricto*, and discusses types of reproduction, inheritance, sex and its determination, the theory of the germ-plasm, and the inheritance of acquired characters. The most noteworthy feature of this section is the author's determined attack upon neo-Mendelism, including the whole factorial idea and the chromosome theory. Prof. Paton dismisses all such with the blessed word 'static,' and seeks to substitute more 'dynamic' conceptions, in terms of what he calls *hereditary inertia* and *definite lines of metabolism*. His main attack, however, rests upon an elementary, but very fundamental, misapprehension.

The simplest way for me to substantiate this statement will be to begin with a brief outline of the position to which Mendel, Bateson, Morgan, and Goldschmidt, to mention only the four outstanding names, have brought the factorial theory of heredity. It is as follows. The hereditary constitution of at least all higher organisms consists of a number of units (factors or genes), each of which may exist in a number of forms (allelomorphs); these genes exist in definite proportions, and are arranged in a definite order; the whole gene-complex is divided up among the separate chromosomes, which in Drosophila have been shown to correspond to the linkage-groups established by genetic experiments. The mode of action of a particular factor is not something absolute or unalterable. It depends (*a*) upon the totality of other factors with which it is associated (theory of chromosomal and genic balance—which is not even referred to by Paton); and (*b*) upon the environmental conditions. The analogy between, on one hand, the hereditary constitution and its component factors, and on the other, an organic molecule and its component atoms, is complete, except that we have not yet been able to obtain single factors in isolation.

It should be noted that Mendel's and Morgan's theories concern almost exclusively the *distributive* mechanism of heredity, whereby new hereditary combinations arise; Morgan himself laments our comparative ignorance as to the methods by which factors come to exert their influence during ontogeny.

On this last point, however, others have brought forward evidence to show that some factors at least are concerned with qualitative differences in metabolism (*e.g.* factor for yellow colour in mice causing, in addition, adiposity in single dose, death *in utero* in double dose; factor for wrinkled condition of peas causing a different condition of the reserve carbohydrates); or with quantitative differences in rate of some definite metabolic process (Goldschmidt's multiple series of sex-factors in Lymantria; Ford's factors affecting rate of melanin-production in Gammarus).

Now Prof. Paton makes the extraordinary error of assuming that to adopt the Mendelian idea is to suppose that the effect of a factor (or of a chromosome, as in sex-determination) is always identical. After this, it is naturally simple for him to demolish the Mendelians —only, unfortunately, it is not the Mendelians he is demolishing, but imaginary beings of his own creation. Every standard text-book of genetics (I have verified it for those of Morgan, Goldschmidt, Baur, Babcock, and Clausen, and Crew) makes a special point of explaining that the fundamental assumption of Mendelism is the constancy of *factors*; while the *characters* affected by factors naturally *cannot* be constant, since they are always the product of the hereditary constitution interacting with a varying environment.

Prof. Paton (p. 103) states that "if chromosomes are the determining factor [as regards sex] the characters should be clear-cut and distinct," and there should never be intersexuality: p. 100, "on the chromosome theory of sex-determination the lability of sex is most difficult to understand": p. 45, "There is good evidence to show that factors other than the chromosomes act in determining the line of development." (This last truism, accepted by every geneticist, is aimed at the factorial hypothesis!)

Prof. Paton's misunderstandings may perhaps best be illustrated with reference to linkage. He speaks of linkage as a 'hypothesis.' This it is not; it is a name invented to cover the *fact*, which any one can verify, that certain characters and factors stay together more often than they segregate.

Again (p. 107): "Suppositions as to crossing-over as well as 'cross-exchange' itself have in themselves something quite improbable. Especially remarkable are the facts that their exchange is said to take place only in one sex . . ." (*a*) It is of course quite inaccurate to state that crossing-over always occurs only in one sex, but this is Prof. Paton's error, not Morgan's. (*b*) The exchange not only is *said* to occur in only one sex of Drosophila but actually *does* do so, as Prof. Paton could verify for himself if he would take the trouble. Finally, suppositions as to crossing-over may be "quite improbable," but crossing-over itself is again merely a convenient name for a set of *facts*, namely, the existence of linkages that are not complete.

On p. 34 Prof. Paton italicises part of a statement by Morgan, namely: "the percentage of cross-overs is definite *for a given stock of a given age and under given environmental conditions*," and proceeds to treat this as a damaging admission. To this, and to his whole view that if neo-Mendelism is correct, then sex and every other factor-dependent character must be fixed and unalterable, I would like to oppose myself most vigorously. It is a denial of the ordinary canons of experiment, and, indeed, of common sense. Because the same dose of thyroid produces tadpoles' metamorphosis at high temperature but not at low temperature, is thyroxin therefore not a definite chemical individual? Or again, does Prof. Paton expect the same physiological preparation always to give the same result, even if the salt composition or the *p*H of the perfusion fluid be altered? Chromosomes being living constituents of the cell, how is constancy of crossing-over to be expected if the environment alters?

When we come to details, matters are not much better. On p. 34 we are told that in the cross between normal and bar-eyed Drosophila, "The F2 shows all gradations from bar-eye to normal eye." This surprised me so much that I have looked up the original papers (Tice, *Biol. Bull.* 26, 1914; Morgan and Bridges, *Carneg. Inst. Publ.* 237, 1916). The statement is simply incorrect. In fact, *bar* segregates so well that it is used as a fixed locus in linkage determinations. The assertion should at once be withdrawn. P. 30, and elsewhere, Prof. Paton adduces against Mendelian ideas the fact that dominance is not always complete. As was early recognised, however, dominance is a sporadic phenomenon, apparently existing only when the difference between allelomorphs is of a certain kind, and its presence or absence has no bearing whatever upon the fundamental Mendelian idea, namely, that of unit-factors which are constant (save for mutation), and are capable of segregation and of some degree of independent recombination. His statement that segregation is not always complete appears to be based mainly on the bar-eye case mentioned above. Other examples which he cites depend upon multiple and modifying factors, the very existence of which he apparently refuses to accept.

Finally, Prof. Paton quotes with approval, as in favour of his views and against those of Morgan's, Johannsen's words: that when we find "one single genotypical point of difference between them [*sc.* two organisms], this difference may probably consist in an alteration of the 'chemism' at a special point of the chromosome. . . . ." However, this view of Johannsen's is precisely what not only I for one, but Morgan himself, finds most probable (see the close of Morgan's latest book, "The Theory of the Gene").

I have dealt with these points at length because they involve grave misconceptions; and it seems to me a serious matter that such misunderstandings, appearing under a name so deservedly distinguished as Prof. Paton's, should be allowed to interfere with the progress of biology.

There is no doubt in my mind that the next great step in biology will be the linking up of genetics and physiology via the analytic study of development. But this step will be sadly delayed if physiologists persist in misunderstanding genetics and in substituting for its clear-cut achievements such nebulous phrases as Prof. Paton's 'hereditary inertia' in place of the definite hereditary gene-complex, or fluctuating 'lines of metabolism' in place of the constant chemical units or genes, that segregate at reduction.

As final illustration of the inadequacy of the one view and the adequacy of the other, I will cite one further example. Prof. Paton prefers the view (against all the cytological evidence for chromosome continuity, especially of McClung, Miss Carothers, and L. V. Morgan) that chromosomes are "developed as the result of the metabolism of the cells." An acquaintance with the literature, however, would show that this is entirely negatived by the Drosophila results with haplo- and triplo-IV chromosomes, and by all the numerous results on supernumerary chromosomes in plants, notably Gates's on Oenothera and Blakeslee's on Datura. Further, in respect of the sex-chromosome, it is put out of count by the Drosophila results on gynandromorphism; and especially by the results of breeding from animals whose sex has been reversed, these *retaining* the original chromosomic constitution (as shown by the sex-ratio of the offspring: Crew and Witschi in frogs, Goldschmidt in moths, and Crew in fowls) in spite of the metabolic and functional change.

With reference to the inheritance of acquired characters, Prof. Paton is equally uncritical. He accepts Pavlov's preliminary communication on mice, for which no full paper with protocols has ever been published, but omits to mention the fully documented contrary results of Vicari and of McDowall. Alytes of course is adduced; on this point I would refer him to Dr. Noble's article in Nature of August 7. Finally, he quotes Tornier's work on goldfish. Now, if he had looked up Tornier's original paper (he does not quote the reference—it is *Sitzb. Ges. Naturf. Freunde*, Berlin, 1908), he would have seen that Tornier has never conducted any genetic experiments at all. Tornier has shown (what we all knew before) that fish and amphibia raised under unfavourable conditions produce monstrosities; but he has never raised even an F1 generation from these animals, nor has this been done by his pupil Milewski, the only other worker who has essayed to extend Tornier's results. It should surely by this time be universally agreed that we cannot possibly distinguish what changes and characters are somatic and what are germinal until we have tried the test of breeding. As they stand, Tornier's results have no bearing one way or the other, either on genetics or on evolution.

Any stick will do to beat a dog with, so this *petitio principii* of Tornier (and, following him, of MacBride) is used in support of Lamarckian views. When it comes to the other side of the picture, however, we find Prof. Paton solemnly adducing Yule's analysis of Darbishire's pea figures as a proof that the law of segregation is not valid. I have referred to the original paper in the *Journal of Genetics*. In the crucial results, four classes are expected, in the percentage proportions 56·25, 18·75, 18·75, 6·25. In the material as a whole the actual proportions are 56·6, 18·9, 18·7, 5·9. They are 56·8, 21·2, 18·2, 4·8 in the 'worst' sample. Would any physiologist regard these figures as a bad fit? Yule has shown, it is true, that the divergences are statistically significant, but a slight acquaintance with genetic literature would show that numerous divergences of much greater magnitude may exist, but have been shown to depend on physiological differences between the zygotes (as when one type is less viable) or between the gametes or gametophytes (as when one type of pollen-tube grows faster than another, *e.g.* Renner's beautiful work on Oenothera). To deny segregation on the basis of such facts is on a par with denying any validity to the principle of the reflex arc, because in Nature the isolated or unmodified reflex arc does not exist.

Passing now to the rest of the book, we find some interesting chapters on reproduction, and especially on the relations of the endocrines to the gonads and to growth. The chief criticism I would urge of these chapters is that the student will be left with a somewhat chaotic impression. It is doubtless impossible to lay down such clear-cut principles as regards endocrine interaction as are possible in genetics. None the less, it would have been illuminating to have put forward frankly provisional views along the lines indicated by so many endocrinologists, showing the probable reinforcements and antagonisms of the various ductless glands.

Further, we miss any discussion of the question whether the reproductive and other hormones are chemically similar in all vertebrates; of the specificity of tissue responses to hormone action; of Keith's principle; and of the relation of hormonally-induced differentiation to that brought about within the cells by chromosomes (as in the sex-characters of insects). None the less, this part is a useful compendium of facts, and, if somewhat expanded, would be of considerable value.

There is an undue proportion of misspelt proper names, and an irritating irresponsibility in the matter of giving references, some being given, others of equal importance being omitted. A number of minor errors should be corrected. The frog has no organ of Bidder (p. 66). Drosophila is the *pomace*—not the 'pumice'—fly (p. 46). Pp. 71, 173, Inachus is not an example of alternating sex. It reverts in the non-breeding season to an 'infantile' or, better, neutral condition, exactly as do many small mammals in winter.

On p. 82 Prof. Paton repeatedly refers to "the passage from parthenogenic to sexual reproduction," apparently as if this had been the actual course of evolutionary events. Most biologists would certainly uphold the contrary view, that parthenogenesis is secondary. P. 157: if the author is so particular about *thyreoid* as the etymologically correct spelling, why does he use the hybrid and unfamiliar word *somal* for *somatic* throughout the book? P. 85: the term *sex-limited* for *sex-linked* should be dropped, since it is a misnomer. P. 92: the number of chromosomes and type of the sex-chromosomes of man is no longer in serious doubt, as Prof. Paton avers, since the publication of Painter's papers. I saw Painter's beautiful preparations in the University of Texas in 1924; there are 48 chromosomes, with a highly dissimilar XY pair in the male. P. 23: in quoting the experiments of Sumner (misspelt Summer throughout), who obtained an alteration of bodily proportions in young mice by exposing their parents to low temperature, Prof. Paton states that this must be an effect of the soma upon the germ cells. He does not seem to be aware of the elaborate and conclusive experiments of H. Przibram, who showed that the internal temperature of rats is altered by about 0·2° C. for every alteration of 5° C. in external temperature, and proved that changes of proportions in the offspring such as those observed by Sumner were in point of fact direct effects of change of maternal body-temperature upon the developing embryo.

Such examples only go to show the difficulty nowadays of an investigator who has specialised in one field seeking to master and to criticise results in another field—the difficulty, in other words, of effecting the synthesis that is so desirable.

Prof. Paton's book is, it appears to me, a failure chiefly because he has tried to be destructive without full comprehension of the principles or knowledge of the facts in the branch of science which he has attacked. If he would but collaborate with a geneticist to help us towards an understanding of the interrelations between genetic factors and endocrine (and other) modifiers of development, it would be a more fruitful task, in which he would be eminently qualified to achieve valuable results.

J. S. HUXLEY.

Fuel Utilisation.

(1) *Fuels and their Combustion.* By Prof. Robert T. Haslam and Prof. Robert P. Russell. Pp. xiv + 809. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 37*s.* 6*d.* net.

(2) *Industrial Stoichiometry: Chemical Calculations of Manufacturing Processes.* By Warren K. Lewis and Prof. Arthur H. Radasch. (Chemical Engineering Series.) Pp. xi + 174. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 12*s.* 6*d.* net.

(1) THE question of the economical use of fuel is becoming steadily more insistent, but the problems involved are far from simple. Most textbooks on the subject deal only with some aspects, and there is a distinct need for a text-book giving a general

view of the whole subject, descriptions of the various natural fuels, the principles underlying their use for different purposes, together with examples of how these principles are applied in practice. The book by Profs. Haslam and Russell is intended to fill this gap, and does so with success. It deals with many points on which information is not readily available, and the fact that it is written for use in America, though it detracts to some extent from its usefulness in Great Britain, enhances its interest in other respects. It makes very clear the complexity of the problems involved in the economic use of fuel and the necessity both for further research and the better dissemination of the knowledge already existing.

One of the most noticeable facts brought out by a study of the book is the confusion that is liable to result from the multiplicity of units in use. The chemist thinks in the metric system of units and degrees Centigrade; the industrialist and engineer generally think in pounds, feet, and degrees Fahrenheit. As an example of the lack of system prevailing, the following energy units, which are all in use, may be cited: British thermal units, pound-centigrade units, calories, foot-pounds, kilogram-metres, horsepower-hours, kilowatt-hours, and Joules. To make matters worse, 'Standard Temperature and Pressure,' when considering measurements of gases, are 0° C. and 760 mm. of mercury, but the normal conditions under which gas is sold, and the legal conditions in Great Britain, are 60° F. and 30 inches of mercury. The authors steer ably through the resulting maze, but the unnecessary confusion of units undoubtedly retards progress in fuel economy. The English reader of an American book must further remember that the American 'ton' is 2000 lb. and the American gallon only 8·33 lb. of water, while the Imperial gallon is 10 lb.

The book deals first with the occurrence and nature of the natural fuels, solid, liquid, and gaseous. Analyses are given of many typical American coals, and various proposed coal classifications are considered; the Seyler classification, however, found so useful in England, is not mentioned. There is still much to be learned on the spontaneous combustion of coal and the changes that take place during storage; this is well brought out in Chap. iv., which gives a good account of present knowledge and practice.

The chemistry of the reactions occurring during combustion is dealt with more fully than usual, and the equilibrium conditions, velocity of reactions, flame temperatures, and the factors affecting them are clearly dealt with. Useful tables are included of the heats of reactions, specific heats, sensible heat in gases at various temperatures, and many of them are plotted as graphs—in some cases the data are given only in the form of graphs. It is a pity that these graphs, some of them of great practical use, are reproduced on so small a scale. The numerical examples given to illustrate their use quote data, as obtained from the graphs, to an accuracy quite unobtainable from the reproductions. Many numerical examples are given of combustion calculations, but these would frequently have been easier to follow had the authors been less afraid of using algebraic symbols. After dealing with theory, examples are given of practical applications to boilers and furnaces, and sufficient details of typical plants, both of American and European type, are given to illustrate current practice, and to emphasise the widely varying importance of the different factors involved according to the requirements of the various industrial processes.

The properties and methods of manufacture of producer gas, water gas, oil gas, coal gas, and coke are all considered. The chapter on carbonisation of coal is excellent, but it is somewhat surprising that the work of the Fuel Research Board on steaming in vertical gas retorts, and on carbonisation at 'low' temperatures, is neither mentioned nor referred to in the bibliography. It is clearly brought out that chemical analyses give little indication of the coking properties of a coal, and though results of various British workers are quoted, and several laboratory tests for coking properties are mentioned, no reference is made to the Gray-King assay apparatus developed for the Fuel Research Board, and found so useful by them and other workers in England.

It is frequently forgotten in text-books and academic discussions that commercial efficiency and thermal efficiency are two distinct things; an increase of thermal efficiency may indeed sometimes only be obtainable by actually increasing the cost of the service required. This is well brought out in many places in the book, and examples are given of how to determine the most economical design and method of working under given conditions and with a given fuel. These are valuable in driving home the fact that the most economical method to adopt depends on a host of factors which vary greatly with local conditions. At the same time, there is sometimes a tendency to generalise from insufficient data, probably because really adequate data are not available.

The authors have apparently felt it desirable to assume that the reader has no knowledge of mathematics beyond simple arithmetic, until they come to the discussion of the flow of liquids and gases, the flow of heat, and the rate of heating, which are well dealt with, but relegated to appendices. One feels that, at any rate for the English student, and one hopes for the industrialist, a knowledge of algebra could have been safely assumed with advantage to the explanations.

Apart from the small size of some of the graphs, and a few misprints, the book is well produced, and the difficult problem of apportioning the available space to the different subjects dealt with has been well solved. A bibliography at the end of each chapter gives references to the authorities quoted, and indicates where further information can be obtained.

(2) This book is in quite a different category from the preceding; it is a classroom text-book which deals with chemical calculations in industrial processes. So far as combustion is concerned, it covers some of the ground dealt with in (1), but extends also into other chemical processes. Copious numerical examples are given, together with problems to be worked out by the student. In a table of constants at the end appears the statement that "one gallon of water" is "8·33 lb. per cubic foot," a rather alarming misprint to occur in a text-book of this nature.

A Popular Work on Tides.

The Tide. By H. A. Marmer. Pp. xi+282+4 plates. (New York and London: D. Appleton and Co., 1926.) 10*s.* 6*d.* net.

THIS excellent book is written by the assistant chief of the Division of Tides and Currents of the U.S. Coast and Geodetic Survey. It gives an account of the subject of tides intended for the general reader and without the use of mathematics. Its chapters cover the development of tidal knowledge, the tide-producing forces, the characteristics of observed tides in rivers, bays, and the open sea, the effects of wind and weather, the analysis of observations, the making of tide-tables, the utilisation of tidal energy, and the evolutional effects of tidal friction. Special chapters are devoted to the tides of the Bay of Fundy and of New York Harbour.

The book is written with remarkable accuracy, lucidity, and force, and should find few readers who cannot master its contents. In kinematical and dynamical explanations the aims of the author are very modest, many relationships being referred to the authority of the mathematicians. Nevertheless, numerous simple calculations are given regarding the mechanics of actual tides, and these throw much light on the subject.

To explain the making of the tides in 'the seven seas,' a sketch is given of some of the principles underlying the theories of R. A. Harris, and one is bound to admire the way in which on this subject the author has kept within the justifiable. The cotidal charts of Harris have been wisely omitted, but an explanation of the meaning of a cotidal chart would have fallen easily within the scope of the book. As is natural, the illustrations are taken chiefly from the tides of the New World, but an exception might well have been made for one of the well-attested cotidal charts, which happen to belong to the Old World, especially as these always prove so interesting to those unfamiliar with the subject. No mention, however, is made of the results of the sort of work in this connexion on which R. Sterneck and A. Defant have been continuously engaged since about 1910, though the introduction asserts that the book refers more especially to the results of recent investigations.

It is curious that in describing the action of the tide-predicting machines the amplitude of the curve for a single harmonic constituent is stated (p. 197) to be equal to the length of the crank-arm instead of double this length. The printing and general appearance of the book are very good, but two lines have got interchanged on p. 168. Also, in the reviewer's copy, pp. 275-280 are unfortunately omitted; they include the end of the text and much of the index.

Perhaps it may be of interest to compare the book with the well-known non-mathematical work of Sir G. H. Darwin. The two are very different; that of Darwin reflects the dynamical researches of a great cosmogonist, while the present volume reflects the work of a member of a national survey. Much of Darwin's book is not immediately concerned with ocean tides, but with kindred phenomena of the solar system, and lies outside the scope of Marmer's book. J. P.

The History of Fishing.

Fishing from the Earliest Times. By William Radcliffe. Second edition. Pp. xxi+494+22 plates. (London: John Murray, 1926.) 21*s.* net.

MR. WILLIAM RADCLIFFE'S interesting volume upon the history of the fisherman's craft received a well-deserved welcome when it was first published in 1921, and was accepted at once as an attractive and instructive contribution, filling an important gap in the literature of the subject, voluminous though this literature already was. We may rejoice with the author over the success of the first edition, as evidenced by the advent of a second. Actually, little needs to be said in regard to this new edition, since it differs but slightly from the earlier. The new volume is in fact a reprint with sundry minor alterations and emendations. The pagination remains the same, and the alterations have been governed by the necessity of making the new passages conform exactly to the spaces occupied by the discarded ones. This, no doubt, has been considered imperative, but one cannot but realise that the emendations would have proved more satisfying had these limitations not been imposed.

The author, in his preface to the new issue, deals briefly and disarmingly with some of the criticisms applied to the first edition, but one feels that those criticisms would have been more ably and fully met had the author been given a free hand to re-write some of the passages, instead of trimming them with carefully equated verbal modifications, which do not completely succeed in spiking the critics' guns. Thus, the passages relating to Aristotle as the earliest 'scale reader' might have been so rendered as to differentiate more satisfactorily between the shell laminæ of the mollusc and the scales of a fish, which belong to such different structural categories. Also, in regard to his including dolphins among the fishes, one would feel more appeased by the added footnote on p. 90 had he applied inverted commas to the word *fish* whenever it functions for the cetacean. Aristotle himself was at pains to differentiate dolphins from fishes, and thus early set a good example.

The '*pattern* of Torpedo fish' identified by the author upon the Campanian plate (p. 180) has in the new edition been reduced to *one* Torpedo fish; but he still does not enlighten us as to which individual in the group *is* the fish in question. The prominent figures represent clearly three teleostean fishes and one squid (decapod mollusc). There remains, on the right-hand margin of the plate, a small indefinite figure; but, if *this* is the Torpedo-ray, it is a very unconvincing portrayal, scarcely justifying the inclusion of the whole-page illustration.

Mr. Radcliffe refers in his new preface to the lengthy correspondence and controversy which was stimulated by his disquisition upon the *κέρας βοὸς ἀγραύλοιο* of the "Iliad." He adds yet another suggestion, based upon an epigram by Quintus Maccius, though it is very hard to see how this may help in the solution of this interesting and elusive problem. One would have welcomed from him a judicial summing up of the case, in the light of all the suggestions hitherto offered, but this clearly was not possible without playing havoc with the existing pagination. But one or more appendices might have been added and the interest and authority of the new edition might thus have been further augmented. The feasibility of such added appendices is, indeed, exemplified by the useful and welcome bibliography which appears as a new feature in the second edition. This bibliography does not profess to be exhaustive, but gives a complete list of authorities referred to by the author in his text. The index could still be expanded and revised with advantage, and in the text of the volume sundry misprints and slips seem to have been inherited by the second from the first edition.

Many readers may still cavil at Mr. Radcliffe's chosen definition of 'Angling' as "the action, or art, of fishing with a Rod" (p. 47), and, in spite of his interesting statement of the case, will prefer to retain 'fishing with a Hook' as more nearly in keeping with such etymological evidence as is available. But a subject which includes no debatable items risks being a dull one, and Mr. Radcliffe is the last person to allow any subject of which he treats to be dull; so, while casting a few friendly 'lures' over him, to induce a 'rise,' we offer to him a second edition of our thanks in welcoming a second edition of his important, suggestive, and entertaining book.

H. B.

Our Bookshelf.

Physico-Chemical Methods. By Prof. J. Reilly, Prof. W. N. Rae, and Dr. T. S. Wheeler. Pp. xi+735. (London: Methuen and Co., Ltd., 1926.) 30*s.* net.

THE task of providing an English substitute for the well-known "Handbuch und Hilfsbuch" of Ostwald is a formidable one, if only because the latter volume has had thirty years' start, with the further advantage of revision and expansion in successive editions during that period. The present volume must therefore be regarded as the beginning rather than as the completion of a new enterprise.

Nevertheless, a first reading of the book gives an impression of unexpected completeness, and suggests that the authors have perhaps checked their own table of contents against those of other works of a similar character, in order to avoid the type of omission which may be revealed more clearly by practice than it can be foreseen by theory. Thus a careful search through several sections has been required to discover the possibility of supplementing the text by including descriptions (1) of the home-made glass Bourdon gauges which are now used for measuring the pressure, *e.g.* of corrosive gases; (2) of the method of measuring low pressures by observing the rate of cooling of a hot wire; and (3) of Rast's method of determining molecular weights with an ordinary thermometer by observing the large depressions of the freezing-point of camphor. The apparatus used by Adam for measuring the lowering of the surface tension of water by the addition of films of oil is also sufficiently practical to be included in a volume of this kind. On the other hand, the methods of X-ray analysis of crystals are so difficult to master that one may reasonably question whether a chapter of 23 pages can be of any real value to a beginner who wishes to undertake work of this kind. The inclusion of a chapter in colloid chemistry is much easier to justify, although it is scarcely possible for such a chapter to compete successfully with books which are devoted entirely to this subject.

The book is well illustrated, but a mistake has been made in reproducing some of the figures on a far larger scale than is necessary; in particular the diagram of a burette tap on p. 168 is singularly out of proportion to its importance. Better results could probably have been obtained if the number of writers had been increased to such an extent that each chapter could be entrusted to an author specially selected for his experience in the particular type of measurement to be described; but, leaving this possibility out of account, the three authors of the present volume may be congratulated on the measure of success which they have already attained in covering, by their joint efforts, the wide field of physico-chemical measurements.

Food, its Composition and Preparation: a Textbook for Classes in Household Science. By Mary T. Dowd and Jean D. Jameson. Second edition, revised. Pp. x+177. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1925.) 7*s*. 6*d*. net.

THIS book is intended to supplement notes of students attending domestic science classes, and deals with the theory of food as applied to the kitchen and the household. A general outline of food and its physiological functions comprises the first chapter, which is followed by a discussion of water and its use as a cooking medium. The chapters on carbohydrate deal with the subject from the viewpoint of sugars and starches in such a way as to obscure their connexion in diet unnecessarily. Thus while it is admitted that sugar is mainly a source of energy to the body, "starch plays a most important part in the construction of body tissue," on account of its "nucleo-protein." Such is, unfortunately, typical of some of the chemistry of the book, which should be corrected in the event of another edition being forthcoming.

Tables are given of the time required for cooking various foods, although actual recipes are withheld, as the authors feel that each teacher will prefer to introduce her own. Bread-making is, however, explained in detail, and throughout the book little points are clearly defined, the omission of which frequently spoils what is otherwise excellent food. The use and preparation of the protein foods occupy five chapters, under the headings of milk, eggs, meats, poultry and game, fish. The directions for planning menus, and the combination of foods in meals, are well presented, although based upon American usage, which has little differences from those generally adopted in England. Thus, after a meatless breakfast and luncheon, dinner is left to complete the total daily allowance of 2500 calories, about one-tenth of which are to be derived from the mayonnaise dressing on our salad to be served with our ration of "two thin slices" of roast beef.

The book has the merit that it never allows the student to lose sight of the cost of the different foods. This is achieved by a list of suggested experiments and examples for laboratory and kitchen practice at the end of each chapter. The book is well illustrated and contains a glossary of the principal terms used.

British Snails: a Guide to the Non-Marine Gastropoda of Great Britain and Ireland, Pliocene to Recent. By A. E. Ellis. Pp. 275+14 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1926.) 10*s*. net.

"THE want of a handy work of reference, giving in a convenient form descriptions and figures of all the British non-marine Gastropods," inspired the author to attempt the present publication. He has, wisely we think, included in his scope some forms, such as *Littorina neritoides*, *Otina otis*, and *Onchidiella celtica*, that dwell just above high-water mark and are apt to be omitted by writers on the marine forms on one hand and on non-marine on the other. For an obviously first endeavour this book is a remarkably successful and well-written piece of work, and it will prove of very great use to those for whom it is intended. No pains have been spared to make it complete and the net of research has been thrown wide. Still one cannot but regret that the author did not stay his pen until he had acquired more extensive first-hand knowledge of his subject. There are minor errors and slips on every page from the first, where rhinophores are treated as if synonymous for tentacles, down to the last, where the bracketing of the geological formations has gone all wrong. By the time, however, that a second edition is called for, the author will probably have realised this and rectified matters.

The introductory portion treats briefly and wisely, in an elementary manner, the structure of the snail, the classification of the mollusca, the origin of the non-marine mollusca, and further includes a "Synopsis of the Genera" which takes up space that might have been far more profitably employed. There are fourteen plates, which, save the two illustrating the slugs, are half-tone reproductions of photographs taken by the author's father. As photographs they are remarkably good, and far surpass Rimmer's first essay in this mode of illustration in 1880, while the originals must have been even finer. As illustrations from which to name species, however, they cannot be deemed a success, while some are for that purpose useless. This, though, is the fault of the sitters and not of the photographer. The text illustrations are unexceptionable, while the get-up of the whole book is only what one expects from its publishers, and no higher praise than that is possible.

Handbuch der Experimentalphysik. Herausgegeben von W. Wien und F. Harms. Band 1: *Mess-Methoden und Mess-Technik*, von Dr. Ludwig Holborn; *Technik des Experiments*, von Dr. Ernest von Angerer. Pp. xx + 484. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1926.) 42 gold marks.

THIS handsome book with its large pages, clear type, and numerous illustrations, has a very attractive appearance. It forms the first volume of the important 'Handbook' of experimental physics now in course of publication in Leipzig. The editors state that it appeared desirable to place in the forefront of their work a summary account of physical measurements and the technique of experimentation. It would be unfair to criticise the scope of the work in the absence of the later volumes, as it forms only the first part of a complete whole.

Dr. Holborn, the author of the first section (on methods of measurement), has had no easy task to perform in having to avoid, on one hand, the mere reproduction of an instrument-maker's catalogue and, on the other, the supply of information to be found in any text-book of practical physics. He has been limited to a description of the more fundamental methods, since it is obviously impossible, for example, to give an exhaustive account of the measurement of electrical resistance in some ten or twelve pages. We could, however, have wished for a more critical discussion as to the relative merits of different methods.

The experimental physicist has to carry out or superintend the construction of many kinds of apparatus, and it is necessary for him to be familiar with many mechanical processes and the properties of various materials. In the second section of this book he will find much useful information as to the characteristics of metals, solders, and cements, the working of glass and the deposition upon it of thin metallic layers. Hints are given on such widely different topics as the preparation of vacuum tubes and the choice and treatment of photographic plates. It is only by actual trial that such instructions can be tested, but so far as can be judged, they are just those which the experimenter is likely to require. The information seems well up-to-date, and where necessary, references are given to books in which further details of methods and processes are to be found.

Crop and Stock Improvement. By A. B. Bruce and Dr. H. Hunter. (*The Farmer and Stock-Breeder* Manuals.) Pp. 119. (London: Ernest Benn, Ltd., 1926.) 5*s.* net.

The authors have succeeded in presenting, in the form of a readable story, an account of the methods used in the improvement of plants and animals, and the results achieved thereby. So far as possible the story is told in simple, non-technical language, but does not suffer in accuracy on this account. The historical method is followed, and throughout the book the attitude of the authors is refreshingly critical.

In the plant section Dr. Hunter deals first with improvement by selection, then with the work of the hybridisers, pre- and post-Mendelian. A long chapter is devoted to a description of the results which have been achieved, and there is an excellent final chapter on the distribution of improved strains of crops.

Mr. Bruce's treatment of the improvement of animals, on account of the much greater complexity of the subject, is necessarily more general. The first chapter describes the main principles of Mendelian segregation. In the second and third chapters are discussed the methods by which the present-day improved breeds of farm animals have been produced. The last chapter is devoted to an examination of the methods and use of inbreeding.

The book is commended to all those who are interested in agriculture, whether students or farmers or both. It will give them a measure of the results which have been achieved in the past, and a basis on which they may estimate what further improvements may be hoped for in the future.

Chemistry of the Proteins and its Economic Applications. By Dr. Dorothy Jordan Lloyd. Pp. xii+279. (London: J. and A. Churchill, 1926.) 10*s.* 6*d.* net.

This volume, bearing, as it does, an introduction by Sir Frederick Gowland Hopkins, is developed from a series of lectures by the author. The subject naturally falls into two main parts, the chemical constitution and the physical chemistry. The first part, after dealing in a general way with the composition of the protein molecule, proceeds to outline one or two of the more usual methods of analysis. A full discussion of the use of the amino acids from the physiological point of view is followed by a chapter on the problems of food preservation. It cannot be claimed that this part of the work offers more than a compilation of material already available to the student or general reader. The second part is devoted to a systematic discussion of the physical behaviour of the proteins so far as research has been carried. The results of Loeb, Cohn, and others are dealt with side by side and compared in such a way that their study will be repaid by a grasp of the different aspects of the subject by any student already possessing fundamental knowledge of physical chemistry. The value and importance of the physical chemistry of the proteins are well illustrated by the chapter on the "Industrial Uses of the Proteins," which could with advantage have been extended. Each chapter bears a bibliography, which, while not quite complete, gives reference to most of the fundamental research on the subject.

Adventures of Exploration. Book 5: *Australia and New Zealand.* By Sir John Scott Keltie and Samuel Carter Gilmour. Pp. iv+204. (London: George Philip and Son, Ltd.; Liverpool: Philip, Son and Nephew, Ltd., n.d.) 2*s.* 3*d.*

The fifth volume in this series is even better than the earlier ones. The material has been chosen with so much care and the stories told with such admirable lucidity that no one reading the volume can fail to get a well-balanced general view of the stages by which Australia, New Guinea, New Zealand, and South Victoria Land became known and were explored. After some account of early voyages of discovery, there are chapters on the work of Cook, Bass, and Flinders, the overland journeys of Oxley, Stuart, Eyre, Grey, Burke, and others in Australia, followed by chapters on New Zealand and Papua. The book closes with two chapters on the Antarctic, giving accounts of the work of Scott, Amundsen, and Shackleton in the Ross Sea and Mawson in Wilkes Land. There are a number of well-chosen illustrations and portraits, and every chapter has its own map. The series should be a valuable aid in teaching school geography.

Immunochemical Studies. Edited by Prof. Carl H. Browning. Pp. xiii+239. (London: Constable and Co., Ltd., 1925.) 12*s.* 6*d.* net.

In this small volume the editor has gathered together a series of papers published by himself and his collaborators over more than a decade. The matter has been rearranged to make it suitable for book form. The work is entirely on the humoral aspects of immunity. The first chapter gives an excellent short account of antibody action in general: among the subjects dealt with in the succeeding chapters are the antigenic power of globin, the alterations which occur in hæmolytic immune bodies during the process of immunisation, heterophile antigen and antibody, and complement. The section on the latter contains a certain amount of matter which has not hitherto been published. The work will appeal to those interested as giving in handy form information which is scattered in a number of different volumes.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor 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 Fayum Lakes.

THE first of six reasons given by Sir Flinders Petrie (NATURE, Oct. 9, p. 514) for maintaining his view that the level of the Fayum lake gradually rose with the rise of the Nile, is that there must have been an open channel which it is unlikely would have become blocked when a large mass of water flowed to and fro each year. The flood waters of the Nile are heavily silt laden, and when they entered and filled the Fayum the surplus would have re-established its ordinary course northwards along the valley. The lake, connected by a channel at least 10 kilometres long, would never have filled quite to the highest flood level of the river. As soon as the crest of the flood passed and the water levels began to fall, the current in the connecting channel would die away, silt would be deposited, and it would have become choked and blocked up. The river carries most silt at the highest levels of the flood, and the rapidity with which deposits are formed must be seen to be realised. The inlet, once closed with a bank of silt, would not have been readily reopened.

Such conditions are illustrated by many depressions bordering the Blue Nile between Singa and Roseires. They are minute in comparison with the Fayum, but the same principle doubtless applies.

Under organised government, the connecting channel could have been kept open and the annual influx and efflux referred to by Sir Flinders may have been maintained; the lake being subject to a range of levels depending principally on the height of the Nile flood, the efflux, and evaporation. Under natural conditions, on the other hand, when the connecting channel had been closed by silt, communication would not have been re-established until either erosion cut away the bank or an exceptionally high flood occurred. In our own times there have been the very high floods of 1874 and 1878; had such floods silted an inlet channel, several decades might also have passed before communication could have been re-established. Sir Flinders Petrie remarks that complete drying up would occupy only about twenty-five years. It is for such reasons that it is difficult to understand how lakes with fairly stable water-levels could have been maintained in the Fayum under the conditions we know in the Nile Valley to-day, which have certainly prevailed over a large part, if not the whole, of historic times.

Another factor which might influence the relations of the Nile to the Fayum is the position of the sea-shore and consequently the slope of the river in the intervening distance. We know that the Delta has been subject to earth movements, and in fact Sir Flinders was understood to say in his contribution to the discussion that it had fallen about 30 ft. before Ptolemaic times, when it rose about 15 ft. It may be readily supposed that a fall of 30 feet at the Delta shore might have led to considerably increased slopes and a consequent incising of the river bed affecting conditions at least so far as the neighbourhood of the Fayum, which is about 110 kilometres upstream of the apex of the Delta. This is a second reason for doubting the view that the Fayum lake-levels belong to a simple progressive series.

The levels under consideration are as follows:

	Feet above Birket Qarun.	Metres, referred to mean sea-level, Alexandria.	W.F.P. dating, submerged since.
Present Nile flood	243½	+29	
Present valley floor	237	+27	
High-level lake	222	+22·5	
Neolithic lake	205	+17·4	
Implements on gravel	185	+11·3	8,000 B.C.
Flints	176	+ 8·5	9,000 B.C.
Lake	160	+ 3·6	
Prehistoric pottery	156	+ 2·4	14,000 B.C.
Pigmy flints and cores	138	− 3·0	17,000 B.C.
Present Birket Qarun	zero	−45·1	

If the Nile now had unrestricted access to the depression, the resulting lake, depending on the connecting channel cut through the Nile flood plain, might be expected to stand at about 25 or 26 metres above sea-level. The dates have been culled from *Ancient Egypt*, March 1926, where they were added by Sir Flinders Petrie. In reducing the levels given there, he adopted − 144 ft. as that of Birket Qarun, while in the papers presented at Oxford − 148 ft. has been used.

Sir Flinders evidently considers that the lake-levels have been gradually rising for a very long period of time. Have we any justification for supposing that the same steady rise has extended so far back into prehistoric times? The definite lake margins recorded by Sir Flinders' assistants appear to oppose his theory of a gradually rising lake.

It seemed generally agreed by those who had studied the subject in the field that the lake which stood at 22·5 m. above sea-level was of very much older date than the 17·4 m. lake associated with the neolithic remains. Sir Flinders in his reply did not refer to the date of this higher lake. He has doubtless given the evidence very careful consideration, and it would be of interest to know how he fits it into his scheme of dates. It appears that the fauna of the 22·5 m. lake, while distinctly Nilotic in character, shows certain differences when compared with the 17·4 m. lake, and also that the deposits associated with the higher lake were consolidated and eroded before the 17·4 m. lake came into existence.

Among the six reasons given by Sir Flinders for maintaining the view that the levels of the Fayum lake gradually rose, the fourth, stating that there is no trace of human work anywhere below the Nile level of its own age, makes the strongest appeal. May this not be due to the fact that the dried-up floor of the depression attracted no inhabitants in the intervals between the lakes, and also because any remains are hidden from us by deposits of silt? Even if Herodotus did see the water flowing to and from the lake of his time, and the quays of late origin were made for a lake that stood at 215 ft., it does not necessarily follow that the early lakes belong to the same progressive sequence. We can accept, too, what Sir Flinders gives as his third reason, namely, the discovery of a cooking pot, fire, and flints *in situ* at 170 ft. level, and that these were submerged by a lake in Greek times, again without need to suppose that the levels rose progressively from one to the other. The two lakes may have been quite independent. The remaining point as regards the water that filled the lake being from the Nile has no direct bearing on the sequence of levels.

The band of brilliant workers who have been studying the ancient history of the Fayum and the Nile valley, stimulated by Sir Flinders' leadership, have established a number of facts, among them the existence of definite lake margins. The researches are admittedly incomplete and further developments, besides elucidating the sequence of the lakes, may show during what lengths of time they existed and what were the conditions that allowed the water to remain steady for those periods. While some of the facts do not seem to fit the older ideas, it might be better to hold those theories in suspense.

Turning to another aspect of Sir Flinders' letter, the epithet of unfortunate irrelevance seems severe to apply to the remarks contributed about the character of the implements. Has not Sir Flinders figured implements from the Fayum as Solutrean (*Ancient Egypt*, 1915), and remarked on their close equivalence to the Solutrean of Europe, basing his comparisons largely on a group which he tells us were selected at a dealer's from among the contents of a barrel? G. W. GRABHAM.

Khartoum, November 3

Laue-Photograph taken with a Long Slit.

ORDINARY metals are composed of aggregates of small crystals. These small crystals may be made to grow, by suitable processes, to very much larger ones, so that we can obtain a test piece of proper size composed entirely of a single crystal of a metal. Such test pieces of single crystals of metals do not, as a rule, possess plane faces, that is, the external forms of crystals, but X-rays afford us a means of determining the orientations of the axes of such crystals. A. Müller (*Proc. Roy. Soc.*, London, 1924) photographed the Laue-spots at various orientations of the specimen, and from the position of the characteristic *K*-radiations of the anticathode on the photograph, he determined the orientations of the axes of the crystal. Next, T. Fujiwara (*Mazda Kenkyu Jiho*, Tokyo Electric Co., 1926) achieved the same purpose by finding the characteristic *K*-radiation in some of the ordinary Laue-spots; while H. Mark, M. Polanyi, and E. Schmid (*Zeit. für Phys.*, 1923), and K. Weissenberg (*Zeit. für Phys.*, 1924) applied the method of rotating the crystals. All these authors employed a narrow and nearly parallel beam of X-rays, so that only a small portion of the specimen could be tested at one time.

In order to examine the whole of the specimen at once, we have utilised divergent X-rays starting from the focus on the molybdenum target of a Coolidge tube. These divergent rays were made to pass through a long narrow slit, and then to illuminate a long thin specimen composed entirely of a single crystal of aluminium. The Laue-spots thus became an assemblage of many lines on the photograph, as seen in the accompanying illustration (Fig. 1). Each one of these 'diffraction-lines' is a spectrum of the X-rays caused by reflection from a certain atomic plane of the crystal; any one point on one of these lines being registered by the X-ray of a certain wave-length, which is reflected from a part of the atomic plane of the crystal situated at a certain point of the specimen. Thus each point on any one of the diffraction-lines in the photograph corresponds to a certain part of the specimen. This correspondence is important, and we have made it recognisable on the photograph by the shadows cast by some thin wires of lead, which were stretched across the slit situated very near to the specimen.

When this correspondence and the data of relative positions of various parts of the apparatus are known, the orientation of the atomic plane of the crystal which caused a diffraction-line on the photograph, and the glancing angle of the beam of X-rays to this atomic plane, can be calculated readily at each corresponding point on the specimen. Moreover, for a diffraction-line on the photograph, on which the characteristic *K*-radiations of the target appeared, the indices of the atomic plane of the crystal which is responsible for that diffraction-line can be found easily. By knowing the values of the glancing angles at two points on the specimen which correspond to two shadow-points on the diffraction-line, the glancing angle for the *K*-radiation on the same diffraction-line can be obtained by interpolation. With this value of the glancing angle for the *K*-radiation, and wave-lengths of that radiation, the value of the grating constant, and consequently the indices of the atomic plane under consideration, can also be found immediately.

For the present purpose an X-ray tube with a sharp focus is preferable. The focus of the tube we used was not quite sharp, being about 5 mm. in diameter. We could, however, use it as a sharp focus—one of about 1 mm.—by setting it in such a position that the surface of the target is nearly, but not exactly at right angles to the slit.

With this apparatus we could determine the orientations of the axes of single crystals of some thin aluminium wires and of a fairly thick block of lead which had a nearly cylindrical surface. Single crystals of aluminium wires were made by H. C. H. Carpenter and C. F. Elam's method (*Proc. Roy. Soc.*, London, 1921). Their diameters were about 2 mm.,

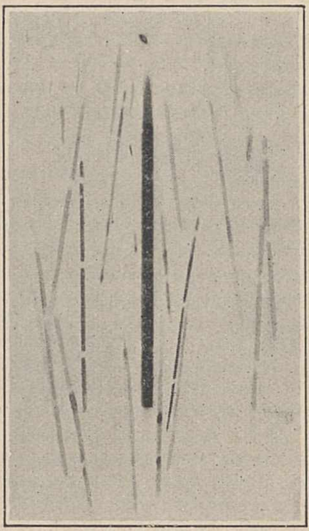

FIG 1.

and their lengths were not the same for all the specimens, varying from 4 cm. to 12 cm. With these specimens many diffraction lines were usually obtained in a single photograph, which contained the impressions of the *K*-radiations of molybdenum, as seen in the accompanying illustration. We have calculated the orientations of the axes of the crystal with reference to the co-ordinate axes fixed to the specimen by these several diffraction-lines. In the following table the angles between the axis of the wire and the three edges of the elementary cubic lattice of the aluminium crystal are given for six different crystals examined.

No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
87°	87°	85°	88°	89°	89°
62	57	65	63	61	61
29	34	26	27	28	30

Though it may be premature to state general conclusions here, it seems not out of place to note that these angles are nearly the same, and that one of the (100) planes of the crystal is situated nearly parallel to the axis of the wire, at any rate for all the six specimens tabulated above.

The present method of determining the orientation of the axes of crystals is very simple, and at the same time it shows very clearly on the photograph whether the specimen is composed of a perfect single crystal or not. So far we have applied this method to thin wires only, but it may equally be applied to thin plates or to any specimen which has a plane or cylindrical surface.

USABURO YOSHIDA.
KENZO TANAKA.
Physical Laboratory,
Kioto Imperial University, Kioto,
Japan, September 21.

The Crystalline Nature of the Chief Constituent of Ordinary Coal.

AN examination of a microscope section of Indian coal from the Raniganj coal-field showed that the main substance of the coal was a madder-red coloured, translucent material, which in a section cut vertical to the bedding planes of the coal, gave faint pleochroic effects when examined in plane polarised light. The same substance, when viewed between crossed Nicols, had distinct extinction parallel to the lines of the laminæ and behaved like a uniaxial mineral. The peculiarity is that the whole of the red-madder substance, seen in the field of the microscope, behaved as though in optical continuity and as if part of a single crystal.

Eight slides, two each, one cut parallel to the planes of bedding and the other vertical to this direction, of so-called clarain, vitrain, durain, and fusain made by Mr. James Lomax of Bolton, were procured, and in the vertically cut sections the same phenomena are to be observed. In the sections cut parallel to the bedding the substance behaves as an isotropic mineral. The first six slides are of the thick coal of Exhall in Warwickshire, while the sections of fusain are of the Trencherbone coal of Lancashire.

These slides show that there is only one chief constituent in the coals examined, which for lack of a better name, one may speak of as vitro-clarain (after Stopes) or anthraxylon (after Thiessen). Scattered through the coal, usually along the planes of bedding, are sections of bright gold or red resinous matter suggestive of the sheaths or walls of sporangia, and smaller gold specks and lenticles which may be spores. In addition, there are red translucent patches of a rough, pitted nature, which might be the outer skin of sporangia, as some of these, cut obliquely, show a distinct cellular structure.

In the sections of durain the laminæ are rather closer together than in the slides of clarain, and the laminæ are well marked, as though with thin sheets of opaque inorganic material. The fusain is obviously associated with 'dirt' bands in which pyrite, siderite, and calcite can be distinguished along with the powdery carbon. In some cases a beautiful reticulated structure is evident in the fusain, as though the inorganic matter was an infilling in some organic structure.

Thus it appears, from a petrographic examination of the usual kind, that these coals consist of four components, but rather different from those identified by Dr. Marie Stopes. My components are as follows: (*A*) One main constituent which simulates a crystalline structure, and (*B*) three minor or relatively minor constituents—(1) resinous bodies, such as sporangia and spores which may be present in large or small quantities and may markedly affect the quality of the coal; (2) powdery, soft carbon with the macrostructure of charred wood, which is well known as mineral charcoal or fusain; and (3) inorganic matter—clay along the laminæ or scattered through the coal, as well as other such recognisable minerals as pyrite, calcite, siderite, etc., usually associated with the fusain. With this inorganic matter could be grouped the inorganic impurities, for example, ankerite, etc., which occur in cracks and joints in the coal.

The most important and certainly most uniform substance of these coals is the material, designated *vitro-clarain* in courtesy to Dr. Stopes, which constitutes the main bulk of good coal and probably represents the mineralised form of woody tissue. Its crystalline behaviour is strange, but will probably be fully accounted for by organic chemists as some kind of strain phenomenon.

CYRIL S. FOX.
Geological Survey of India,
Calcutta, September 23.

THE application of the petrological microscope to the study of coal sections may lead to interesting observations on the details of coal structure, and I am glad Mr. Fox is taking it up. It is a little unfortunate, however, that he should add to the complexities of coal nomenclature on so slender a basis as his observations on his first few sections.

In his third paragraph he writes as though "vitro-clarain (after Stopes)" were identical with "anthraxylon (after Thiessen)," a confusion which has already been exposed concisely by Seyler; see "The Nomenclature of the Banded Constituents of Coal" (NATURE, April 3, 1926).

In his fourth paragraph Mr. Fox describes "a beautiful reticulated structure" as being evident, "as though the inorganic matter was an infilling in some organic structure." This is a truism to students of coal, the "reticulated structure" being tracheids of woody tissue, generally the secondary wood of Lepidodendron, or Cordaitean trees, which constantly have crystalline matter filling the laminæ of the tracheids.

Mr. Fox's main point, however, that there is *one* main constituent which simulates crystalline structure in coal, is a suggestion which, if true, would have a very material bearing on the details of research into coal structure, and should certainly be checked by observations on much larger numbers and varieties of coal sections.

It must be borne in mind that, in general, the large bulk of bituminous coal contains ulmic compounds which are colloidal in their nature.

I must dissent from the phrase in the concluding paragraph that this ". . . constitutes the main bulk of good coal and probably represents the mineralised form of woody tissue." The major part of coal substances is not mineralised but mummified; and woody tissue is *one* of its constituents, but only one of many.

MARIE C. STOPES.
Givons Grove, Leatherhead, Surrey,
October 25.

Adsorption of Dyes to Silver Halides.

THE quantitative determination of the amounts of dyes taken up by crystalline solids has both a general and special interest. The adsorption of dyes to silver halides, and particularly of sensitising dyes, has considerable photographic importance in relation to the theory of optical sensitising. Work has been in progress for some time in this laboratory on this problem by methods devised by the writer and Mr. H. Crouch. The dyes investigated are of the iso-cyanine and carbo-cyanine class, and the bulk of the work so far has been carried out with orthochrome T-bromide (*p*-toluquinaldin-*p*-toluquinoline-ethylcyanine bromide).

These dyes are decolorised at sufficient acidity, the colour being restored by alkali, and the colour change being sharp enough for the dye to be used as an indicator. The partition coefficient of the dye between a weakly buffered aqueous solution of about 1/100th normal buffer content and chloroform was determined at different *p*H values; at about $pH = 8$ the dye is practically completely removed from the water by the chloroform.

The concentration of dye was determined by extraction with chloroform and measurement of the spectro-photometric extinction at the wave-length of maximum visible absorption, about 570 $m\mu$. The dye solution of given *p*H was shaken with a silver bromide precipitate, the integral surface of which could be computed from the size-frequency curve of the particles. On plotting amount of dye carried down by the silver bromide against residual concentration of the dye in the solution, curves were obtained which first rose rapidly, then reached a period of practically equal adsorption, which was again followed by a period of almost vertical ascent. The interpretation of these results is as follows: The dye is at first adsorbed to the surface to the point of surface saturation of the silver halide with *dye* molecules. The dye disperses in water to *colloidal* as well as to true solution and the last ascending portion of the curve corresponds to the precipitation of the dye on the silver bromide, that is, to the *colloidal* or *mechanical* adsorption. The point at which the final ascending portion of the curve when produced cuts the concentration axis of the dye, represents the *true solubility* of the dye in the aqueous solution.

Of various adsorption formulæ, the so-called Freundlich formula failed entirely to represent the data, but a modification of Langmuir's formula for the monomolecular adsorption of gas molecules to a plane surface was found to fit the data very well.

From the known total area of the silver bromide, and the lattice interval, the number of ions in the surface layer can be calculated. Assuming octahedral surfaces, which all the evidence indicates, the adsorption density of the dye on the surface diminishes as the *p*H of the solution is decreased, but at a *p*H of 5·5 it was calculated that one molecule of dye was adsorbed for 20 ions of the lattice surface.

Several reasons might be advanced in explanation of the low adsorption density of the dye. From optical sensitising experiments it has been known for a long time that the effective amount of dye adsorbed was of a very low order. Mr. T. Thorne Baker has recently contended (*Phot. J.*, 50, 299, 1926) that the dye is only adsorbed to what have been termed the 'sensitivity specks' in the silver halide, which have been shown by the writer to be, in all probability, silver sulphide. This interpretation does not at present seem probable, in view of the existence of a similar order of adsorption of the dye when the silver halides are prepared in the absence of sulphiding material. It seems equally probable that the dye is actually held to the silver halide, that the dye molecule has a very large area, and very possibly tends to orient itself parallel to the lattice surface. The most obvious condition would be for the dye cation to be held to a bromide ion of the silver halide lattice, but residual affinity in other parts of the molecule may also be exerted.

The solubility of the dye in water is enormously diminished in the presence of quite small amounts of soluble halides, and the part which these play in the adsorption process is being investigated. These measurements must be carried out in a yellow light such as is given by Wratten Safelight 00, owing to the photochemical reactivity of the dye.

The work is to be extended, and it is hoped to publish a fuller account shortly.

S. E. SHEPHERD.
(Assistant Director of Research.)
Eastman Kodak Company,
Rochester, N.Y., October 29.

The Genetics of Evening Primroses and Mice.

IN 1905, Dr. G. H. Shull, of Princeton, received from Dr. de Vries ten rosettes of *Oenothera lamarckiana* from the locality at Hilvershum, Holland, which had supplied the original material for the classic researches of de Vries many years before. In 1921, among the descendants of these plants appeared a colour-mutation which Shull calls 'old gold' (*vetaurea*). The petals are flushed with apricot-colour, strong toward the base, fading out distally. In a very interesting and detailed paper (*Genetics*, May 1926, p. 201), Shull describes the behaviour of this mutant in a variety of crosses. It is recessive to the ordinary yellow flower. In order to test it further, Shull introduced into his cultures the very pale yellow mutant called 'sulphur' (*sulphurea*), and was surprised to find that old-gold was complementary to sulphur, the two when crossed giving invariably plants with flowers of the normal yellow colour. Accordingly the normal yellow is expressed by the symbol SSVV (double dominant), the homozygous sulphur by ssVV, and the homozygous old-gold by SSvv. By suitable crosses the double recessive ssvv was obtained, and proved to be a pale flower, with the bases of the petals flushed with the apricot tint. Shull called it 'gold-centre' (*aurata*). The amount of the reddish or old-gold colour is much less than in old gold.

From my experience in breeding sunflowers, and to a lesser extent evening primroses, I feel sure that microscopical and chemical investigations would make this case clearer. The normal yellow is due to plastids in the cells, and 'sulphur,' while possibly having paler plastids, more probably has them less numerous or diluted, with more air in the cells—an approach toward the condition of the white-flowered species. The old-gold effect must surely be due to an anthocyanin soluble in the sap. An inhibitor of this anthocyanin suffusion is dominant, and exists in the normal yellow flowers. Thus the allelomorphs are not really yellow and old gold, but no flush, and flush; yellow being present in either case. If the allelomorphs in the case of yellow and sulphur are dense and dilute, this explains why less anthocyanin is visible in the double recessive than in old gold, on the same principle as that of the white evening primroses, which turn pink on fading. It is possible that as much anthocyanin could be extracted from the one as the other.

In experimenting with transplantable neoplasms or tumors in mice (*Genetics*, May 1926, p. 294), Mr. Leonell C. Strong, of the Bussey Institution, found that transplants from a spontaneous cancer rarely grew well in the first generations, but usually the number of successful takes increases until a very high rate is attained. He directs attention to certain cases in which abrupt changes have taken place in the behaviour of the tumours, so that from one original type he now has four, with different reactions appropriate to each. He shows that these differences cannot possibly be ascribed to anything in the host mice, and so is driven to the conclusion that somatic mutations have occurred in certain of the tumour cells. The general improbability of the occurrence of such mutations in so short a time apparently cannot count against the observed facts. Possibly there may be a slightly different explanation. The complicated mitotic phenomena are of course controlled by genetic factors. If we assumed (and the idea is not new) that the original tumour cells arose as the result of a breakdown in or disturbance of the mitosis-controlling factor or factors, this one change would seem to account for all the rest. The partially inadequate control would result in sundry mitotic errors, and those which led to the most prolific and 'non-specific' tumours would be perpetuated in preference to others. T. D. A. COCKERELL.

University of Colorado,
Boulder, October 23.

Mathematical Proof *versus* Observation.

THE history of the physical sciences offers many examples of theories which have been 'proved' mathematically and been set as foundation-stones in the edifice of science, only long after and when a superstructure has been reared upon them to be abandoned as untenable. The operation of taking out a 'foundation stone of science' presents all the difficulties which are encountered in extracting its physical parallel.

Mathematical formulæ to be applied practically require the use of numerical factors which are often wanting or are subject to such wide range that a large element of guessing enters into the computation. In actual practice a far greater source of error is one which might well be eliminated—the neglect to compare and check carefully the results of the mathematical treatment with the facts of observation.

A noteworthy example of the abiding faith in mathematical formulæ when not in harmony with observation, is afforded by a formula in common use where the disparity between the calculated and the observed numerical values is that between 26,000 and 200. A neglected factor has just been discovered which brings the theoretical and the actual values in this case into harmony. Obviously this example might be cited to show the value of mathematical treatment; but even more clearly it sounds the warning against putting our faith in any mathematical treatment of physical phenomena where a careful comparison has not been made to see that the results of the computation check with the observations.

Even when the mathematician has himself been careful to state the limitations to which his conclusions are subject because of the assumptions made, those who cite him are not so easily controlled. As a striking example it is stated in a recent review: "Dr. Jeffreys has recently demonstrated (*Quart. Jour. Roy. Met. Soc.*, vol. 52, p. 85, January 1926) that whatever superficial increase of pressure there may be over either pole or over Greenland, in consequence of the cold, this is a shallow surface effect, and that both poles are seats of low pressure"; as though such a fact could be proved by mathematical discussion alone. When we consult the original, we find that this eminent mathematician has stated that his discussion has not been developed for the actual earth on which we live; but for a hypothetical earth on which the atmospheric circulation is assumed to be symmetrically disposed with reference to the geographical poles, operates without friction, and is without interference from the irregular distribution of land areas. No one of the assumptions holds true of our earth.

It should be stated that Dr. Jeffreys has faithfully tried to compare his conclusions with observation, though without very happy results; for neither Greenland nor the north and south polar areas are regions of low atmospheric pressure. The north polar area is one of nearly normal atmospheric pressure, whereas the south polar region and Greenland are both notably areas of high atmospheric pressure. Observations are consistent in support of these statements. WM. H. HOBBS.

Ann Arbor, Michigan, October 28.

The Oscillations of Superposed Fluids.

THE explanation of Franklin's experiment quoted in NATURE of December 4, p. 823, is purely dynamical. When a stratum of oil rests on water the restoring forces of gravity called into play by any disturbance of the interface are comparatively small, owing to the slight difference of density. Free oscillations are consequently slow, and so in Franklin's case apparently came within the range of the imposed periods due to the motion of the ship.

The formula for the periods $(2\pi/\sigma)$ of waves of given length $(2\pi/k)$ in the case of two superposed liquids of depths h, h' and densities ρ, ρ' was given long ago by Stokes. The equation has two roots, which reduce to

$$\sigma^2 = gk \tanh k(h+h'), \quad \sigma^2 = gk\frac{\rho-\rho'}{\rho}\frac{\sinh kh \sinh kh'}{\sinh k(h+h')},$$

approximately, when the ratio $(\rho-\rho')/\rho$ is small. The former root corresponds to the motion of the fluid mass as a whole, as if it were of uniform density throughout. The second root is relevant to the observed phenomenon, the disturbance being confined to the neighbourhood of the interface. The ratio of the amplitudes at the upper and lower surfaces is in fact

$$-\frac{\rho-\rho'}{\rho}\cdot\frac{\sinh kh}{\sinh k(h+h')},$$

approximately. If the fluids are contained in a cylindrical vessel of radius a the admissible values of k are given by the roots of $J_n'(ka)=0$. The slowest oscillation of all corresponds to the smallest root of this in the case of $n=1$, namely, $ka=1\cdot841$. The interface then oscillates about a nodal diameter.

For a numerical example, probably not very different from the circumstances of Franklin's case, we may assume $h=h'=4$ cm., $a=4$ cm., $(\rho-\rho')/\rho=0\cdot9$. With the above value of ka this gives a period of 1·36 sec. The corresponding ratio of the amplitude at the upper surface to that of the interface is only 0·0155, or less than one-sixtieth. If the oil were removed the period would be 0·302 sec. H. LAMB.

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Rainfall Interception by Plants.

THE major part of the 'interception gain' found by Mr. Phillips in his experiments at Deepwalls, described in NATURE of Dec. 11, p. 837, is no doubt due to the screen catching rain which would otherwise have fallen on the lee side of the gauge. This would become negligible if a large area were covered by a comparatively close network of screens, except for a narrow strip at the edge of the area, where the gain would still be appreciable. This particular experiment does not appear likely to give information about the amount of water deposited on plants when there is no rain (or practically no rain) falling to the ground.

The percentage excess in Mr. Phillips' experiment should be greatest when the ratio of the velocity of the wind to the rate of fall of the raindrops is greatest.

E. GOLD.

Allotropy.

By Prof. A. SMITS, University of Amsterdam.

THE liquid state of aggregation or phase of an element under its own vapour pressure is always stable over a certain temperature range, that is to say, from the critical point to the solidifying or melting-point. Below this point the liquid is not stable, for in this case it has gone beyond its range and should have crystallised, but seems to be too indolent or has forgotten to do it.

All liquids can be cooled more or less below the solidifying point without freezing, or, in other words, can be supercooled. This supercooled state is metastable, since although it is not stable it can be realised. But what about the crystallised aggregation? If only *one* solid state exists the case is very simple, for then we can say, from the solidifying point to lower temperatures the solid state is stable. It is generally found, however, that the same element can exist in two or more crystalline states, or modifications, differing in physical and chemical properties. This phenomenon is called *allotropy*, or better *phase-allotropy*, as the intention is to indicate the appearance of two or more similar *phases*. If at any time two liquid states of an element are found, one may also speak of phase-allotropy. It should be observed that though we have referred here to elements, the same holds for compounds, if the different phases have the same composition.

Two cases must now be distinguished. It is possible that what is said above holds only for one of the solid states, whilst the other modifications are always metastable. This phenomenon is called *monotropy*. The peculiarity of such metastable states is, that contact with the stable state or with a solution, etc., can effect the transformation into the stable state. When such a metastable state can be heated to the melting-point, then it appears that the melting temperature is lower than that of the stable state. Sometimes these melting-points are very close and sometimes they are a great way apart. For example, the stable violet phosphorus melts at 589·5° C., whilst the metastable black modification melts at 588°, and the metastable white modification at 44·1°. It appears also that the stability is transferred from one modification to the other. For example, over a certain temperature range A is stable and B metastable, and above a given temperature the position is reversed; B becomes stable and A metastable, and at this given temperature both of the two modifications can exist stable, side by side, and be in equilibrium. This temperature is called the transition temperature and is completely comparable with the melting temperature, at which the solid and the liquid aggregation are in equilibrium. This phenomenon is called *enantiotropy*. A good example is mercury iodide: below 127° the red tetragonal modification is stable and above this temperature the yellow rhombic modification is the stable one. At 127°, the transition temperature, both forms are stable. It must be remembered here that we have considered liquid and solid phases, being under vapour pressure. It is necessary to mention here that it happens frequently, that whilst under vapour pressure only one crystalline phase is stable; under higher pressures the transition phenomenon occurs.

Though, consequently, two modifications only can be stable, side by side, at the transition temperature, it happens frequently, owing to retardation, that a stable and a metastable modification exist side by side over a large range of temperature. In this case, consequently, the substance is a *conglomerate* of two modifications, one only of which is stable. This behaviour, as it is only a consequence of retardation phenomena, might have been expected, and has no connexion at all with those to be described below.

Until fifteen years ago it was considered that the so-called single substances were completely understood, and that no new aspects remained for investigation. The connexion between the different aggregations of a single substance was indicated simply by a diagram on which the vapour pressure curves and melting-point curves were drawn, or in other words, by indicating how the vapour pressure changes with temperature and how the melting-point changes with pressure. Such a diagram shows that the vapour pressure of the liquid or of the solid state, at a certain temperature, has a constant value, and the same holds for the melting-point at a definite pressure. As, however, in some cases it was found that the vapour pressure could be changed without altering the temperature, and that the melting-point could be altered without changing the pressure, and that in certain cases the transition temperature could be shifted, it was clear that something was lacking in our knowledge of the states of aggregation.

Some of these phenomena to which I refer are described below. It was found that by partial distillation of most carefully purified crystalline violet phosphorus at 360°, a residue was obtained showing a much lower vapour pressure than the original substance. The original violet phosphorus at 460° had a vapour pressure of 3 atmospheres, whilst the vapour pressure of the residue at the same temperature was 1 atmosphere (*Zeitsch. f. phys. chem.*, 91, 249, 1916; "The Theory of Allotropy," p. 214). Further, it was found that the melting-point of violet phosphorus was considerably lower when the substance was slowly heated, than that observed when the heating was carried out quickly. The maximum difference observed was about 20°, and the melting did not take place at a constant temperature, but over a range of temperature (*Zeitsch. f. phys. chem.*, 91, 249, 1916; "The Theory of Allotropy," p. 195).

In the same way, according to the previous history of the substance, the fat trilaurine could be caused to melt, arbitrarily, at any temperature between 18° and 46°. Rhombic sulphur showed similar results, but on a small scale. As regards the transition phenomenon mentioned above, it was found that according to the rate of cooling the transition temperature of mercury iodide could be raised some degrees ("The Theory of Allotropy," pp. 188, 193, 201, 206), and the same holds for the transformation of β-crystobalite into α-crystobalite, where the effect is more marked. Two crystalline modifications of silica prepared at 1600° showed that the transformation $\beta \rightarrow \alpha$ had already taken place about 18° above the temperature at which the change in material prepared at 1000° occurs.

It is evident that a change of the vapour-pressure of the liquid state causes a change in the boiling-point; consequently a change of the boiling-point indicates that the vapour-pressure of the liquid is altered. A change of the vapour-pressure of the liquid causes also a change of the melting-point, unless the new vapour tension of the solid state has accidentally such a value that the new vapour tension lines of liquid and solid meet at the ordinary melting temperature.

As regards changes of the boiling-point, most interesting results were obtained by H. B. Baker and Mrs. Baker (*Trans. Chem. Soc.*, 51, 2339, 1912). They found that while pure, not intensively dried nitrogen trioxide boils under atmospheric pressure at −2°, the intensely dried liquid, freed from the last traces of water by phosphorus pentoxide, boiled at +43°, that is, 45° higher. With nitrogen tetroxide they obtained a similar result, the boiling-point of the intensely dried liquid having risen more than 47°.

These investigations were the beginning of a series of still more important experiments, carried out by Baker (*Trans. Chem. Soc.*, 121, 568, 1922) on the intensive drying of ten liquids and some solid substances of very different character. The examination of these substances, being postponed by the War much longer than was intended, was delayed eight or nine years. The result was that all the liquids showed a great rise of boiling-point. For example, the boiling-point of benzene had risen from 80° to 109°, that of ethyl alcohol from 78·5° to 138°, that of ethyl ether from 35° to 83°, that of hexane from 68·4° to 82°, that of bromine from 63° to 118°, and that of mercury from 358° to 420°.

Further, it was found that if these intensively dried liquids were allowed to take up a trace of water-vapour, for which purpose contact with ordinary dried air (air which had been passed first through concentrated sulphuric acid and then over phosphorus pentoxide) was sufficient, the liquids regained their original state with the normal boiling-points. In some cases, as with alcohol, the normal state was reached in twenty-four hours, but with benzene it required a month.

At first sight it might be thought that this phenomenon is a simple superheating of the liquid. Indeed it is well known that if a liquid and the wall of the vessel containing the liquid are freed from gases, it is possible to heat the liquid some degrees above the normal boiling-point before boiling occurs. Now if intensive drying facilitates this phenomenon, Baker's results might be described to superheating. For those who are not familiar with the phenomenon of superheating, it may be mentioned that should anyone succeed in heating water in an open vessel, for example, up to 130°, it would be most necessary for the experimenter to place it under cover, since that at any moment an intense and explosive boiling might take place (explosion of boilers). Taking now into consideration the fact that boiling-points up to 60° above the normal boiling-points were observed by Baker and that the boiling took place very quietly, then it is clear that considerable superheating was altogether out of the question. Corresponding to this, Baker found that at the same temperature intensively dried ether showed a lower vapour-pressure than the moist liquid. The vapour-pressure is a quantity which can be accurately measured, and since a decrease of vapour-pressure corresponds to a rise of the boiling-point, it was proved that the phenomenon observed by Baker was the result of a change of the state of the substance involving a change of the vapour-pressure. That the state of the substance is really changed by intensive drying followed from the results obtained by determining the mean size of the molecules in the intensively dried liquids, for which values were found 2 to 2·5 times as large as in the moist liquids. Consequently, association or polymerisation had taken place.

These results, being completely unsuspected and lying far beyond the horizon of current conceptions, were at the time not generally accepted. It was not possible to say how Baker could have erred, but one could simply not believe that the properties of a substance could change so much.

Though chemists and physicists in general were sceptical, in the chemical laboratory of the University of Amsterdam the results obtained by Baker were received with great enthusiasm, since there in 1911 a theory had been put forward by means of which such results could be easily explained. Baker's results were, indeed, a valuable confirmation of the new theory ("The Theory of Allotropy," 1922).

This theory assumes that every state of aggregation, even of the most simple substance, in reality is complex, that is to say, it is built up of molecules of different kinds. Taking, for example, benzene, it is assumed that in each state of aggregation, namely, gaseous, liquid, and solid, it consists of different kinds of molecules. For simplicity only two different kinds of molecules are assumed, indicated by the indices α and β, thus $C_6H_6\alpha$ and $C_6H_6\beta$. In general, we cannot say beforehand in what way these kinds of molecules will differ. First, it is possible that these molecules are equal in size but different in structure, and these differences may be very small. Secondly, the molecules may be of different size. With benzene it is probable that the different kinds of molecules differ in size, and for simplicity we shall assume here that one kind is a simple molecule, C_6H_6, and the other kind is an associated molecule $(C_6H_6)n$, formed by combination of n simple molecules to form a new large molecule. Let us consider now pure benzene. This liquid boils at 80°. Supposing we had a liquid consisting only of simple molecules C_6H_6, then this liquid would be more volatile, would have a higher vapour-pressure and a lower boiling-point than ordinary benzene, let us say 70°. If we had, on the other hand, a liquid containing only the larger molecules $(C_6H_6)n$, this liquid would be much less volatile, and would have a much higher boiling temperature, let us say 150°. Ordinary benzene boils at 80°, since in this liquid, molecules of the liquid boiling at 70° and molecules of the liquid boiling at 150° are present side by side.

It is natural then to ask: Is benzene a mixture? Certainly it is, for that is exactly what these considerations indicate. Benzene vapour and benzene liquid are gaseous and liquid mixtures, and crystallised benzene, that is to say, every crystal of the solid state, is also a mixture, namely, a mixed crystal, but, as we shall see, they are not ordinary mixtures.

By adding water to alcohol we obtain an ordinary mixture, and the properties of that mixture depend on the proportion in which the substances are mixed. A certain mixture begins to boil at a definite temperature, begins to solidify at a definite temperature, and shows a definite vapour-pressure at a certain temperature. The property by which a liquid is known as a mixture is this, that by distilling off a portion, or by solidifying a part, we obtain a liquid of different composition and therefore different boiling-point, different vapour-pressure, and different solidifying point. The easiest manipulation is partial distillation. Applying this method, for example, to a mixture of equal quantities of water and alcohol, then a vapour escapes which is richer in alcohol than the liquid, and the remaining liquid has become poorer in alcohol, effecting a decrease of the vapour tension and an increase of the boiling-point.

This decrease of the vapour-pressure and increase of the boiling-point by partial distillation is a characteristic property of a mixture. If a solidifying mixture gives mixed crystals—*i.e.* crystals in which all the substances we have mixed are present, just as every drop of a liquid mixture contains each part present (a mixture of chlorine and bromine is a very good example)—then for these mixed crystals this rule holds just as for liquid mixtures, namely, by partial distillation the vapour tension is decreased.

It is mentioned above, however, that pure benzene is a mixture. Yet if benzene is submitted to partial distillation the properties of the liquid are not changed at all. Vapour-pressure, boiling-point, melting-point are exactly the same as before. What is, then, the explanation of this behaviour, which is characteristic of a true simple substance, whilst benzene is not simple? It seems indeed a contradiction, but it is not so. Although benzene is composed of different kinds of molecules, it behaves as a single substance, on account of the great velocity with which these kinds of molecules are transformed in each other. These mutual transformations are indicated in the following way:

$$nC_6H_6 \rightleftarrows (C_6H_6)n.$$

These two very rapid opposite reactions lead to a so-called equilibrium, in which the proportion between the single and the associated molecules, or the composition, has a definite value at constant temperature and pressure. If we have to do with ordinary dried benzene, we have no means of changing this composition, temperature and pressure remaining constant. Let us assume we had an instrument which enabled us, just as a stork catching fish from the water, to catch up and carry off the large molecules in liquid benzene. Still we should not succeed in making the remaining liquid poorer in big molecules, for so soon as the number of large molecules is decreased the small molecules will be associated to form large molecules, until that proportion between small and large molecules is reached which corresponds with the inner equilibrium.

By distilling benzene as rapidly as possible a similar process occurs; the smaller molecules are more rapid than the large ones, and in consequence of this the smaller molecules will leave the liquid surface in greater numbers per second than the large molecules. Notwithstanding this the liquid does not get poorer in small molecules, since the larger molecules dissociate until the proportion of the different kinds of molecules, corresponding with the inner equilibrium, is reached.

According to these considerations, a so-called simple substance is in reality a mixture, not an ordinary one, but a mixture with an inner equilibrium. Now it is evident that if we were able, for example, in the case of benzene to withdraw the big molecules with a velocity greater than the velocity with which they are formed again, the properties of benzene would change. But in most substances these inner transformations are so rapid that an artificial change of the composition is impossible.

We can say, consequently, that it is the rapid establishment of the equilibrium between the different kinds of molecules of the same substance (inner equilibrium) which makes a substance such as ordinary pure benzene, behave as a true single substance.

Considering the results of Baker's experiments from this point of view, it is not difficult to give an explanation of them. Only one very probable supposition is to be made, namely, that the process of intensive drying effects a decrease of the velocity of the transformation between the different kinds of molecules, and that finally the transformation is stopped completely.

In benzene, not intensively dried, the two opposite rapid transformations,

$$nC_6H_6 \rightleftarrows (C_6H_6)n$$

are taking place, but in intensely dried benzene these transformations take place no longer, and the arrows have no longer any signification; the two kinds of molecules have become strangers to each other; *i.e.* intensively dried benzene has become an ordinary mixture.

What can we say now of this mixture? We have already mentioned above that a liquid consisting exclusively of the small simple molecules, C_6H_6, would be more volatile and would boil perhaps at 70°, whilst a liquid containing only the big, associated, molecules $(C_6H_6)n$ would be much less volatile and would boil perhaps at 150°. From this it follows that when, by intensive drying, benzene has become an ordinary mixture, it is a mixture of two substances differing greatly in volatility. Heating this mixture in an open vessel, then, as in most cases, principally the more volatile part will escape, by which the remaining liquid becomes richer in the less volatile part, and when the boiling-point is reached the liquid, considerably enriched in the less volatile and higher boiling part, will begin to boil at a temperature higher than the boiling-point of moist benzene.

This explanation has been tested and confirmed (*Jour. Chem. Soc.*, 125, 1068, 1924), but in addition another supposition has been confirmed, namely, that the process of intensive drying effects more or less a change in the proportion between the different kinds of molecules at the drying temperature; *i.e.* it effects a change of the inner equilibrium (*Jour. Chem. Soc.*, 128, 2655 and 2657, 1926). It seems that with the progress of the drying process the molecular proportion mentioned above changes gradually more or less; this is accompanied by a decrease of the velocity of the two opposite transformations, until finally *they are stopped completely*. Now it will be clear that the theory is also capable of explaining the phenomenon noted already in the solid state of some substances, for the theory states that every state of aggregation, consequently also the crystalline state of a so-called single substance, is built up of different kinds of molecules. The crystalline state of a single substance is consequently a mixed crystal, not an ordinary one, but a mixed crystal in inner equilibrium.

As I have observed already, the velocity with which the inner equilibrium between the different kinds of molecules is established in the different states of aggregation, seems to be a very characteristic property of substances, so that we can speak of rapid and slow substances. Rapid substances can undergo rapid changes without coming out of inner equilibrium, but slow ones can be disturbed. In the light of these new considerations, the results obtained with violet phosphorus can be explained easily. Violet phosphorus is a slow crystalline substance; it is a slow mixed crystal, and therefore evaporation at relatively low temperatures will cause the remaining mixed crystal to become poorer in the most volatile molecular species, thereby decreasing its vapour tension.

Another phenomenon, mentioned already, showing that the melting-point and transition-point depend on the previous history, can also be predicted by the theory. If the pressure is kept constant and the temperature is changed, it will of course depend on the velocity with which inner equilibrium is established and the rate of change of the temperature, whether for practical purpose inner equilibrium always exists. If the temperature changes so rapidly that the inner equilibrium cannot adjust itself to it, inner equilibrium is not realised, but disturbed conditions are obtained, which are naturally metastable, and the properties of these states, such as specific gravity, solubility, transition-point, melting-point, boiling-point, etc., will deviate from those of the inner equilibrium state. In connexion with this it is clear that it is very difficult or impossible to show complexity with rapid substances. It is easily understood, therefore, that complexity is apparent only in rather slow substances, and as most substances are rapid, the complexity was only proved in a relative small number of cases.

It will be evident now how valuable it is to have a means by which it is possible to change a rapid substance into a slow substance, and finally to bring all inner molecular transformations to rest. A substance to which this has been applied with great success is sulphur trioxide (*Jour. Chem. Soc.*, 125, 2554, 1924; 128, 1108, 1603, 1926). The intensely dried crystalline state has been studied in detail and the phenomenon already found with violet phosphorus was observed here in a marked degree. It was found that sulphur trioxide, dried for one month or longer in a certain way with freshly distilled, purest, very fine phosphorus pentoxide, becomes so exceedingly slow that it behaves distinctly as a mixture. Since the range of temperature and pressure within which that behaviour reveals itself is much more easily approached than in the case of phosphorus, it could be studied more closely. Thus we could obtain by partial distillation substances of nearly every lower vapour-pressure and, within wide limits, of varying melting-points. The vapour-pressure could at 50° be reduced to 1/15 of its normal value, whilst the melting-point could be raised from 62° to 95°, an increase of no less than 33°. The melting process in such a crystalline state, which has been much changed by partial distillation, is rather dangerous, since in the liquid formed, notwithstanding the intensive drying, in consequence of the higher temperature, inner transformations take place very rapidly. This causes a rapid increase of vapour-pressure, so that the chances are that the apparatus will burst.

The influence of X-rays on such markedly changed crystalline states is also noteworthy. We found that X-rays affect not only the establishment of the inner equilibrium, but also the transformation of the metastable forms into the stable modifications. I have referred here to the phenomena, observed with phosphorus and sulphur trioxide, but recently we have found analogous phenomena with a number of other substances such as phosphorus pentoxide, nitrogen tetroxide, hexane, benzene, etc.

All these phenomena show the complexity of the so-called simple substances, and we may expect that other substances in the intensely dried state will also show complexity, for there is little doubt that complexity is a general phenomenon. Whilst the old ideas of allotropy are completely powerless to explain these phenomena, they give strong confirmation to the principles on which the theory of allotropy is built, while the new phenomena can be explained completely by this theory. The new theory of allotropy shows among other things that in the most simple case the vapour-pressure lines and the melting-point line of a so-called single substance belong to a pressure-temperature-composition model in three dimensions, in which the two different kinds of molecules are the components. These lines take up a particular place in this space model, since they indicate the phases which are in inner equilibrium. But the whole space model refers to the field of the so-called single substance. When the substance is indeed completely dry and inner transformations are stopped, the whole domain of the substance can be studied. So long, however, as the intensive drying is not complete and the inner transformations are only strongly retarded, the same space model shows which phenomena may be expected. As to the different kinds of molecules, I have pointed out that the reason for the existence of these different kinds of molecules must probably often be sought in the existence of different kinds of atoms (*Ber. Sächs. Akad. Leipzig*, 75, 58, 1923), and in connexion with this it is interesting that recently, from the side of physicists, the same assumption has been made on quite different grounds (de Haas, *Kon. Akad. Amsterdam*, 1926).

Finally, to prevent confusion it is necessary to direct attention to the following points. Recently, papers have been published referring to experiments on the influence of 'traces' of water on different properties of substances, as for example solubility, etc. It will be sufficient to state here that these experiments deal with substances containing 'traces' of water *many thousand times* larger than in our cases of intensive drying and are consequently in quite a different field.

From the preceding considerations it follows that whilst for several years the so-called single substances were considered to have been completely investigated, and it was believed that new points of view could only be obtained by the study of more complicated systems, the close study of these single substances has recently become extremely interesting. From the new point of view already reached, the phenomenon of allotropy with all the various phenomena associated with it and the influence of intensive drying can be surveyed.

In conclusion, one among several interesting questions may be put forward here. Consider for a moment a substance such as benzene, which has become an ordinary mixture by intensive dryings. Benzene is one among the large number of substances for which, after drying in the ordinary way, various physical constants, such as critical-point, melting-point, vapour-tension, specific weight, etc., are determined. Now it cannot be said that these constants have no value; on the contrary, they are very valuable, but they are not physical constants of the pure substance but of impure benzene, contaminated by an extremely small trace of water. Before the phenomena to which I have referred above were known, one would have attached little value to this observation, and one would have answered, that such an extremely small contamination cannot have any perceptible influence and can therefore be neglected. This is quite true, speaking of contamination in general, but now we know that water is a very special contamination, for on removing it completely, benzene becomes an ordinary mixture and our physical constants are no longer suitable. Thus the new theory opens up another field for investigations, on which many generations of scientific workers may carry out important research. In future the so-called single substances will be really purified, which means they will also be dried intensively. From the mixtures obtained in this way the components will be separated and studied carefully. Thus the components of a so-called simple substance will be discovered, and no doubt will often cause great surprise, since big and noteworthy differences may exist between the different kinds of molecules.

Sea-birds: Their Relation to the Fisheries and Agriculture.

By Dr. WALTER E. COLLINGE.

UNDER the above title in NATURE of April 8, 1920 (pp. 172-173), I gave a brief résumé of an investigation on the economic status of the commoner species of sea-birds of Great Britain then being carried out under the auspices of the Carnegie Trust for the Universities of Scotland. In that investigation, large series of each species from various localities during each month of the year were examined, and the food content of the stomach was estimated by the volumetric method. The investigation has now been completed, and a final résumé of the more important results may not be without interest. In all, nineteen species were examined, embracing 2309 specimens.

One of the most striking facts shown by this work is the very small percentage of fish consumed by the common gull, the herring gull, the black-headed gull, the common tern, the little auk, and the puffin. Hitherto, it has been generally assumed that all sea-birds feed upon fish, and that this item of their diet constituted the bulk, but such is far from the case. Of the total bulk of food consumed in a year, fish constitutes only 5·16 per cent. in the common gull, 18·20 per cent. in the herring gull, 3·73 per cent. in the black-headed gull, 18·01 per cent. in the common tern, 1·17 per cent. in the little auk, and 22·22 per cent. in the puffin. In the first three species, much of this small percentage of fish is obtained from shore refuse.

The case of the black-headed gull is most striking and significant. As a destroyer of injurious insects it is a most valuable bird, 24·70 per cent. of its food being of this nature, which is more than that consumed by either the rook or the blackbird. It also takes 4·38 per cent. of neutral insects and 0·19 per cent. of beneficial ones. The nature of the insect food is of considerable interest, both on account of the enormous amount that is consumed, and the particular species. Of these latter, it must here suffice to state that upwards of sixty different species were identified.

Respecting the bulk of food, accepting Newstead's computation that each bird feeding upon crane-flies will consume some 4000 per day or 28,000 per week, the total quantity destroyed must be enormous. On the Fifeshire coast we have estimated in passing from field to field that at least 5000 birds were present on the land ten miles south of St. Andrews. Such flocks would consume 140,000,000 insects in a week. This, however, is only on a small area. All along the coast and farther inland the same thing is taking place, so that the amount of insect life consumed must be prodigious. Moreover, it must be borne in mind that the percentage of cereals destroyed by this species is only 0·37 per cent. A similar striking record can be shown for the other five species mentioned.

Of the fish consumed, 27 species were identified. The highest percentage consumed of any one species was 9 per cent. in the case of the greater sand eel, 8 per cent. of the lesser sand eel, 6·5 per cent. of the gurnard, and 6 per cent. each of cod and herring; haddock follows with 5·5 per cent., and then gunnel and sprat each 3·5 per cent.; of flat fishes (all species), only 2·5 per cent. was present. Practically the whole of the food of the cormorant, shag, gannet, goosander, red-breasted merganser, and great skua consists of fish, whilst 50 per cent. of the same item forms the food of the guillemot and the black-throated and great northern divers.

The bulk of the fish-food consumed by the nineteen species of birds investigated consists of species that are exceedingly common and also plentiful. There is no scarcity of these fishes, and were they still more plentiful they would in all probability only form additional food for predaceous fishes, and thereby add to the increase of a factor over which man has little or no control.

Of the 2309 stomachs examined, 422 were empty or nearly so. It would seem that if there is any scarcity or lack of food, the female bird is the one to suffer, for of 97 partly filled stomachs of the herring gull, 70 per cent. were of female birds and 30 per cent. males; whilst of 68 empty stomachs 60 per cent. were of females and 40 per cent. males. Of 123 partly filled stomachs of the black-headed gull 73 per cent. were of female birds and 27 per cent. of male birds, and of 82 empty stomachs 65 per cent. were of females and 35 per cent. of males. Only 16 guillemots were obtained with empty stomachs, and here again 75 per cent. were of female birds and 25 per cent. male. Of the remaining empty or partly filled stomachs of eleven species, namely, thirty-six in all, 62 per cent. were of female birds and 38 per cent. of males.

The range of variation of the food according to locality is interesting. Of the 539 herring gulls examined, 351 were obtained on the coast, or nearby, and 188 were obtained from agricultural districts. In the former, food fishes constituted 13 per cent. of the total food consumed, other fishes 4·7 per cent., and injurious insects 14·1 per cent. Those from agricultural districts gave the figures 9·2 per cent. of food fishes, 7·2 per cent. of other fishes, and 12·5 per cent. of injurious insects, showing that the diet of this species gives only a small range of variation. With the black-headed gull the figures are more striking. Those from the coast show 11·5 per cent. of food fishes, 8·3 per cent. of other fishes, and 24 per cent. of injurious insects. From agricultural areas the percentage of food fishes is only 4, other fishes 2, and injurious insects 32·7.

In all the gulls, annelids, crustaceans, molluscans, echinoderms, etc., figure largely, and in nearly all cases a considerable percentage of this is obtained from shore refuse. In the common gull the percentage is 60·69, the herring gull 48·36, the lesser black-backed gull 39·75, and the black-headed gull 44·04.

For the first time we have a volumetric analysis of the food of the common tern, and the results are all in this bird's favour. The whole of the food is of an animal nature, and 53·70 consists of fish. Of this item 18 per cent. is made up of food-fishes and 35·70 per cent. of non food-fishes. Summarising the figures for the total food content, it is shown that 81·99 per cent. of the food is of a neutral nature, and (if we regard the food-fishes eaten as an injury) 18·01 per cent. injurious. It is very significant that no traces of fresh-water or flat fishes were met with.

As a result of this investigation, and the expression of opinion of those who have devoted a lifetime to fisheries investigation, we are of opinion that no action of sea-birds can produce any appreciable effect upon the plenitude of the fishes of the sea. Moreover, many of the species of birds are exceedingly valuable from an agricultural viewpoint, and their wholesale destruction may be fraught with the gravest possibilities.

Obituary.

PROF. C. J. EBERTH.

PROF. CARL JOSEF EBERTH, whose death occurred in Berlin at the beginning of December, was born in 1835 and completed his ninety-first year last September. His earlier work was carried out in Zürich, but for many years he held the post of professor of pathological anatomy in the University of Halle. Zoology, anatomy, histology, pathological anatomy, and bacteriology were all enriched by his researches, and his published papers include investigations on nematode worms, fœtal rickets, the structure and development of blood capillaries, thrombosis, the histology of the lung and liver, mitosis, and on inflammation.

Eberth's name is probably best known in connexion with the discovery of the bacillus of typhoid fever. In 1880 and 1881 he published papers in Virchow's *Archiv* describing a bacillus which he found present in the spleen and mesenteric glands of cases of typhoid fever. The bacilli occurred in scattered groups, and were not distributed generally in the tissues, and appeared to be characteristic and distinct from other organisms which were occasionally seen. Of 40 cases of typhoid fever investigated, this bacillus was found in 18 only; it was also absent from 24 cases of tuberculosis and other diseases. Koch, about the same time, also noted the presence of a similar bacillus in typhoid cases and published photo-micrographs of it. Gaffky, in 1884, confirmed Eberth's observations, finding the bacillus in 26 out of 28 cases of typhoid fever investigated, and isolated and cultivated the organism, which since has sometimes been known as the Eberth, or Eberth-Gaffky, bacillus.

Prof. Eberth, who had lived in retirement for many years, was created a "Geheimrath," and a *Festschrift*, with excellent portrait, was dedicated to him on the occasion of his ninetieth birthday last year (*Beiträge zur path. Anat.* Bd. 74, 1925). R. T. HEWLETT.

MR. LESLIE D. CURRIE, palæontologist on the staff of the Burmah Oil Company, was drowned while bathing in Burmah on November 9. Mr. Currie had only three weeks before arrived in the country, after a brilliant career in the University of Glasgow, during which he had done some promising research work on some undescribed Silurian Crustacea. His death, at the age of twenty-two years, removes a palæontologist of great promise.

WE regret to announce the following deaths:

Dr. Walther Bremer, Keeper of the Irish Antiquities in the National Museum, Dublin, whose archæological work included the identification of Asturian flints at Island Magee.

Dr. Franz Exner, emeritus professor of physics in the University of Vienna and a member of the Vienna Academy of Sciences, on November 15, aged seventy-seven years.

Dr. James F. Kemp, professor of geology since 1891 in Columbia University, distinguished for his work in economic geology, on November 17, aged sixty-seven years.

Dr. C. L. Withycombe, formerly of the Imperial College of Tropical Agriculture, Trinidad, and recently appointed lecturer in advanced and economic entomology in the University of Cambridge, on December 5, aged twenty-eight years.

News and Views.

THE congratulatory dinner given at Cambridge on Saturday last to Sir J. J. Thomson, Master of Trinity, will long be cherished in the memory by all who were privileged to take part in it. The occasion was Sir Joseph's seventieth birthday, and the celebration was arranged by the Cavendish Society, which consists of past and present students of the Cavendish Laboratory, together with members of the staff. Sir Ernest Rutherford occupied the chair, and about 130 other members of the Society were present, while numerous messages of affection and esteem were sent by old students who are carrying on the Cavendish tradition of faithful work and productive insight in many parts of the world. To all of these, 'J. J.' is, what man finally became to Wordsworth, "an object of delight, of pure imagination and of love." He is the uncrowned king of physical science, and it is an honour and an inspiration to have come within his sphere of influence. Something of the spirit of devotion which he creates in all who have been associated with him is expressed in the following address, which was presented to Sir Joseph at the dinner, bearing the signatures of 230 of his disciples :—

"WE, the past and present workers in the Cavendish Laboratory, wish to congratulate you on the completion of your seventieth year. We remember with pride your contributions to theoretical and experimental physics, and especially your pioneer work on the structure of the atom. The additions you have made to knowledge are conspicuous even in this age of remarkable achievement, and have profoundly influenced the history of science. Succeeding to the Chair of Clerk Maxwell and Lord Rayleigh, you have made the Cavendish Laboratory, during your forty-six years' association with it, an unrivalled centre of intellectual activity. We, who have had the privilege of working with you, cannot adequately measure our debt. We can only express our grateful appreciation of the help, encouragement, and friendship given so freely to all your students, and our hope that you may long live to be an inspiration to the Cavendish Laboratory and the whole world of physical science."

IN presenting this address, together with two silver caskets to Sir Joseph and Lady Thomson, Sir Ernest Rutherford related some personal reminiscences of the years—"the happiest in my life"—spent with 'J. J.' in the Cavendish Laboratory, of which he is now the director, and so successfully penetrating into the innermost courts of eternal wisdom. Prof. P. Langevin, representing men of science from other lands, who have worked in the laboratory and been admitted to the freedom of its fellowship, paid a charming tribute of affection to the guest of the evening. Sir Joseph expressed his thanks in an eloquent speech in which, in generous words, he referred to the unselfish support he had received from all members of his staff, and to the ever-expanding field of scientific research which can never be a terminus but is always revealing new avenues to be explored. The toast of "The Old Cavendish Students" was proposed by Dr. A. Wood, who, with Mr. H. Thirkill, organised the dinner; and Sir Arthur Schuster, Sir Richard Threlfall, and Prof. F. Horton, in acknowledging it, bore grateful testimony to the stimulating influence of the laboratory and its directors upon successive generations of students. All who have worked within its walls have acquired a quality of spiritual radioactivity which makes for light and leading wherever they go. But though they take away this emanation with them, there is no weakening of the parent source, which, we are sure, will continue to illuminate the road along which science advances to secure increase of knowledge for the benefit and admiration of posterity.

THE Council of the Physical Society, at its meeting on December 10, awarded the fourth Duddell medal for meritorious work on scientific instruments and materials to Mr. F. Twyman. The firm of Adam Hilger, Ltd., of which Mr. Twyman has for many years been both managing and technical director, enjoys a reputation for the production of optical instruments employed in physical research which is not approached by that of any other firm in Great Britain or any other country. The fundamental researches which have led to the formation of the current conceptions of the nature of matter have been carried out to a large extent with the aid of instruments of the necessary high degree of precision constructed in the Hilger workshops. The production of these instruments has frequently involved the solution of problems which have only been met successfully through Mr. Twyman's persistence and resourcefulness.

IN addition to the services rendered to the cause of pure science, Mr. Twyman has carried out notable work on a number of technical problems. Two may be specially mentioned. His investigations on the annealing of glass (which incidentally led to Twyman's Law on the influence of temperature upon the mobility of the melt) are of fundamental importance, and his instruments for controlling this operation have been of service to all branches of the glass-making industry. These investigations have been an important factor in securing home supplies of reliable glass-ware for scientific purposes. Moreover, during the War, they led to a notable increase in the output of optical glass, by substituting for the traditional routine a novel scheme of annealing, which, without any deterioration in the quality of the product, enabled the time occupied in this operation to be greatly reduced. As another example of technical work, the extensive series of Hilger interferometers may be mentioned. The Michelson type of interferometer has been modified and adapted to a large number of special uses of interest to the optical industry. By the use of these instruments accurate measurements can now be made of the defects of all manner of optical parts and instruments, whether these defects are due to faulty design, imperfect workmanship, or defective material. It is characteristic of Mr. Twyman that these new instruments were immediately used not merely to measure the defects, but also as a means of removing them.

AT the present time, no problem interests electrical engineers more than the question of the best type of main to use for the underground distribution of electrical energy. In many towns, even the suburban districts are so built over that the use of overhead lines is quite out of the question. As the load increases, the necessity of using very high pressures becomes urgent. It is common knowledge that some of the high-tension mains laid in Great Britain have given a great deal of trouble owing to breakdowns. The paper read to the Institution of Electrical Engineers on December 16 by Colonel E. Mercier on the 60,000-volt underground network operated in Paris by the Union d'Électricité was therefore of great value. The system of distribution most favoured at present is the three-phase system. There are three distributing mains which can either be bound together so as to form a single cable called a three-core cable, or three separate cables can be used. The former solution is that generally adopted in Britain, and the latter is the one adopted in Paris. When they are bound together they can be handled more expeditiously, but there are a few drawbacks. The carrying capacity of the cables is limited by their temperature rise. The heat generated in three-core cables has greater difficulty in getting conducted away, and so they carry less current in proportion. The predetermination of their carrying capacities and breaking-down voltages presents much greater difficulty. The rotating electrostatic fields produced in these cables also produce dielectric losses. The great steam-driven station at Gennevilliers in Paris in linked with the station at Vitry and will soon be connected with the hydro-electric station at Eguzon on the River Creuse. The total power of these stations is nearly 500,000 kilowatts. The network connects a ring of distributing stations round the city of Paris. The company's engineers have recently examined the best types of three-core cable and have reported adversely on them for their extensions. They consider that single cables involve a smaller initial outlay, are more trustworthy, and are easier to repair.

THE annual Philosophical Lecture of the British Academy under the Henriette Hertz Trust is always an event of much interest. This year's lecture, which was given in the rooms of the Royal Society on Wednesday, December 15, was no exception, as the lecturer, Prof. T. Percy Nunn, Principal of the London Day Training College, is a man of outstanding ability and experience in the realms of education, mathematics, and philosophy. The subject of the lecture was "Anthropomorphism and Physics." By anthropomorphism Prof. Nunn stated that he means, broadly, the 'projection' of any human character into the non-human world, and in this way it is a trait of primitive mentality which still colours man's dealings with his environment. As Prof. Nunn showed, it has played an important part in the history of science, and even some of the technical vocabulary is an indication of the way in which the human point of view can be projected. Prof. Nunn pointed out that to some, the theory of relativity allows for an anthropocentric view of Nature; whereas the truth about the modern theory of relativity is that it is really one more step further away from the old anthropomorphic ideas, emancipation from which was begun by the work of Copernicus. Prof. Max Planck has said that physical science can only reach unity by eliminating all anthropomorphous elements. The main purpose of the lecture was to inquire how far this elimination can proceed. The first step is to seek a tenable theory of physical objects which presumes the objective existence of secondary qualities; such theories have been formulated by the Realists. The next step is to raise the question of the reality of such objects as electrons which physics offers. The tendency of recent attempts to overcome such difficulties is to show that physics has no need of the hypothetical forms of matter which have been claimed as the reality behind the apparent world.

ANCIENT surveying instruments were described by Sir Henry Lyons in a lecture to the Royal Geographical Society on December 13. In Egypt, records of land measurements are found from very early times, although no map of landed property in ancient Egypt has survived. The marking of province boundaries was also recognised as being of great importance, and operations of levelling reached a satisfactory accuracy, as can be gauged from the rock pavement on which the great pyramid was built. In ancient Egypt the instruments employed in land survey were very simple, and included probably only the measuring cord of 100 cubits, the measuring rod, and the *merkhet* for laying out lines in any desired direction. The *merkhet* consisted of a plumb-line hanging from a holder, which was aligned on any object by looking through a sight vane made of a cleft stick. The levelling instrument was probably a right-angled isosceles triangle of wood with a plummet attached to the apex. In use it was placed on a long wooden straight-edge resting on pickets. Probably not until Greco-Roman times was another instrument, the *groma*, introduced. Egypt may have been its place of origin, but the Romans used it widely. The *groma* consists of two pairs of plumb-lines suspended from the ends of two rods at right angles to one another. Some of these instruments of different designs have been recovered.

ON Tuesday, December 14, a new research laboratory for physical and inorganic chemistry was opened at East London College by Mr. E. de Q. Quincey, the chairman of the College council. This laboratory is the gift of Mr. and Mrs. Henry Cohen, of Beckenham, and is a memorial to their son David, a former student of the College, who died in May 1925. The laboratory is equipped for research work in physical and inorganic chemistry and chemical microscopy, and contains a small library, also the gift of Mr. and Mrs. Cohen. Mr. Quincey, in accepting the gift on behalf of the College council, pointed out that it was a valuable appreciation of the necessity of assisting advanced work at the College, and expressed the hope that other old students would follow this excellent example. The

Principal of the College and Prof. J. R. Partington, in whose department the new laboratory is situated, both emphasised the importance of a period of study after graduation to students entering industry or the teaching profession.

In the House of Commons on December 15 Mr. W. Baker asked the President of the Board of Education whether his attention had been directed to the planetarium invented by the firm of Zeiss and erected by the Düsseldorf Corporation. The firm declines to supply these structures to any one proposing to make a profit, and having regard to educational possibilities and the poverty of educational authorities, Mr. Baker asked whether the Board would consider the purchase for educational purposes of at least one planetarium. The Duchess of Atholl, Parliamentary Secretary to the Board of Education, who replied, stated that the Board of Education has no power under the Education Act, 1921, to make a purchase of this kind. Two years ago a planetarium was installed at Munich, and a description of the apparatus appeared in NATURE of December 27, 1924, p. 937. According to a letter from Dr. J. Jackson in the *Times* of December 20, the success of this instrument led Messrs. Zeiss to build a larger and improved planetarium for Jena, while similar instruments have been made, or are on order, for Barmen, Berlin, Dresden, Düsseldorf, Hamburg, Hanover, Leipzig, Mannheim, Nürnberg, Stuttgart, and Copenhagen.

At the ordinary scientific meeting of the Chemical Society held on December 16 the president, Prof. H. Brereton Baker, announced that the Council had unanimously resolved to award the Longstaff medal for 1927 to Prof. Robert Robinson of the University of Manchester for his distinguished researches in organic chemistry. It was also announced that, in accordance with the terms of the trust-deed establishing the Edward Frank Harrison Memorial Prize, the selection committee, consisting of the presidents of the Chemical Society, the Institute of Chemistry, the Society of Chemical Industry, and the Pharmaceutical Society, had met to consider applications for the Harrison Memorial Prize. This prize, it will be recalled, is awarded to the chemist of either sex, being a natural-born British subject and not more than thirty years of age, who in the opinion of the selection committee has, during the past five years, conducted the most meritorious and promising original investigations in chemistry and published the results of those investigations in a scientific periodical or periodicals. The selection committee has unanimously resolved that the prize for 1926, of the value of 150*l*., should be awarded to Dr. Charles Robert Harington of University College, London. Dr. Harington has within the last five years synthesised the active principle of the thyroid gland (thyroxine); he has determined its constitution and worked out a practical process by which it may be produced on a large scale. This artificial product has been found to have the same physiological efficacy as the active principle in the natural extract. The presentation of the Longstaff medal and of the Harrison Memorial Prize will take place at the annual general meeting of the Chemical Society on March 24, 1927.

The Kamerlingh Onnes Memorial Lecture of the Chemical Society will be delivered by Prof. Ernst Cohen of Utrecht, at the Institution of Mechanical Engineers, Storey's Gate, S.W.1, on Thursday, February 10, 1927, at 8 P.M.

Dr. A. B. Walkom, secretary of the Linnean Society of New South Wales, has been granted twelve months' leave by the council of the Society to enable him to study palæobotany under Prof. A. C. Seward at Cambridge.

Mr. Heron-Allen has presented the Heron-Allen and Earland collection of Foraminifera to the British Museum (Natural History) under conditions which will enable him and his collaborator to keep it up-to-date, with additions and rearrangement. The collection, which numbers between seventeen and eighteen thousand slides, includes the Millett, Siddall, Sidebottom, and other notable collections, and is undoubtedly the largest and most complete in the world.

The annual meeting of the Science Masters' Association will be held at Oxford on January 4-7, under the presidency of Brigadier-General H. Hartley. The meeting includes lectures by distinguished scientific workers at Oxford, and an exhibition of apparatus and books at the Electrical Laboratory, Parks Road. The organising secretary for the meeting is Mr. W. J. Gale, 50 Stanton Road, Wimbledon, London, S.W.20.

The Eastern Siberian section of the Russian Geographical Society announces the celebration of its seventy-fifth anniversary at the end of this month. The occasion is to be marked by various social functions and an exhibition illustrating the results of the Society's work in Siberia. Various publications are also announced, including the fifteenth volume of the *Isvestia*, with a series of historical articles and a volume of general geographical and statistical articles on Eastern Siberia. These publications are apparently to be in Russian.

The Buchan Prize of the Royal Meteorological Society for 1927 has been awarded to Mr. C. K. M. Douglas for the following papers contributed to the *Quarterly Journal* of the Society during the years 1922–25: "Observations of upper cloud drift as an aid to research and to weather forecasting"; "Further researches into the European upper air data, with special reference to the life history of cyclones"; "On the relation between the source of the air and the upper air temperature up to the base of the atmosphere."

An interesting exhibition of some of the results of research recently carried out in adhesives (glues and sticking substances) and their application has been arranged at the Science Museum, South Kensington, by the Adhesives Research Committee of the Department of Scientific and Industrial Research.

This Committee was established by the Department in 1919 to continue the work of the Adhesives Research Committee of the Conjoint Board of Scientific Societies which was set up towards the end of the War to conduct research on adhesives with the aid of a grant from the Ministry of Munitions. The exhibition was opened to the public on Saturday, December 18, and will remain open for some months.

A BROCHURE on electro-medical apparatus by Messrs. Newton and Wright, Ltd., 72 Wigmore Street, London, W.1, gives a fairly complete list of appliances in current use with illustrations and prices. These appliances include portable sets required for administering faradic or galvanic currents. An electro-medical table shown has all the requisite gear for giving both varieties of current from any D.C. supply between 50 and 250 volts. There is also illustrated an "Omnistat" machine in which the motor is an integral part of the apparatus, which is made in two models; the "Standard," providing galvanic and sinusoidal currents; and the "Therapeutic," in which the faradic is substituted for the sinusoidal. Both types are adapted for the inclusion of vibro-massage apparatus.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant master at the Dewsbury Municipal Technical College, with qualifications in physics and electrical engineering—The Secretary for Education, Education Offices, Town Hall, Dewsbury (January 3). An assistant lecturer in physics at the Bradford Technical College—The Principal (January 11). A director of tubercular research in the University of Melbourne—The Agent-General for Victoria, Victoria House, Melbourne Place, Strand, W.C.2 (February 1). Assistantships in the departments of zoology, botany, entomology, and mineralogy of the British Museum (Natural History)—The Director, British Museum (Natural History), South Kensington, S.W.7. A teacher of engineering subjects and metalwork at the Doncaster Technical College—The Principal, Technical College, St. George Gate, Doncaster.

Our Astronomical Column.

RECENT SUNSPOTS.—The stream of spots seen near the sun's central meridian on Dec. 15 and 16 is the most important group observed for the last two months. Except for occasional short intervals, there has been no dearth, however, of smaller spots, whilst faculæ have been abundant (see also NATURE, Oct. 23, p. 603). The spots recently under observation appear to have originated about Nov. 21, but cloudy weather prevented their development being followed at that time, and later when the group was due to return at the east limb on Dec. 9. When first seen on Dec. 15, the arrangement of the spots was that usually associated with a bipolar group or stream of normal type. With the exception of the leader, the component spots were much broken up. The length of the stream, which was parallel to the sun's equator, was about 12° of solar longitude. Although the aggregate area of the spots was fully 1000 millionths of the sun's hemisphere, the group could be seen on Dec. 15 and 16 only when the disc was very carefully screened. Particulars of position, etc., are given below. It may be noted that no group so large as this has hitherto appeared during the present cycle so close to the sun's equator.

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Area.
11	(Dec. 9–22)	Dec. 15·9	7° N.	1/1000 of sun's hemisphere

THE DOMINION ASTROPHYSICAL OBSERVATORY, VICTORIA, B.C.—Vol. 3, Nos. 9, 10, 11, 12 of the publications of this observatory, deal with the orbits of nine spectroscopic binaries and the radial velocities of 48 stars. 12 Lacertæ is interesting from the rapid change in the amplitude of the radial motion, accompanied, according to Guthnick, by a similar change in the range of variability of light. As in many other cases, the *H* and *K* lines of calcium are stationary, and nearly accord with the solar component of radial motion. The 48 stars were found to include 9 binaries.

Boss 1275 was found to be a binary by Adams at Mt. Wilson in 1916, but the period previously adopted, 27·43 days, is shown to be wrong. The true value is 2·15165 days.

H. D. 191201 is a very massive binary, the minimum values for the components being 13·8 and 12·9 times the sun. The type is Bo, and the estimated distance 5000 light years.

U.S. NAVAL OBSERVATORY, WASHINGTON.—Vol. 10 of the publications of this observatory deals, in the first place, with observations made with the Prime Vertical Instrument during the period 1893–1912. Vega was the star most regularly observed, since it is readily visible by day. It was found, however, that the daylight observations differ systematically from the night ones; the difference is ascribed to lateral refraction produced by unequal heating of the layers of air near the instrument.

The parallax of Vega was deduced to be 0·123″, the aberration constant 20·542″, the nutation constant 9·250″, the mass of the moon 1/80·54. The last was deduced from the nutation constant, assuming the luni-solar precession for 1850 to be 50·373″. The variation of latitude was not deduced from the observations but was taken from the values published by the International Geodetic Association.

The volume also gives in detail the results obtained during the total solar eclipses of 1905, 1918, 1923. Two expeditions were sent to Spain and one to Algeria in 1905. Numerous plates contain reproductions of the coronal photographs and also of drawings, both those made direct from the corona and those from combinations of photographs. There are some excellent reproductions of the chromospheric spectrum; in one plate this is placed in juxtaposition with the corresponding region in Rowland's Atlas.

Some striking drawings in colour of the landscape (showing approach of moon's shadow) and of the corona and prominences were obtained in 1918 by Mr. Howard Russell Butler, and are reproduced in colour in the volume. He gives the corona a distinct blue tint, agreeing with several observers, though others describe it as white. The distant hills in the shadow are drawn as purplish violet; the sky just above them in orange, changing to bluish purple higher up. The orange band was also seen in Norway in 1896, when Mr. N. E. Green made a colour drawing of the landscape during totality. The eclipse of 1923 was observed from aeroplanes; interesting descriptions are given, but they are of little scientific value.

Research Items.

HYDROIDS OF THE *VALDIVIA* EXPEDITION.—The account of the hydroids of the German Deep Sea Expedition (*Valdivia*) (" Hydroiden der Tiefsee-Expedition," bearbeitet von Prof. Dr. Eberhard Stechow. Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia*, 1898–1899, Bd. 17, Hft. 3. Jena, 1925) is a valuable contribution to coelenterate literature. For some years Prof. Stechow has published papers in various journals showing that these hydroids are of a peculiarly interesting nature, and now we have a comprehensive survey of them all. In this material twenty-five per cent. of the species are new and there are two new genera. The author is of the opinion that whilst there are many bipolar genera, the species from the Arctic and Antarctic are themselves distinct, and many examples of confusion of species are here cleared up and thoroughly investigated. Only fourteen out of one hundred and twenty-four species described are medusa-bearing forms. The reason for this is attributed to the presence of ice, which is inimicable to medusæ. The same is found to be the case in Arctic seas. In the coldest regions the medusa-bearing hydroids are almost completely absent. This subject has already been discussed by the author in 1924 (" Über den Einfluss der Temperatur auf die Erzeugung von freien Medusen, etc.," *Verh. d. Deutsch. Zool. Gesellsch.*), and the facts are plainly shown in the present records. There are some extremely interesting hydroids amongst this *Valdivia* material. To mention only a few of the most striking, we have the soft parts of *Hydrocorella africana* described, of the family Bougainvilliidæ, having a skeleton of almost pure lime composed of small spines and large horns and bearing sporosacs. This is perhaps the most interesting of the athecate forms. Most of the remaining species belong to the Thecata. Here amongst the Plumulariidæ is the aberrant and very extraordinary *Dinotheca Dofleini*, already briefly described by Prof. Stechow in *Zoologischer Anzeiger*, vol. 37, in which there are probable affinities with the Graptolites (Rastrites). Altogether an enormous amount that is new is to be found in this most excellent monograph, and the beautiful series of figures in simple outline adds much to its value.

THE STATOCYSTS OF CEPHALOPODS.—M. Ishikawa (*Jour. Coll. Agr.*, Imp. Univ., Tokyo, 7, No. 3, 1924, recently received) has studied the statocysts of 59 species of Cephalopoda principally from Japanese localities. The statocyst was removed and cut transversely into two halves; the internal structure and the processes developed on its wall and projecting into the lumen were then examined. In the Octopoda only one process (labelled *c*) is present, and a corresponding one is found in all cephalopods. In Argonauta and Tremoctopus this process is unbranched, while in Ocythoe and Polypus it is provided with two small knobs, and the author suggests that the two former genera are more primitive than the two latter. In the Decapoda the genera can be divided into two series according as a process *b* is present (in four genera) or absent (in nine genera). In the latter group the processes are two only in the genus Pyrgopsis, nine in Cranchia, ten in Watasenia (and four other genera), eleven in Ommastrephes (and five other genera), and twelve in Loligo and Sepioteuthis. Of those in which the *b* process is present Idiosepius exhibits five processes, Sepia eleven, Sepiella twelve, and Thysanoteuthis thirteen. A phylogenetic tree is shown based on these details, and the author points out that the arrangement is in accordance with other characters, *e.g.* the fins, the shell, and siphonal joint apparatus. Young specimens of a Sepioteuthis were pricked with a needle so as to injure the statocyst of one or of both sides. When the left statocyst was injured the animal moved in a clockwise direction; when the right one was pricked movement was in the reverse direction, and when both statocysts were destroyed the swimming became quite irregular.

NUCLEAR DIVISION IN *Entamœba histolytica*.—Two accounts of nuclear division in *Entamœba histolytica* (*dysenteriæ*) have appeared recently. One of these, by Prof. C. A. Kofoid and Dr. O. Swezy (*Univ. Cal. Publ. Zool.*, vol. 26, No. 19, 1925), is based chiefly on a study of cysts found in freshly examined human fæces. The karyosome migrates from its previously more or less central position towards the nuclear membrane and divides into two parts which draw out the intradesmose between them as they pass to the poles of the spindle, where they constitute the polar caps. These caps are thus in the position of the centrosomes, but a centriole was seen at the ends of the intradesmose only in two examples, both from the cat. The source or sources of the six chromosomes were not fully traced. By this time the nucleus is spindle-shaped, and the chromosomes divide in a seemingly transverse plane but in reality in the end-phases of a longitudinal separation. The two groups of chromosomes migrate towards the poles and the nucleus constricts into two. The second paper, by C. Uribe (*Proc. Nat. Acad. Sci.*, 12, 1926, pp. 305-311), is based on observations of numerous trophozoites in a cat which had been experimentally infected. Division stages were observed both in amœbæ which had invaded the intestinal wall, and in others on the surface of the epithelium. The poles of the dividing nucleus are pointed, and each terminates in a clear cone at the apex of which is a small centriole. The number of chromosomes is six; after their division the resultant daughter chromosomes move towards the poles. The two daughter nuclei are about this time connected only by an elongate thread which later snaps and then the chromatin becomes distributed on the nuclear membrane. The clear cone and the centriole persist in the daughter nuclei after their separation but disappear with the formation of the karyosome. Apparently only a part of the ' peripheral chromatin ' is incorporated in the chromosomes of the dividing nucleus.

THE PROTOZOA OF THE PITCHER PLANT.—" Primitive conditions of digestion might be expected in insectivorous plants, and this idea is responsible for the investigation "—by Prof. R. W. Hegner (*Biol. Bull.*, 50, 1926) of the protozoa of the pitcher plant—in connexion with the general problem of the relationship between intestinal protozoa and their environment. Ten pitchers (*Sarracenia purpurea*) from different localities in Maine were carefully examined, and in all of them protozoa were present—all three classes being represented by several species. The liquid from many other pitchers was examined and similar protozoa found in most of them. The most common organisms in the pitchers were insect larvæ, mites and rotifers; nematodes and Entomostraca were found in a few, and Tardigrada in one pitcher. The protozoa in the pitchers are probably free-living species carried in by flies, though some of them may be restricted to this environment. Paramœcia from a culture were placed in the fluid in or obtained from the pitchers, and were found to be able to live therein for an indefinite period, and in some cases to multiply. Colpoda and Chilomonas could also live in the fluid and multiply.

ARACHNIDISM.—In two papers recently published (*Jour. Amer. Med. Assoc.*, 86, 1926, 1894; *Arch. Int. Med.*, 38, 1926, 623), Dr. E. Bogen, of Los Angeles, brings forward evidence that poisoning by spider bites, on the reality of which a good deal of doubt has been thrown, is quite a material thing. The effective spider in California is *Latrodectus mactans*, which lives in outhouses and similar places and has an unfortunate liking for closet seats. Symptoms come on at once or within a few hours, and consist mostly of agonising general pains which need large doses of opiates to control them. The patients recover in a few days without any after-effects. Poisoning by allied and other spiders is well-established in southern Europe, Madagascar, Australia, and South America, and though the tale of the tarantula is of course a myth, arachnologists seem to have gone too far in doubting the possibility of human poisoning altogether.

A NOVEL GEAR.—In many classes of machinery it is required to vary at will the relative speed of one shaft driven by another. This has usually been done by means of gear-wheels, chains, or belts. With toothed wheels, however, the number of changes are few, while with belts slipping occurs. To increase the number of changes and at the same time to prevent slipping, a novel type of drive has been invented which, in the main, resembles the belt drive between opposed conical discs so commonly used on lathes. In this invention the faces of all the cones have alternate ribs and grooves radiating from the apex, while in each link of the chain are fitted a number of thin steel slats which, while they project sufficiently to engage with the ribs or the cones, have a certain amount of freedom endwise. There cannot thus be any slip, while by closing one pair of cones and opening the other the relative speeds can be altered. The gear is called the "Positive Infinitely Variable" or "P.I.V. Gear," and has been placed upon the market by a syndicate bearing the same name. Trials of the gear have been carried out at the National Physical Laboratory, and these show that under favourable conditions an efficiency of 95 per cent. can be obtained. One example of the gear was shown at the Textile Exhibition at Leicester in October, where an A.C. motor running at 1000 R.P.M. drove another shaft at speeds varying from 250 to 500 R.P.M. The invention is an ingenious one, and provided that the chain does not show abnormal wear with prolonged use, it should have many applications.

LOADING SUBMARINE CABLES.—The competition that has arisen between high frequency radio and submarine telegraphy has accelerated the development of the latter method of communication. The greatest recent improvement is the use of cables the cores of which are surrounded by what is practically a cylinder of metal (permalloy) tape which has a very high permeability for very minute magnetising forces. The theory of the transmission of signals in this kind of cable was first clearly explained by Oliver Heaviside. His predictions as to the great speeding up that could be effected by a 'uniformly loaded' cable have been verified in practice. The New York-Azores permalloy loaded cable is perhaps the best-known cable of this type and it works at a very high speed. A factor, however, limiting the speed of cables of this type is the mutilation of the received signals by electrical disturbances picked up along the cable and transmitted with the incoming signal to the receiving instrument. In a paper published in the *Bell System Technical Journal* for July 1926, J. J. Gilbert explains how this difficulty has been overcome in the New York-Azores cable. At the New York terminal the ocean is comparatively shallow for a distance of about 100 miles. This part of the cable is therefore exposed to atmospheric disturbances and to strong stray fields from the numerous electric railway systems near New York. The Azores end of the cable reaches very deep water after a few miles and is therefore almost completely protected from atmospheric and other disturbances. To prevent the disturbances that experiment showed would otherwise be introduced into the cable at New York, a simple and effective remedy was devised. The earth terminal of the receiving apparatus was connected to the armouring of the cable by means of an insulated cable taken one hundred miles out to sea. This method is entirely successful and the highest speeds can be maintained. Mr. Gilbert's theory of this new type of sea earthing device is clear and convincing.

WROUGHT MAGNESIUM AND MAGNESIUM ALLOYS.—Report No. 1037 of the Engineering Research Board of the Department of Scientific and Industrial Research, by S. L. Archbutt and J. W. Jenkin, deals with magnesium and magnesium alloys. The use of this metal and its alloys is of considerable importance where the saving of weight is a first consideration, as this metal is much lighter than aluminium. Cast magnesium alloys have already been used in aeroplane engines, and the present work commences a research to fill the gap in the knowledge of the wrought alloys. The materials chosen are the metal itself, its alloys with 3 and 13 per cent. of copper, with 6 per cent. of aluminium and the proprietary alloy 'electron,' the composition of which is given as: zinc 4·38 per cent., silicon and aluminium 0·15 per cent. each, and copper 0·22 per cent., the remainder being magnesium. The melting and rolling of the alloys are described in detail. Typical values of the mechanical properties of 1 in. hot-rolled rod at atmospheric temperatures are:

	Magnesium.	6 per cent. Aluminium Alloy.	Electron.
Limit of proportionality, tons/sq. in.	1·60	2·40	4·9
Maximum stress, tons/sq. in.	15·7	18·2	17·8
Elongation per cent. on 2 in.	12·5	20·0	14·6
Reduction of area, per cent.	19·0	22·0	18·7
Wohler endurance limit, tons/sq. in.	4·5	6·5	..
Impact, ft. lb.	4·0	4·8	..
Brinell hardness (500 kgm. load)	39	50	58

The effect of prolonged heating to 350° C. has been determined for the first two of these materials. There is a decrease in both the maximum stress and the elongation. The impact test, however, shows that no embrittling accompanies this loss of elongation, the energy absorbed actually increasing very markedly in the case of the alloy. The Brinell hardness of all the materials has been determined at temperatures up to 350° C. and complicated changes are observed.

HYDRION CONCENTRATION AND PHOTOGRAPHIC EMULSIONS.—Under this heading reference was made in NATURE of December 18, p. 893, to a paper by Rawling and Glassett (*Journal of the Royal Photographic Society*, November). It was stated that "the photographic sensitiveness obtained after digestion is greater as the hydrion concentration is increased." This is incorrect; sensitivity increases as the hydrion concentration decreases.

Stress and Rhythm in Speech.

NOTWITHSTANDING the steady advance of knowledge concerning the physics of speech, with regard to certain of the most fundamental speech-phenomena a lush upgrowth of theory has yielded a very small crop of ascertained facts. Especially is this true concerning speech-rhythm. The reasons are several. Too frequently investigators have failed to formulate their problem with precision and have obscured it with terms of undetermined connotation, such as 'stress,' 'accent,' 'quantity,' even the word 'measurement' being very loosely used; most serious, however, has been their failure to appreciate or apply the methods evolved by other sciences for solving kindred problems.

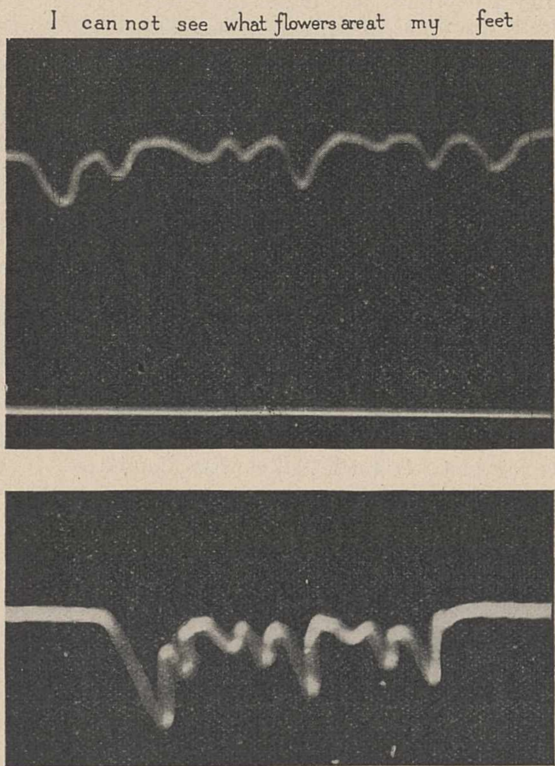


FIG. 1.—Direct photographs of jaw-movement. The lower curve was recorded some months after the upper, but by the same speaker. All the characteristics of the first curve are reproduced in the second, but the latter is more compressed laterally owing to slower movement of film.

Physiological research during the past half-century has shed complete light upon certain rhythms and, in so doing, elaborated characteristic and efficacious methods. A typical case is that of the heart-beat, which presented itself primarily as an *audible* rhythm, but could be subjected to accurate mensuration only when compelled to leave a *graphical* record upon a surface moving with known speed, *i.e.* when time had thus been replaced by its spatial presentment, alone susceptible of measurement. Let the metrician consider the principle involved. Behind the acoustic record of rhythmical sound, the true amplitudes of which were difficult of discovery, the physiologist was interested in the muscular actions, themselves presumably rhythmical, by which it was generated, and he addressed himself to the direct recording and measurement of these, incidentally presenting the metrician with an instructive but neglected example.

Experiments which I have been enabled to carry out during the past few years in the Physiological and Phonetics Laboratories at University College, London, indicate that even a crude adaptation of the physiologist's method yields valuable data as to the nature of 'stress,' and the distribution along the time-line of speech of its moments of maximum incidence. Fig. 1. exhibits the track marked on a photographic film, moving with uniform velocity, by an electric spot-light fixed rigidly between the lower incisor teeth of a speaker who, in profile to the camera and in darkness, recited the line: "I cannot see what flowers are at my feet." It represents, therefore, the rise and fall of the jaw during utterance. I can discuss here only one or two of the problems and conclusions suggested by this and very numerous similar experiments. It seems surprising that previous investigators should have neglected to examine this most evident factor in normal speech—the opening and closing of the mouth. The movements involved can scarcely be adjudged *a priori* superfluous and insignificant, since every depression of the jaw, effected by the combined work of numerous muscles and more particularly of those attached to the hyoid, provokes, as anatomists are fully aware, very special pivotings and displacements of the thyroid cartilages supporting the glottis, and consequently special tensions and special modifications of the resonant cavities of mouth and pharynx. These modifications are strictly conditioned by the number of muscles brought into play and the speed and vigour with which they are contracted. Hence the tracing executed by the moving jaw is a valuable index of the whole process of phonation, and this tracing reacts characteristically to every variation of stress, pitch, and vowel quality (timbre). The stressing (emphasising) of any particular vowel involves increased vigour of jaw-movement, and for each timbre characteristic degrees of descent of the jaw and characteristic expenditure of time.

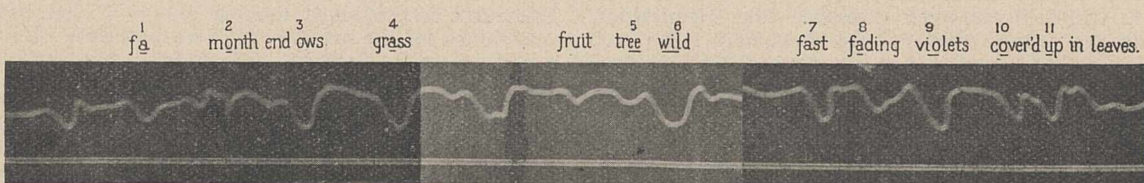


FIG. 2.—Excerpts from a continuous film of jaw-movement: "Wherewith the favourable (*sic*) month endows The grass, the thicket, and the fruit-tree wild," "Fast fading violets covered up in leaves." 1 and 8: characteristic semi-circular trough for *a* in f*a*ding and f*a*vourable. 2, 10, and 11: peaked trough for vowel ʌ in m*o*nth, c*o*vered, *u*p. 4 and 7: characteristic right-hand ascent of trough representing *ɑ* in gr*a*ss and f*a*st. 3, 6, and 9 large diphthong troughs in end*ow*s, w*i*ld, v*i*olets. 5: compare trough of i in fruit-tr*ee* with that of i in *see* (Fig. 1).

In Fig. 1 the vowels occupy the wave-troughs, and it will be realised that the lowest point of each trough, *i.e.* the point of maximum stress, corresponds to a unique position of the vocal apparatus, achieved by increasing muscular contractions on the descent and unmade by reversal of these contractions on the ascent. A 'pure' vowel apparently consists of symmetrical phases of approach and recession about a characteristic quality and pitch at the bottom, the slowest and most audible portion, of the trough. Asymmetry results in diphthongisation and appears as the result of overstress.

Fig. 2 shows some striking examples of the characteristic troughs traced out by vowels of different quality.

Fig. 3 exhibits a different kind of tracing. Instead

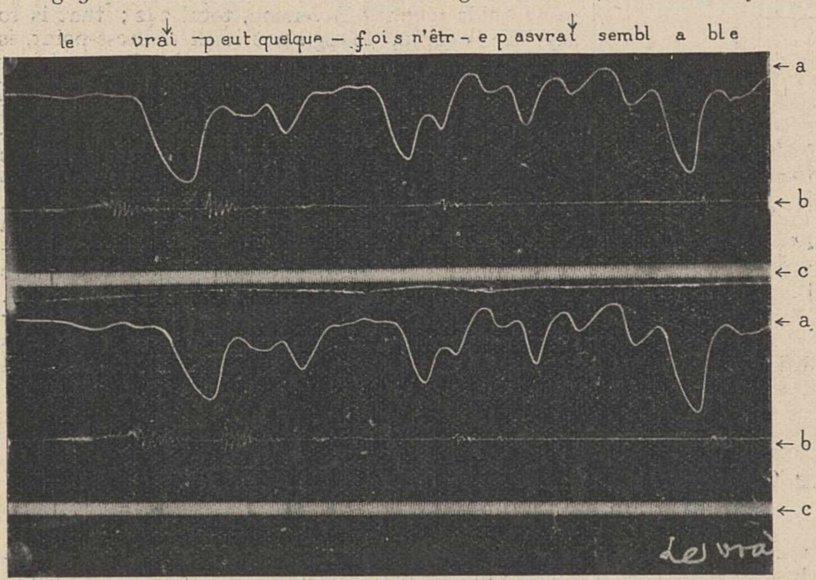


FIG. 3.—Two recitations of " Le vrai peut quelquefois n'être pas vraisemblable." (*a*) Jaw-movement; (*b*) sound record; (*c*) time record (tuning fork, 100 vibrations per sec.).

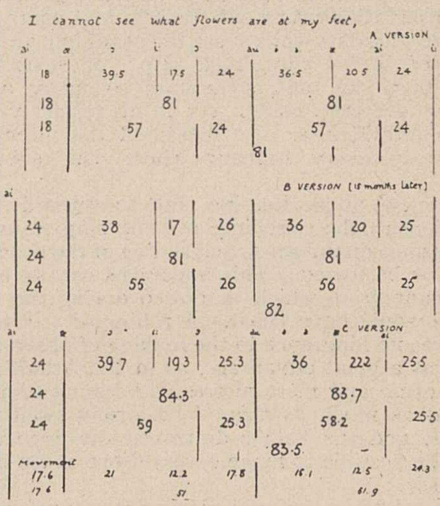
of the direct photograph of jaw-movement we have here (*a*) an inscription made by the lever of a Marey-tambour fitted with an extremely elastic soft rubber diaphragm and hermetically connected with a bulb carried on a plate under the speaker's chin in such a manner as to eliminate the influence of all head-movements other than those of the jaw, the latter being recorded in terms of air-pressure. The figure contains the inscription of two recitations of the French Alexandrine, " Le vrai peut quelquefois n'être pas vraisemblable." The total time taken by each recitation is $2\frac{1}{3}$ seconds between the lowest point of the first vowel trough lE and the lowest point of the last, vraisemblAble. It will be observed that the same intricate curve is reproduced with scrupulous fidelity, and, as this reproduction postulates the identical performance of many highly complex and varied acts by a synergy of numerous muscles, it is difficult to believe that this fine accuracy subserves no practical purpose. It is interesting to observe the different depth and shape of trough corresponding to the vowel *ai* (e) in vr*ai* and in vr*ai*semblable, that is, in circumstances of strong and weak stress respectively. The inscription of jaw-movement is accompanied by simultaneous records (*b*) of sound vibrations, registered by the usual phonetic tambour, and (*c*) of the vibrations of a tuning-fork (100 per. sec.). Clearly by synchronising these three tracings we can determine to what phase of jaw-movement each sound corresponds and the time relations between the points of maximum stress. Most of the records thus synchronised have been registered on surfaces moving at a rate of about 10 in. per sec. and permit of accurate time measurements to within a 200th of a second.

Detailed study of these curves soon reveals a host of unsuspected phonetic data of which the mere summarisation would require more space than is here available. The consonants, according to their nature, can occur only at very definite places on the curve; the stressing of the vowel to which they are contiguous profoundly modifies the conditions under which they are articulated and controls their duration and degree and quality of contact. In fine, the observer is able to watch in operation those very factors that have proved so profoundly influential in the historical evolution of speech-sounds.

The utility of the curves for the mensuration of poetical rhythm, a subject of greater interest to the general reader, can be more succinctly exemplified. We give below two sets of figures typical of those obtained from the mensuration of many experimental tracings of the kind described. To guard so far as possible against chance numerical coincidences, each experiment has been performed in duplicate or triplicate, *i.e.* the speaker has repeated his lines two or three times. In more than one case, after the corrections necessitated by the slight variations in speed of the best-regulated kymograph had been made, the recitation-curves, complex though they were, were found to be absolutely superposable; in others they had been systematically and proportionately varied and reflected slight alterations in the speaker's *tempo*.

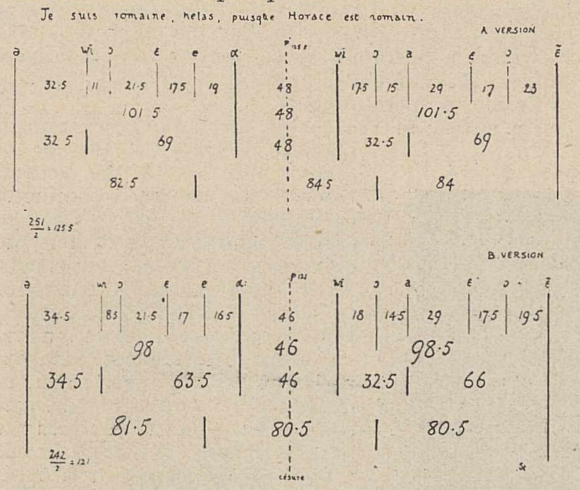
In the following tables each vertical line must be supposed drawn through the lowest point of the trough of the vowel of which the symbol figures at the top of that line; the numbers give the time, in 100ths of a sec., taken by the voice in passing from lowest point to lowest point.

I. Three recitations of the line, "I cannot see what flowers are at my feet."



It is scarcely requisite to insist upon the constant evidence of orderliness displayed by these figures. Excluding the initial interval, the time falls into two equal groups—equal beyond the metrician's dream—delimited by two prominent stress-maxima; each of these groups is again symmetrically subdivisible. The very weak stresses (as may be judged from Fig. 1) show no measurable maxima.

II. Two recitations of the French Alexandrine, "Je suis romaine, hélas, puisque Horace est romain."



Here in each recitation the addition of intervals results in a central symmetry of identical design (apparently the normal organisation of the isolated Alexandrine); a possible trimetric division is obtainable by utilising the less prominent stresses. It must be noticed that in the A recitation the time between the initial and final stress maxima is 251 hundredths of a second. Dividing this by 2 we have 125·5 and on synchronising this point with the voice record we find it to coincide with the closure of the p in *puisque*. The same holds true for B version, total 242; that is to say, the 'cæsura,' though not itself a stress-point, is situated exactly midway between the first and last stress-maxima. This twin experiment is particularly interesting as revealing (*a*) a stress-organisation of French verse; (*b*) the manner in which a reciter while reducing his total time expenditure by 9 in 251 hundredths of a second, yet accurately apportions the reduction so as to maintain the same organic rhythmical structure.

In this preliminary account of a few among a very large number of experiments, I have been compelled to choose only short examples, and to give of these a very summary interpretation. I may, perhaps, add that more extended records, notably those embracing a complete stanza, yield time-forms of beautifully elaborate and accurate symmetrical structure.

J. W. JEAFFRESON.

Dutch Pendulum Observations in the Atlantic and the Pacific.

By Dr. J. J. A. MULLER.

THE voyage of Dr. Vening Meinesz announced in NATURE of June 5, 1926, has almost been completed. The latest information by letter was from Honolulu; a cablegram reported the arrival at Amboina on November 25.

H.M. Submarine *K XIII.* left Helder on May 27 on a calm, sunshiny day, but the weather soon changed and after leaving the channel it was impossible to make any observations above the slope to the deep sea. A few days before sailing the ship had taken in much cargo, especially liquid fuel, and the trim was not known, which made it inadvisable to submerge for the first time in a very rough sea. The first observation was made June 2, and nearly every day after this date while at sea the pendulum apparatus was used in the submerged ship; on several days more than one and sometimes so many as four observations were made. As on his former voyages, Dr. Vening Meinesz also measured the intensity of gravity in every harbour where the submarine called.

The new apparatus has fully answered to expectations; the pitching of the ship causes no troublesome disturbance, and sliding of the pendulums need not be feared. This apparatus can be used in circumstances in which that used during the former voyage would have failed. A rolling of 3°·5 to both sides was no hindrance to the making of observations. This was a great advantage, as in the Atlantic, at a depth of 20 and more metres, the rolling sometimes reached as much as this. The strong swell in the Atlantic and the Pacific destroyed the hope that it might be possible to make observations at the surface of the sea.

Unfortunately for the deep sea soundings, the senders of the underwater clock signals were placed too high in the shipboard, in the wave zone. The echo was not a definite sound, and consequently the echo method could not be used for soundings at the surface of the sea; in the submerged vessel the place of the senders caused no trouble. The sonic depth-finder, which had been received only a few days before departure from Helder, has been of no use. Before San Francisco was reached, again and again Commander van der Kun and Dr. Vening Meinesz when trying to detect what was wrong, thought at first it was due to the relay; at length it appeared to be a defect in the construction, which only the maker in London can put right. It is a disappointment that owing to these two circumstances the voyage will contribute in only a limited manner to our knowledge of the depth of the sea on the track. For the determination of the interval of time between the production of the sound and the perception of the echo, a stop-watch of the Royal Navy was used indicating a hundredth part of a second.

The time signals used were at first those of Bordeaux, which were audible so far as Mona Passage, and afterwards those of Annapolis, which could be perceived for some days after leaving San Francisco. The use of the signals of Balboa and San Diego could be dropped, and the Naval Observatory at Washington was informed that these stations need not be controlled. In the whole Pacific the time signals of Lembang, given by the powerful radio station of Malabar (Java) can be used; these were clearly audible in Curaçao. The Nardin chronometers were the same as were used on the voyage in 1925; the regularity of the run of both was marvellous. For the comparison of the chronometers with the rhythmic time signals, Dr. Vening Meinesz intercalates the interrupter of the mean time chronometer in the telephone circuit and observes the appearance and the disappearance of the time signals; in this way the personal equation is almost entirely eliminated.

After taking an observation, the film was as a rule immediately developed; often it was directly measured and the preliminary result computed. Only when the temperature was too high was the developing put off until the next harbour was reached. Dr. Vening Meinesz estimates that the difference between the preliminary results will not exceed 0·005 cm./sec.^{2}; the isostatic reduction, however, will produce much greater differences. In this connexion it will be wise not to arrive at far-reaching conclusions immediately with regard to the prevailing theories of the constitution of the earth's crust, but to wait until the final computations are to hand.

The number of observations on sea at the different passages so far as Manila is as follows :

Helder—Horta . .	May 27-June 6 :	4,
Horta—Las Palma .	June 9-June 14 :	5,
Las Palmas—Curaçao .	June 21-July 8 :	17,
Curaçao—Coco Solo .	July 20-July 24 :	4,
Balboa—Mazatlan . .	July 30-Aug. 10 :	12,
Mazatlan—San Francisco	Aug. 17-Aug. 24 :	8,
San Francisco—Honolulu	Sept. 7-Sept. 20 :	15,
Honolulu—Guam . .	Oct. 2-Oct. 21 :	20,
Guam—Manila . .	Oct. 28-Nov. 8 :	12.

The total number is 97 ; up to November 8 the number of observations made at sea and in the harbours is 106 altogether.

With the reservation just made, I give the following particulars about the anomalies shown by the preliminary results. The anomalies refer to the Helmert formula of 1901 and are expressed in cm./sec.^{2} or dynes.

The first observation gave a normal gravity :

June 2, 44° 12′ N., 15° 33′ W., sea-depth 5000 metres, anomaly +0·004.

The three following gave an excess :

June 3, 43° 13′ N.,	18° 46′ W.,	sea-depth 4350 metres,	anomaly	+0·055
„ 4, 41 33	21 37	„ 4000 „	„	+0·042
„ 5, 39 48	24 57	„ 3550 „	„	+0·062

The last was above the mid-Atlantic ridge.

At Horta the anomaly was +0·126.

Eastward from the ridge the anomaly diminished to 0·016 ; near the north coast of Teneriffe the coast effect was shown by an anomaly of −0·008.

At Las Palmas the anomaly was +0·210. According to a communication from Dr. Bowie, it is reduced to +0·089 by applying the isostatic correction.

After leaving Las Palmas the first three observations gave the following anomalies :

June 22, 27° 12′ N.,	17° 51′ W.,	sea-depth 3610 metres,	anomaly	+0·040
„ 23, 26 33	21 39	„ 4630 „	„	+0·029
„ 24, 25 45	25 19	„ 4820 (?) „	„	+0·030

On July 25, the sea being very smooth, an observation was made at the surface, but at intervals a heavy swell occasioned excessive amplitudes of the pendulums and no result could be obtained. The attempt has not been repeated.

On the following days the anomaly amounted to from +0·015 to +0·029 as the sea-depth diminished from 6400 to 3940 metres. The next observation was made on the ridge.

June 30, 23° 21′ N., 47° 2′ W., sea-depth 3460 metres, anomaly +0·046.

On July 1, sea-depth 4520-5820 metres, the anomaly was +0·030.

In the Atlantic between 32° and 54° W. the depth of the sea often showed great changes ; the interval between the sound and the echo varied in the moving vessel in a few minutes by several seconds and then again returned to its former value. The sea bed seems to be extremely rugged there. The sea-depths also showed great differences from those given on the "Cartes bathymétriques des Océans" of the Prince of Monaco.

Farther west the gravity was normal :

July 2, 22° 45′ N.,	54° 35′ W.,	sea-depth 5760 metres,	anomaly	+0·002
„ 3, 22 17	58 27	„ 5640 „	„	+0·002.

Getting nearer to the Porto Rico deep, the gravity increased :

July 4, 21° 35′ N.,	63° 21′ W.,	sea-depth 5480 metres,	anomaly	+0·023
„ 5, 20 42	65 30	„ 5290 „	„	+0·031.

This last observation was at the edge of the deep.

July 5, 19° 30′ N., 66° 51′ W., sea-depth 7660 metres, anomaly −0·321,

above the deep but not at the greatest depth.

July 6, 18° 42′ N., 67° 42′ W., sea-depth 290 metres, anomaly +0·005,

in Mona Passage.

Before reaching Curaçao an observation was made in the Caribbean Sea :

July 6, 16° 54′ N., 67° 42′ W., sea-depth 4740 metres, anomaly −0·006.

In the harbour of Willemstad (Curaçao) the anomaly amounted to +0·174.

Between Curaçao and Colon the Caribbean Sea showed a deficiency of gravity ; in the harbour of Coco Solo (Colon) the anomaly was +0·083 and in that of Balboa (Panama) +0·094.

On July 31 the first two observations in the Pacific were made, but unfortunately they were both failures, the film being insufficiently extended, so that it was wrinkled and got torn. Before reaching Coco Solo there had been some difficulty in changing the speed of the film, the tension being too great, so it had been slackened. Since this experience the tension of the film has caused no further difficulty.

Along the west coast of America from Balboa to San Francisco the number of successful observations was eighteen at sea and one in the harbour of Mazatlan ; so far as this harbour they showed an excess of gravity.

Aug. 1, 7° 1′ N.,	82° 38′ W.,	sea-depth 3020 metres,	anomaly	+0·061
„ 3, 10 22	88 28	„ 3490 „	„	+0·058
„ 5, 13 35	95 27	„ 3840 „	„	+0·051.

On Aug. 6 a set of four observations was made in a profile nearly perpendicular to the coast :

14° 58′ N.,	98° 25′ W.,	sea-depth 3650 metres,	anomaly	+0·042
15 17	98 21	„ 3950 „	„	+0·020
15 38	98 18	„ 4730 „	„	−0·070
16 1	98 12	„ 890 „	„	+0·037.

Aug. 8 a set of three observations :

17° 30′ N.,	101° 21′ W.,	sea-depth 4990 metres,	anomaly	−0·076
18 0	103 26	„ 3010 „	„	−0·070
18 14	103 27	„ 670 „	„	+0·031.

In the harbour of Mazatlan the anomaly was +0·036.

On July 19 a set of three observations was again made ; the results have not yet been received. Along the U.S. Pacific coast the gravity was normal. After leaving San Francisco a last set of three observations was made for the study of the coast effect.

In the eastern part of the Pacific the gravity was at first normal ; after half the way to the Sandwich Islands had been covered it showed a positive anomaly :

Sept. 14, 28° 57′ N.,	141° 16′ W.,	sea-depth 4920 metres,	anomaly	+0·030
„ 18, 22 57	153 41	„ 4540 „	„	+0·065.

It appears that the excesses of gravity in the Atlantic and the Pacific extend over enormous areas, while the excesses or defects on the continents possess a more limited, regional character.

The preliminary results of the observations do not show any trace of a flattening of the equator ; it may be expected that this problem will be solved by the final results.

The long voyage from Las Palmas to Curaçao, 17 days, from San Francisco to Honolulu, 13 days, and from Honolulu to Guam, 19 days, was very strenuous, and the relaxation in the harbours was well deserved. In every harbour at which the submarine called, the crew met with the most cordial reception. Scientific workers, especially at San Francisco and at Honolulu, took much interest in Dr. Vening Meinesz and his work. In the latter place he met a number of delegates to the Pan-Pacific Congress on their voyage to Tokyo.

Thus far the voyage, the longest ever made by a submarine, has been very successful. If all goes well Dr. Vening Meinesz should have reached Surabaya about December 10; he will then stay at Java for some time to recover from the fatigues of the voyage before his return home on board a mail steamer. It may be recorded with satisfaction and thanks that the commander, the officers, and the crew of the submarine did all they could to facilitate the fulfilment of his task.

After the receipt of particulars about the rest of the voyage up to the arrival at Surabaya, I propose to give a brief account of the later results and to complete the present information.

Since the above was written, I have received from Washington the isostatic reductions of the observations made between Helder and Curaçao. These have been computed by the U.S. Coast and Geodetic Survey as a token of appreciation of the work of Dr. Vening Meinesz, which is justly considered to be of international interest. I must express here a word of thanks for this valuable co-operation, especially to Dr. William Bowie, Chief of the Division of Geodesy.

For the present it may suffice to mention that the excess of gravity in the Atlantic is confirmed, after the isostatic reductions have been taken into account.

The Burning of Carbonic Oxide.

IT was a sound movement on the part of the directors of the Gas Light and Coke Company to invite Prof. Bone to lecture before the Company and others on the work which he is carrying out on gaseous combustion, and particularly on the investigations made by Mr. F. R. Weston, the first holder of the Gas Research Fellowship, founded by the Company three years ago, at the Imperial College of Science. Prof. Bone had no difficulty in proving what important scientific results can be secured by means of such endowments of research, and Mr. Milne Watson, governor of the Company, showed that he realised that the development of chemical industries depended on the successful prosecution of strictly scientific investigations in the laboratory.

After comparing and contrasting the flames of hydrogen and carbonic oxide, and the effect of their mixture in water-gas, Prof. Bone took up the tale of the burning of carbonic oxide as it began to be studied in Oxford fifty years ago, when H. B. Dixon, in repeating Bunsen's experiments on the distribution of oxygen between hydrogen and carbonic oxide, showed that the latter apparently did not react directly with oxygen but was oxidised by the steam, and that the final division of the oxygen depended on an equilibrium being established between this and the reverse action—the reduction of the carbon dioxide by the hydrogen:

$$CO + H_2O \rightleftarrows CO_2 + H_2.$$

The non-inflammability of dried mixtures of carbonic oxide and oxygen led to many conjectures as to its cause, and as to the mechanism of steam in the reaction. That no chemical reaction can take place without 'conducting' water; that *liquid* water particles are the necessary electrical go-between; that gases can only react molecule with molecule, *i.e.* in equal volumes; that the oxygen molecule is too stable to be broken up, but steam is more yielding—these and other explanations were advanced by men of scientific eminence. For some years Dixon has held the more prosaic view that the direct oxidation of carbonic oxide in explosions is limited by the thermal dissociation of the carbon dioxide molecules, and that steam afforded the means of producing comparative cool molecules. The burning of dry cyanogen and the direct union of carbonic oxide and oxygen in contact with heated platinum seemed to show that steam was not essential, but this and the function of the steam were matters of inference. No direct proof of what happened in the flame was forthcoming.

Prof. Bone, whose first research on gaseous combustion, carried out at the Owens College, was the study of the slow union of carbonic oxide and oxygen when circulated over heated surfaces, now brings forward direct evidence of two kinds. He shows, first, that a very well-dried mixture of the two gases, which cannot be inflamed by an ordinary spark, can be exploded (at all events partially) when the electric discharge is made sufficiently powerful. In such conditions the flame traverses the bulb containing the mixture, though not with violence, and a large percentage of the gas combines in the flame. Again, Prof. Bone and Mr. Weston have shown that as the moisture is gradually removed from the mixture, the energy of the condenser discharge required to ignite it progressively increases. Lastly, the spectra of the flames of the well-dried mixture, the moist mixture, and of mixtures containing hydrogen have been photographed. The flame of the dried mixture burning under 25 atmospheres pressure shows a *continuous* spectrum and no steam lines. The flame of the undried mixture shows a strong *continuous* spectrum overlying a '*steam-line*' spectrum. On the addition of hydrogen the continuous spectrum grows less and the lines emerge, so that there is direct evidence that two reactions are taking place simultaneously in the ordinary flame—the direct oxidation of carbonic oxide by oxygen, and the indirect oxidation by steam. The intense electric discharge, on one hand, and the high pressure on the other, can confer on carbonic oxide the power of direct union with oxygen; in the presence of much steam the indirect reaction is predominant; with traces of steam both reactions occur together.

University and Educational Intelligence.

BIRMINGHAM.—The degree of D.Sc. has been awarded to Sydney Raymond Carter for numerous published papers on the oxidising properties of sulphur dioxide and other subjects.

LEEDS.—Sir Berkeley Moynihan, Bart., has resigned the professorship of surgery on his retirement from the full staff of the Leeds General Infirmary. In recording its regret at Sir Berkeley's retirement, the Council referred to his brilliant career as student in the Yorkshire College, with which the Leeds Medical School became incorporated, and after. "Throughout his career he has followed the tradition of the Leeds Medical School in bringing scientific knowledge into the service of surgery. With this he has associated a consummate skill in the art of surgery, thereby contributing substantially to the efficacy of surgical methods and the accuracy of diagnosis."

LONDON.—A lady, who desires to remain anonymous, has offered the University the sum of 10,000*l.* towards the establishment of a chair of dietetics.

Subject to certain conditions, the offer of Mr. J. G. Wilson to present to the University a 24-inch reflector telescope has been accepted. Lady Godlee is giving a sum of money, to be held in trust for University College and University College Hospital Medical School, to found a Rickman Godlee Lectureship in memory of her husband, the late Sir Rickman J. Godlee. The managing director of the Vultex Products, Ltd., on behalf of Mr. Patrick Gow, is to give a sum of money for three years for lectures on colloidal chemistry.

The following doctorates have been conferred:—*D.Sc. in Botany* on Mr. T. G. Hill, University reader in plant physiology, for a thesis entitled "The Water Economy of Maritime Plants"; *D.Sc. in Physics* on Mr. S. C. Roy (King's College), for a thesis entitled "On the Total Photo-electric Emission of Electrons from Metals as a Function of Temperature of the Exciting Radiation"; *D.Sc.* (*Engineering*) on Mr. L. B. Pfeil (Imperial College, Royal School of Mines, and Battersea Polytechnic), for a thesis entitled, (1) "The Deformation of Iron, with particular reference to Single Crystals," and (2) "The Effect of Cold Work on the Structure and Hardness of Single Iron Crystals, etc."; *D.Sc. in Chemistry* on Mr. T. H. Durrans, for a thesis entitled "The Preparation of Sulphuryl Chloride and the Chlorination of Substances of the Aromatic Series"; together with subsidiary contributions.

Dr. Percival Hartley has been awarded the William Julius Mickle Fellowship for 1927 in respect of the work which he has carried out during the past five years on special problems in connexion with diphtheria and other problems of a more general character in connexion with serology and immunity. The Fellowship this year is of the value of about 280*l.*

THE Educational Commissioner with the Government of India in his Report for 1924–25 gives a new and very convenient summary of statistics showing totals of 88,750 students, 5700 teachers and 7500 graduations in arts and science of the fifteen universities. 52 per cent. of the students, 50 per cent. of the teachers, and 48 per cent. of the graduations belonged to the two universities of Calcutta and Madras; Bombay and the Panjab account for 25 per cent. of the students, 21 per cent. of the teachers, and 20 per cent. of the graduations; leaving 29 per cent., 23 per cent. and 32 per cent. respectively as the share of the remaining eleven universities. These eleven, namely, the recently reconstituted Allahabad University and the ten new universities of Aligarh, Benares, Dacca, Delhi, Hyderabad (Osmania University), Lucknow, Mysore, Nagpur, Patna, Rangoon, had in the aggregate not much more than two-thirds of the number of students of the single university at Calcutta. An act constituting a new "Andhra" university was passed in 1926. Every one of the universities had a faculty of arts; all except the Osmania University of Hyderabad (Deccan) had a faculty of science; all except Aligarh and Mysore a faculty of law; all except Aligarh, Allahabad, Benares, Dacca, Delhi, Nagpur, and Osmania, a faculty of medicine. There were faculties of education at Aligarh, Madras, Nagpur, Patna, and Rangoon; of theology at Aligarh, Benares, and the Osmania University; of agriculture at Madras and the Panjab; of forestry at Rangoon; of engineering at Calcutta, Madras, Mysore, Patna, and Rangoon; of economics at Allahabad and Rangoon; of commerce at Allahabad, Lucknow, and the Panjab. The total expenditure on universities, arts colleges, professional colleges, and intermediate colleges in India in 1924–25 was Rs. 83,76,000, Rs. 1,06,28,000, Rs. 65,16,000, and Rs. 28,00,000 respectively; in all Rs. 2,83,20,000 or, say, 2,124,000*l.* The sources from which the expenditure was met were: Government funds Rs. 1,43,29,000, district board and municipal funds Rs. 76,000, fees Rs. 1,08,43,000, other sources Rs. 30,73,000. Universities, notably Bombay and Calcutta, have received in recent years substantial additions to their resources through the generosity of private donors, but it will be seen that they are in the main dependent on Government funds and fees.

Contemporary Birthdays.

December 26, 1838.	Sir W. Boyd Dawkins, F.R.S.
December 26, 1881.	Sir Thomas Lewis, F.R.S.
December 28, 1882.	Prof. A. S. Eddington, F.R.S.
December 28, 1853.	Dr. Alexander Scott, F.R.S.
December 30, 1850.	Dr. William Garnett.
December 31, 1849.	Prof. Sydney H. Vines, F.R.S.

Sir WILLIAM BOYD DAWKINS, honorary professor of geology and palæontology in the University of Manchester, celebrates his eighty-eighth birthday to-morrow. We offer our very hearty congratulations. A fellow of the Geological Society for sixty-five years, he will, next year, attain diamond jubilee fellowship of the Royal Society. He is the author of two classical works, "Cave Hunting" and "Early Man in Britain."

Sir THOMAS LEWIS, born at Cardiff, was educated at Clifton College; his medical training was conducted at University College Hospital, London. Eminent in long-continued developmental studies relating to the mechanism and clinical disorders of the mammalian heart-beat, he has established conclusions of prime importance in physiology and practical medicine. Sir Thomas was Croonian lecturer at the Royal Society in 1917, delivering an address on "The Excitation Wave in the Heart."

Prof. EDDINGTON was born at Kendal. A student at Owens College, Manchester, he graduated at Trinity College, Cambridge, as senior wrangler, and was Smith prizeman. He was chief assistant at the Royal Observatory, Greenwich, from 1906 until 1913, leaving this post to become Plumian professor of astronomy in the University of Cambridge. Prof. Eddington was president of the Royal Astronomical Society, 1921–23; in 1924 he received its gold medal for his work on star-streaming, on the internal constitution of a star, and on generalised relativity. In the same year he was awarded the Henry Draper medal of the National Academy of Sciences of the United States.

Dr. A. SCOTT, a native of Selkirk, and educated there at the Grammar School, graduated at the University of Edinburgh, and also at Trinity College, Cambridge. From 1896 until 1911 he was superintendent of the Davy-Faraday Research Laboratory, Royal Institution. Dr. Scott was president of the Chemical Society, 1915–17, after many years of service to the Society in various administrative capacities.

Dr. GARNETT, born at Portsea, was educated at the City of London School and Royal School of Mines. Proceeding to St. John's College, Cambridge, he graduated fifth wrangler, becoming later a fellow of his college. Entering the Cavendish Laboratory, he had the distinction of being the first demonstrator of physics there under James Clerk Maxwell. After teaching at University College, Nottingham, he did valuable work as principal of the Durham College of Science. The advancement of technical education in London and elsewhere claimed earnest attention at his hands; from 1904 until 1915 he was educational adviser to the London County Council. Dr. Garnett is Hon. D.C.L., Durham.

Prof. VINES, distinguished as a botanist, is a Londoner. Educated privately, he graduated at Christ's College, Cambridge. For many years he was Sherardian professor of botany in the University of Oxford. He was president of Section K (Botany) at the Bradford meeting of the British Association in 1900, when he gave, in his address, a conspectus of botany in the nineteenth century. Prof. Vines was president of the Linnean Society, 1900–4.

Societies and Academies.

LONDON.

Geological Society, November 17.—C. J. **Stubblefield** and O. M. B. **Bulman**: The Shineton shales of the Wrekin district, with notes on their development in other parts of Shropshire and Herefordshire. In the Wrekin district, the Shineton shales represent almost the whole of the Tremadocian succession, as developed in the Tremadoc district. The subdivision of shales in this main outcrop are:—(6) Arenaceous beds; (5) zone of *Shumardia pusilla*; (4) Brachiopod beds; (3) zone of *Clonograptus tenellus*; (2) transition beds; (1) zone of *Dictyonema flabelliforme*. In the smaller outcrops of the shales lying on the west and south-west, only the lower part of the sequence has been identified. In the Wrekin district a thick mass of shales has been compressed against a north-eastern ridge formed of earlier Cambrian and pre-Cambrian strata, resulting in isoclinal folding with faulting in the north-eastern part of the shale outcrop. In the south-west of the district the shales are less disturbed, except in the immediate neighbourhood of the Church Stretton fault. Six new species of trilobites have been established, of which three belong to new genera; one new brachiopod and three new hyolithids are described.—W. J. **Arkell**: The Corallian rocks of Oxfordshire, Berkshire, and North Wiltshire. The subdivisions adopted are: (5) upper Calcareous grit; (4) *Trigonia-clavellata* beds; (3) Osmington Oolite series; (2) Berkshire Oolite series; (1) lower Calcareous grit. It is particularly emphasised that the Coral Rag is a facies deposit which may occur at any date, and that the use of 'the Coral Rag' as a stratigraphical term is not permissible. The substitution of the term by Blake and Hudleston's 'Osmington Oolite Series,' is suggested. Coral associations started in Yorkshire at the time of the lower Calcareous grit, and migrated southwards during the Corallian epoch, failing to become established in Dorset until the closing phase of the upper Calcareous grit. The chief feature of the Berkshire Oolite series, the Trigonia beds of Berkshire, are contrasted with the much later Trigonia beds of Dorset; whereas the former belong to the Argovian, the latter must be assigned to the Sequanian, the intervening Osmington Oolite series undoubtedly representing the Rauracian.

Linnean Society, November 18.—Miss E. R. **Saunders**: The origin of the double garden stock. A plant which appeared in the present season in an F_2 family from the cross, pure-breeding glabrous single cream ♀ × double-throwing glabrous white ♂, is of considerable interest, for the normal single and fully double condition were here exhibited in the same individual. The cross was made in 1923 and the resulting seeds sown the same autumn. The F_1 plants, which were purple and hoary (the factorial constitution of the parents being RHK and CK respectively), flowered in 1924. The seeds collected from one of these plants, which was covered, were not sown until the spring of 1926, when they yielded 179 hoary and 100 glabrous, of which 214 were single and 58 double. One of the hoary single-flowered plants produced six primary lateral axes in addition to the main axis; some of the flowers on the main axis showed characters intermediate between those of the single and those of the double flower. The sixth lateral branch produced mainly double flowers indistinguishable from those borne by the ordinary double-flowered plant. It is therefore possible that the mutation occurring here in only one branch may at some time have occurred throughout a whole individual, and so have given rise at one step to the double-flowered type.—Miss A. E. **Chesters**: The vascular supply of the bracts of some species of Anemone. In types exhibiting a large leafy involucre the vascular system of the peduncle is dominated by that of the involucre. In species like *A. Hepatica*, in which the involucre closely approximates to a calyx, the incoming bundles take a less prominent part in the formation of the vascular ring of the axis. The resemblance between the course of the bract bundles of *A. Hepatica* and the sepal bundles of *Ranunculus Ficaria* is very striking. The vascular supply of the bracts of *Eranthis hyemalis* resembles that of *A. nemorosa* in all essentials, suggesting that the modifications shown in the vascular system of *A. Hepatica* and *A. angulosa* are correlated with the reduction of the involucral leaves rather than with the difference in position. The evidence appears to support the view of the homology of the involucre of *A. Hepatica* and the calyx of *Ranunculus Ficaria*.

Physical Society, November 26.—H. C. **Hepburn**: Electro-endosmosis and electrolytic water transport. Determinations were made of liquid transport produced by passing an electric current through aqueous solutions of copper sulphate divided perpendicular to the flow of electricity by a diaphragm of powdered glass. The probable factors that determine the liquid transport are investigated over a wide range of concentrations, by an examination of the dependence of the flow at constant applied voltage and of the electric charge of the diaphragm on the electrolyte concentration, and also by a study of the relation between the flow per faraday and the dilution of the electrolyte.—L. **Hartshorn**: The input impedances of thermionic valves at low frequencies. Accurate measurements of input admittance (or of input impedance) under various conditions can be made by means of the Schering capacity bridge. The input circuit is regarded as being equivalent to a condenser with a definite phase angle, ϕ, or "loss angle," $\delta = 90° - \phi$, and the results are expressed by stating the effective capacity and value of tan δ for each set of experimental conditions. The effective capacity may vary from about $10\mu\mu$F. to $100\mu\mu$F. for an *R* valve, and the phase angle may vary from about 80° leading to 126° leading, depending mainly on the load in the anode circuit. Values of phase angle greater than 90° correspond to a negative resistance or negative power factor, and occur when the load in the anode circuit is inductive.

CAPETOWN.

Royal Society of South Africa, September 29.—T. R. **Sim**: The Bryophyta of South Africa.—E. Percy **Phillips**: Some notes on South African grasses. The characters and distribution of the various South African grasses, and the economic questions associated with them are discussed, and the effects of veld burning described.—J. H. **Power**: Some tadpoles from Griqualand West.

October 20.—John **Phillips**: Faurea McNaughtonii Phill. ("Terblanz"), a note on its ecology and distribution. This stately forest tree (Proteaceæ: sect. Persoonioideæ) is of peculiar regional and local distribution.—M. R. **Levyns**: Note on the genus Lobostemon (Lehm.) A new classification, based on floral characters, is used. It is proposed to restrict the genus Lobostemon to those forms in which a definite scale or swelling is present on the corolla at the base of each stamen, and to constitute a new genus for those forms in which a scale or swelling is absent.—P. R. v. d. R. **Copeman**: Studies in the growth of grapes. Equations have been developed for the growth changes in the acid, sugar, and soluble solid content of the juice and in the total solids in the berry for six different varieties of grapes analysed during three seasons. The growth of the grape berry may be divided into two distinct cycles. In the first cycle the soluble solids formed consist mainly of acid and protein. During the second cycle the changes in the soluble solids are practically entirely due to the changes in the sugar and acid. Growth constants can be derived which serve as a means of comparison between the different varieties for the different seasons.—H. O. **Monnig**: On a new Physaloptera from an eagle and a Trichostrongyle from the cane rat, with notes on *Polydelphis quadricornis* and the genus Spirostrongylus.—D. F. **Bleek**: Bushmen of Central Angola. These Bushmen are Kung, speaking a language similar to the like-named inhabitants of the South-West Protectorate. They are much influenced by the surrounding Bantu tribes, on whom they are becoming more and more dependent. Their religious beliefs are akin to those of other Bushmen, save for an acquired fetish worship. The tribe will probably be absorbed by the Bantu races.

ROME.

Royal National Academy of the Lincei, Communications received during the vacation.—U. **Cisotti**: Inversion of Poisson's formula on rigid motions.—Giorgio **Abetti**: Observations on the motions of metallic vapours in sunspots.—L. A. **Herrera**: Chemotaxis and phagocytosis in imitation of leucocytes. The microscopic amœba-like forms produced in petrol and olive oil by the injection of drops of alkaline water are due to currents and movements produced by rapid penetration into the osmotic pockets of the oil rendered more fluid by the petrol. The results indicate that phagocytosis must be regarded as of mechanico-physico-chemical character. Acetic acid acts as an anti-body or opsonin which determines the chemotaxis of the oily 'amœbæ.' It seems probable that similar currents are produced between the natural leucocytes and bacteria.—Tommaso **Boggio**: The geodetic deficit. —E. **Bompiani**: The geometry of surfaces considered in ruled space.—Alessandro **Terracini**: The linear projective element of a surface.—E. **Raimondi**: General formulæ for the calculation of the dynamic effect of a current flowing between a strip and an indefinite plane wall.—Renato **Mancinelli**: The Evershed effect in sunspots.—Mario **Picotti**: Results of the physico-chemical investigations made in the Italian cruiser *Marsigli* in the Straits of Messina. The amount of oxygen dissolved in the water of the Straits of Messina rises to maximum values in April and in September, in which months plankton are exceptionally plentiful. The value of *p*H lies mostly between 8·1 and 8·2, but values below 8·1 are sometimes encountered in the depths and values above 8·25 at the surface.—Marya **Kahanowicz**: Spectrum of the Pickering type in argon. Under a suitable pressure and when strongly excited, argon gives rise to an enhanced spectrum of the Pickering type. The emissive atom exhibits hydrogenoid behaviour, an electron revolving about the nucleus.—G. **Wataghin**: The aberration of light and the theory of relativity. The relativistic formula for aberration, established by Einstein for plane-waves, is valid also for spherical waves. The theory of aberration may be developed on the basis merely of the hypothesis that light is propagated in a straight line with respect to any inertial system whatever. Various particular aspects of the theory are discussed.—Bianca **Nannei**: Method for the measurement of variations in the calorific capacity in magnetic fields.—Marcelle **Philibert**: Apparent doubling of the optic axis of calcite with Federow's plate.—G. **Carobbi**: Investigations on some noteworthy Vesuvian sublimates. The presence of traces of soluble vanadium compounds is observed for the first time, and that of soluble titanium compounds and boric acid confirmed, in deposits on Vesuvius.—Gaetano **Charrier**: 1-*N*-Phenyl-$\alpha\beta$-naphtho-1 : 2 : 3-triazolequinone.—Raoul **Poggi** and Angiolo **Polverini**: The determination of phosphorus and arsenic in organic substances. The method suggested consists in oxidising the substance by means of concentrated sulphuric acid and potassium persulphate, and afterwards determining the phosphorus or arsenic by the ordinary methods.—G. **Scagliarini** and G. **Tartarini**: Compounds of titanium halides with oxygenated organic substances.—Edoardo **Benedetti**: The action of the high frequency oscillating electromagnetic field on vegetable seeds. Experiments made with maize, wheat, barley, and rice show that the oscillating field results in both accelerated growth and increased percentage germination.—Umberto **D'Ancona**: The reproduction of *Alosa finta* (Cuv.).

SYDNEY.

Royal Society of New South Wales, October 6.—A. R. **Penfold** and R. **Grant**: The germicidal values of some Australian essential oils and their pure constituents; together with those of some essential oil isolates, and synthetics (Part 4). The Rideal-Walker co-efficients of some Australian essential oils and perfume synthetics have been determined. The following coefficients were measured: Western Australian sandalwood oil, 1·5; East Indian sandalwood oil, 1·5; *Zieria macrophylla*, 2·0; zierone, 2; isomenthol, 20; phloracetophenone-dimethyl-ether, 10; hydrocinnamic-aldehyde, 7 (5·3); hydroxy-citronellal, 6 (4); C_8 aldehyde, 16 (22); C_9 aldehyde, 9·5 (23); C_{10} aldehyde, 7 (9·25); C_{11} aldehyde, 7 (9·25); C_{12} aldehyde (methylnonyl acetic), 1 (3·5); C_{12} aldehyde (laurinic), 3 (5); C_8 alcohol, 25 (26); C_9 alcohol, 13 (19); C_{10} alcohol, 5 (6·25); C_{11} alcohol, 4·5 (5·75); C_{12} alcohol, 2·75 (3·5). The dispersions consisted of 1 per cent. of the constituents in 7·5 per cent. rosin-soap solution. The numerals in brackets refer to the dispersions in absolute ethyl alcohol.

Official Publications Received.

BRITISH AND COLONIAL.

Royal Agricultural Society of England. Report of the Council to the Annual General Meeting of Governors and Members of the Society, to be held at the Royal Agricultural Hall, Islington, London, N., on Wednesday, December 8, 1926, at 2.30 P.M. Pp. 20. (London.)

Journal of the Chemical Society: containing Papers communicated to the Society, November 1926. Pp. viii+iv+2763-2973. (London: Gurney and Jackson.)

Transactions of the Institution of Chemical Engineers. Vol. 3, 1925. Pp. 137. (London.)

Calendar of the Royal Society of Medicine, 1926-27. Pp. 77. (London.)

Department of the Interior, Canada: Topographical Survey. Bulletin 58: The March of the Compass in Canada, and Daily Variation Tables. By W. H. Herbert. Pp. 20. (Ottawa: F. A. Acland.) 10 cents.

The Journal of the Royal Horticultural Society. Edited by F. J. Chittenden. Vol. 51, Part 2, November. Pp. 177-356+xciii-cliv+44 plates. (London.) 7*s*. 6*d*.

Tide Tables for the Eastern Coasts of Canada for the Year 1927: including the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits; and Information on Currents. Issued by the Tidal and Current Survey Branch of the Hydrographic Survey, in the Department of Marine and Fisheries of the Dominion of Canada. (Thirty-first Year of Issue.) Pp. 76. (Ottawa: F. A. Acland.)

Proceedings of the Society of Psychical Research. Part 100, Vol. 36 December. Pp. 345-392. (London: Francis Edwards.) 3s. net.

Journal of the Indian Institute of Science. Vol. 9A, Part 5: The Fat from 'Salvadora Oleoides'; Khakan Fat. By C. K. Patel, S. Narayana Iyer, J. J. Sudborough and H. E. Watson. Pp. 117-132. 12 annas. Vol. 9A, Part 6: The Constituents of some Indian Essential Oils. Part 19: The Essential Oil from the Rhizomes of 'Kaempferia galanga,' by Puthan Madhathil Bhaskara Panicker, B. Sanjiva Rao and John Lionel Simonsen; Part 20: The Essential Oil from the Rhizomes of 'Curcuma aromatica,' Salisb., by B. Sanjiva Rao, Vishnu Purushottam Shintre and John Lionel Simonsen; Part 21: The Essential Oil from the Wood of 'Erythroxylon Monogynum,' Roxb., by B. Sanjiva Rao, Vishnu Purushottam Shintre and John Lionel Simonsen. Pp. 133-148. 12 annas. Vol. 9B, Part 2: The Characteristics of Beam Transmitting Aerials. By J. K. Catterson-Smith. Pp. 9-19+4 plates. 1 rupee. (Bangalore.)

The Medical and Scientific Archives of the Adelaide Hospital. No. 5 (for the Year 1925). Pp. 34. (Adelaide: R. E. E. Rogers.)

Hull Museum Publications. No. 142: Record of Additions, No. 69. Edited by T. Sheppard. Pp. 16+14. (Hull.)

Canterbury College (University of New Zealand). Records of the Canterbury Museum, Vol. 3, No. 1. Pp. 81+17 plates. (Christchurch, N.Z.)

The Wellcome Bureau of Scientific Research and Museum of Medical Science (including Tropical Medicine and Hygiene), 25-28 Endsleigh Gardens, London. Pp. 92. (London: The Wellcome Foundation, Ltd.)

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 1, No. 1: The Glacial Geology of the Southern Uplands of Scotland, West of Annandale and Upper Clydesdale. By Dr. J. Kaye Charlesworth. Pp. 23+1 map. 3s. 6d. Vol. 55, Part 1, No. 2: The Readvance, Marginal Kame-Moraine of the South of Scotland, and some later Stages of Retreat. By Dr. J. Kaye Charlesworth. Pp. 25-50+1 map. 3s. 6d. Vol. 55, Part 1, No. 3: The Petrology of Iceland. By Dr. G. W. Tyrrell and Dr. Martin A. Peacock. Preface; and Part 1: The Basic Tuffs, by Dr. Martin A. Peacock. Pp. 51-76+2 plates. 4s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Philosophical Transactions of the Royal Society of London. Series B, Vol. 215. B425: The Aloinæ; a Cytological Study, with Especial Reference to the Form and Size of the Chromosomes. By Nesta Ferguson. Pp. 225-253+plates 18-19. (London: Harrison and Sons, Ltd.)

Kent Education Committee. Report of an Investigation of the Free Place Scholarship Examination, 1926, in the County of Kent. By Andrew Bell. Pp. 55. (Maidstone: Director of Education.) 1s.

Transactions of the North East Coast Institution of Engineers and Shipbuilders. Edited by E. W. Fraser-Smith. Vol. 43, Part 2, November. Pp. xxviii+25-98. (Newcastle-upon-Tyne.) 5s.

The Imperial College of Tropical Agriculture. Prospectus for 1927-28, also Principal's Report for 1925-26 and Register. Pp. 29+2 plates. (St. Augustine, Trinidad, B.W.I.; London: 14 Trinity Square, E.C.3.)

The Imperial College of Tropical Agriculture. Speeches at a Luncheon to the Prime Ministers and Representatives of the Dominions and India to the Imperial Conference, 1926. Pp. 12. (St. Augustine, Trinidad, B.W.I.; London: 14 Trinity Square, E.C.3.)

Foreign.

Spisy vydávané Přírodovědeckou Fakultou Masarykovy University: Publications de la Faculté des Sciences de l'Université Masaryk. Rok 1926. Čis. 70: Iter Turcico-Persicum. Pars 3: Plantarum collectarum enumeratio. Scripsit Dr. Fr. Nábělek. Pp. 75+7 tab. Čis. 71: O krystalech pyropu od Agua Suja v Brasilii (Sur les cristaux du pyrope de Agua Suja en Brésil). Napsal Vojtěch Rosický. Pp. 9. Čis. 72: Sur les correspondances analytiques entre deux plans projectifs, Première partie. Par Otakar Borůvka. Pp. 40. Čis. 73: Katalytická redukce dimethylglyoximu 2, 3-diaminobutan (Réduction catalytique du diméthylglyoxine 2, 3-diaminobutane). Napsali J. Frejka a L. Zahlová. Pp. 43. Čis. 74: Jak působi světlo na povrchové napětí rostlinných štav (The Influence of Light on the Surface Tension of Plant Sap). Napsal Ferd. Herčík. Pp. 18. Čis. 75: Kopulace žabronožky sněžni, Chirocephalus Grubii Dyb (Copulation chez Chirocephalus Grubii Dyb). Napsal Bruno Valoušek. Pp. 15. Čis. 76: Onobrychis generis revisio critica, Partes secunda et tertia. Scripsit G. Širjaev. Pp. 155. Čis. 77: O některých skapolithech moravských (Sur quelques scapolites de Moravie). Napsali B. Konečný a V. Rosický. Pp. 28. Čis. 78: Vztah mezi atm. srážkami a nadm. výškou na Moravě a ve Slezsku (Le rapport entre les précipitations atmosphériques en Moravie et en Silésie et l'altitude au dessus du niveau de la mer). Napsal Fr. Říkovský. Pp. 15. Čis. 79: "Asterophyllites Dumasi Zeill. var. moravicus nov. var." z permu boskovické brázdy ("Asterophyllites Dumasi Zeill. var. moravicus nov. var." du Permien de la fosse de Boskovice). Napsal Dr. Josef Augusta. Pp. 12. (Brno: A. Píša.)

Biologické spisy vysoké Školy Zvěrolekařské, Brno (Publications biologiques de l'École des Hautes études vétérinaires, Brno). Svazek 4, Spis 51-60 (Tome 4, Fascicule 51-60), 1925. Pp. ii+35+29+12+11+22+20+30+23+27+12. (Brno: A. Píša.) 40 Kč.

Sborník vysoké Školy Zemědělské v. Brně (Bulletin de l'École supérieure d'agronomie, Brno). Sign. C7: Druhý příspěvek k rozšíření zoocecidií v. Čechách (Deuxième contribution à l'extension des Zoocécidies dans la Bohême). Napsal Dr. Ed. Baudyš. Pp. 105. Sign. C8: Pátý příspěvek k zoocecidiologickému prozkoumání Moravy a Slezska (Recherches sur les Zoocécidies de Moravie et de Silésie, Cinquième contribution). Napsal Dr. Ed. Baudyš. Pp. 48. (Brno: A. Píša.)

University of California Publications. Publications of the Lick Observatory, Vol. 14, Part 2: The Spectra of Nova Geminorum (1912). By William H. Wright. Pp. 23-91+plates 2-6. (Berkeley, Cal.: University of California Press; London: Cambridge University Press.)

University of California Publications in American Archaeology and Ethnology. Vol. 23, No. 2: Historic Aboriginal Groups of the California Delta Region. By W. Egbert Schenck. Pp. 123-146. (Berkeley, Cal.: University of California Press; London: Cambridge University Press.) 30 cents.

Diary of Societies.

TUESDAY, December 28.

Royal Institution of Great Britain, at 3.—Prof. A. V. Hill: Nerves and Muscles: How we feel and move: (1) Nerves and the Messages they carry.

THURSDAY, December 30.

Royal Institution of Great Britain, at 3.—Prof. A. V. Hill: Nerves and Muscles: How we feel and move: (2) Muscles and how they move.

FRIDAY, December 31.

Junior Institution of Engineers, at 7.30.—Questions and General Technical and Practical Discussions.

SATURDAY, January 1.

Royal Institution of Great Britain, at 3.—Prof. A. V. Hill: Nerves and Muscles: How we feel and move: (3) The Heart and some other Muscles.

TUESDAY, January 4.

Institution of Automobile Engineers (jointly with Royal Agricultural Society) (at Royal Society of Arts), at 7.—Dr. B. A. Keen: The Place of the Tractor in Soil Cultivation.

CONFERENCES.

December 30 to January 7.

Annual Conference of Educational Associations (at University College).

Thursday, December 30, at 3.—Sir Henry A. Miers: The Choice of What is Good for Others (Presidential Address).

Friday, December 31, at 11.30 a.m.—Earl of Clarendon: Empire Settlement and Development.—King Alfred School Society, at 3.—J. Wicksteed: The Evolutionary Value of Co-Education.—Royal Drawing Society, at 5.30.—H. E. Peacock and P. Griffith: The Education and Development of Æsthetic Ability in Young People.

Saturday, January 1.—Educational Handwork Association, at 2.—J. H. Everett: The Teaching of Practical Elementary Science.—Leplay House, at 3.—Discussion: The Periodical Observation. Its Use for Observational and Regional Survey Work.—International Language (Ido), at 5.—G. H. Richardson: International Language: The Present Situation and the Prospect.

Monday, January 3.—Eugenics Society, at 11 a.m.—Prof. E. W. MacBride: The Nature and Origin of Racial Differences.—British Psychological Society (Education Section), at 6.—Discussion: S. J. F. Philpot, Miss Barbara Low, and others: The Cinema in Relation to the Mind of the Child.—British Association for Physical Training, at 5.30.—C. S. Thomson: Hygiene and Physical Training.

Tuesday, January 4.—School Nature Study Union, at 3.—Dr. E. J. Salisbury: Salt Marsh Vegetation.

Wednesday, January 5.—Society for Experiment and Research in Education, at 10.30 a.m.—J. H. Whitehouse and others: Creative Education.—Child Study Society, at 5.30.—Miss Lilian Barker: The Girl Delinquent.—British Esperanto Association, at 5.30.—Rev. Prof. T. G. Bailey: Esperanto in the World to-day.

Thursday, January 6.—National League for Health, Maternity, and Child Welfare, at 5.—Miss Gardner, Dr. R. J. M. Horne, and others: Discussion: Open Air Schools.—London Head Teachers' Association, at 5.—W. A. Brockington and Prof. Godfrey Thomson: Technique of Examination.

Friday, January 7.—British Broadcasting Company, at 11.—J. C. Stobart and others.

Geographical Association (at London School of Economics, Houghton Street, Aldwych, W.C.2).

Thursday, January 6, at 11.30 a.m.—Major C. Patrick: Mapping from Air Photographs.—At 5.—Miss Eileen Power: Trans-Asiatic Caravan Routes in Ancient and Modern Times.—At 8.—J. Fairgrieve: Geography Teaching in Primary Schools.—Sir Henry G. Lyons: Geography in the Universities.

Friday, January 7, at 10.—Prof. H. J. Fleure: The Teaching of Geography.—At 11.45.—Sir C. F. Close: Population Problems of the Empire (Presidential Address).—At 2.—Col. Jack: The Work of the Ordnance Survey Department.

Saturday, January 8, at 10.—Prof. T. P. Nunn: Boy Scout Geography.—At 11.30.—Mrs. Ormsby: Regional Survey in a Large City.

January 4, 5, 6, and 7.

Science Masters' Association (Annual Meeting) (at Oxford).

Tuesday, January 4, at 8.15.—Brig.-Gen. H. Hartley: Presidential Address.

Wednesday, January 5, at 9.45 a.m.—Prof. F. Jenkin: The Astrolabe as an Introduction to Astronomy.—C. N. Hinshelwood: Catalysis.—Prof. R. A. Peters: Recent Advances in our Knowledge of Vitamines.—At 5.15.—J. H. Morrell: Short Wave Work.—At 8.15.—Prof. E. B. Poulton: Protective Resemblances and Mimicry in Insects.

Thursday, January 6, at 9.45 a.m.—F. Twyman: Spectrum Analysis by Emission Spectra.—E. J. Holmyard: Alchemy.—N. V. Sidgwick: Atomic Structure and the Periodic Law.—At 5.15.—R. S. Capon: Aeroplane Performance Testing.—At 8.15.—Prof. H. H. Turner: Eclipses, with special reference to the Total Eclipse of June 29, 1927.

Friday, January 7, at 9.45. a.m.—G. M. B. Dobson: The Upper Atmosphere.