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The Loss of the Airship *R101*.*

THE Report of the *R101* Inquiry, to which reference was made in NATURE of April 11, represents the unanimous finding of Sir John Simon and his two assessors, Lieut.-Col. J. T. C. Moore-Brabazon and Prof. C. E. Inglis. It is a remarkable document, in that it contains probably all the available relevant knowledge of the various phases of airship work, culled from a variety of sources, and presented in the form of a logical and reasoned argument that bears the obvious imprint of Sir John Simon's unbiased legal mind. The witnesses called before the court were, roughly, of three types, namely, those professionally concerned with the design and construction of the airship, who dealt with their own specialities; eyewitnesses of the disaster, mostly non-technical, whose evidence served to confirm or disprove certain theories; and other airship experts who came forward with suggestions of their own to assist the court. These matters are dealt with in one part of the Report. Another section is devoted to the question of assessing the responsibility for the existence of the general state of affairs that led to the undertaking of the flight to India at that time.

The court, in justification of the conclusions of its Report, says:

"In discussing the cause of the accident, one starts with a series of definitely ascertained facts. It is then possible to exclude, by a process of reasoning which appears conclusive, certain suggested explanations which need to be examined before they can be rejected. In the result, the analysis indicates, with some degree of confidence, the general nature of the true cause, though precise detail can never be attained, since no one who was in the control car has survived."

The final movements of the ship leading to the crash can be, it is suggested, divided into three phases. First, the ship, while in a deliberate downward pointed attitude correcting an upward deviation, was caught by a down current, and descended through a steep angle for about half a minute, thus losing height to a dangerous extent. It was probably brought to an approximately horizontal attitude by the use of the maximum possible up-elevator by the end of this dive. Second, in spite of using all the devices provided, the commander found that he was unable to get her nose up and regain his lost height, the ship continuing horizontal flight probably for a few seconds. Third, another

* Cmd. 3825. (London: H.M. Stationery Office.) 2*s*. 6*d*. net.

dive at about fifteen degrees, during which she struck the ground. In this last phase it was evident that those in charge had realised that a landing was inevitable and were seeking to minimise the crash. Their efforts were so far successful that the actual mechanical damage was remarkably slight, and the estimated forward speed at the time of impact was no more than four to five miles per hour. The fire broke out after the ship struck the ground, and but for this it is not improbable that there would have been no fatalities. It is also definitely established that the loss of control during these phases was not due to any failure of the structure of the airship, or of the control gear.

The primary cause of the accident was heaviness, which could only have been due to abnormal loss of gas. This loss was twofold. First, the bags had already given trouble by holing, due to rubbing against protruding points on the framework. This was due to the wiring round the bags, by which the framework of the ship is slung to them parachute fashion, having been let out in order to accommodate larger bags and give extra lift. This had been dealt with by padding the fouling points, but the Report makes it clear that the inspectors were by no means happy about it. Secondly, there was probably a complete deflation of one of the larger forward bags, due to the "buffeting that it would receive in consequence of a tear in the outer cover". Exactly how much either one of these is contributory to the other is not suggested in the Report. There might also have been an additional loss of gas through the gas valves, which were of novel design, if the ship had rolled excessively—and there had been expressions of opinion that *R101* was prone to rolling in rough weather.

If this theory is accepted, it fully accounts for the unmanageability of the ship; and the suggestion that the height coxswain, only on duty a few minutes, had not had time to get the 'feel' of the elevators, while it is probably true, seems to have little to do with the real cause of the disaster. In this connexion, it appears that the ship was always sluggish on horizontal control, as it came out of a dive much lower than was intended at the Hendon Air Pageant. This was before the ship was lengthened, so that afterwards it was probably even worse, and the man in charge must certainly have known this.

The other part of the Report, dealing with the responsibility for taking decisions as to making certain flights, has no direct scientific interest, but indirectly it provides damning evidence of the danger of the system of control of expenditure upon experimental work that is based upon the principle that work cannot "be proceeded with until the existing outlay is seen to be justified by results", or that such work must be held to an estimated time or expenditure. The Report makes it only too clear that the decision to undertake the flight to India, and by inference *R100*'s Canadian flight as well, at a time when it was politically expedient, was very largely influenced by the necessity to rehabilitate the airship policy when it was becoming somewhat discredited owing to its continued failure to give spectacular performances.

The Report is now public property, and as it has already been stated in Parliament that the decision upon the continuance of airship development was awaiting this, it would appear to be reasonable to examine the present position. We have now the sister ship *R100* laid up at Cardington. Two ships were purposely built in order that "accidental failure of one ship should not terminate the whole programme". The Report makes it clear, in fact it emphasises, that there was nothing fundamentally wrong with *R101*, either in general principles or structural design. Logically, therefore, the experiment should proceed. We ought to be able to avoid a repetition of this catastrophe by taking precautions suggested by the various decisions in the Report. Most of these are only too obvious now.

A non-inflammable gas must be used. This is a pity, as there was a distinct promise of success for a scheme for burning hydrogen in conjunction with the atomised oil in the engine. This was a considerable economy, as it would derive power from the gas which has now to be deliberately thrown away as the ship becomes lighter, as fuel is consumed. It is, however, inevitable, as the accident to *R101* would have been nothing like as serious had it not been followed by the instantaneous ignition of the gaseous mixture around the torn bag.

Spectacular long-distance flights must never be undertaken for psychological reasons alone. The necessity for completing an advertised programme imposes upon the experimenter an extra anxiety that is quite unfair. It is legitimate to suspect that the "very alarming experience when over the St. Lawrence River" with *R100* nearly resulted in a similar tragedy. The chafing of the gas bags and their consequent excessive leaking and weakening was the result of reducing the clearances between them and the frames to an amount that

was less than the designers originally thought safe. This was only necessary in order that the long flight to India might be undertaken. The introduction of the extra length must have made some difference in the handling of the controls, which could only have been mastered by the several watches of helmsmen after a long series of flights in all kinds of weather, under the easier conditions of mental strain that would prevail on an ordinary practice flight, in daylight, over familiar country, and without distinguished passengers on board.

The question of the time taken to swing the controlling surfaces over by hand appears to need very full investigation. The servo-assisted controls were removed in order to save weight, only after what would certainly have been full consideration of all the circumstances. It should be possible to deal with this problem by some system of gyroscopic control which would anticipate movements of the ship's bulk from the normal, rather than wait for these to be read by a helmsman and then corrected, even with mechanical assistance.

All ballast should be capable of being jettisoned immediately by the person in charge in the control room. Such decisions have to be made and acted upon instantaneously. If it is of any value to release the contents of a certain tank, that value is largely nullified if the commander has to come to the decision some minutes beforehand, in order to dispatch a man to perform the operation.

The technique of emergency landing on the ground or water should be developed as part of the routine handling. There does not appear to have been any concerted action of this kind in this case. The handling of the ship in the last dip was obviously correct, and established the competence of those in charge at the time beyond all question, and but for the failure to release the front ballast in time, she would probably have gently stranded in a horizontal attitude. It is significant, however, that both Disley and Church, who were called upon to perform the vital operations of cutting off the electric current and releasing the emergency ballast respectively, were off duty at the time, and would probably not have been so luckily available had the accident not have happened immediately after the changing of the watch. That it is possible to land a large airship on the ground under normal conditions, as would prevail when doing such manœuvres for practice, has been proved by the *Graf Zeppelin* upon many occasions.

The broader question as to the advisability of continuing airship development at all, also must be considered. Here we cannot lose sight of the fact that there are two distinct outlooks, the war and the commercial uses. It is certain that for patrolling the high seas the airship is quicker, cheaper, and has a wider range of vision than any surface vessel. Its flying range is also greater than any heavier-than-air craft. Its relative unwieldiness, and consequent vulnerability to attack, must be put on the opposite side of the scale in judging its usefulness, but the exact balance between these cannot be judged by the layman. It is certain that the distinctly naval type of airship development was only given up for reasons of economy, and the continued interest of the fighting services in them is proved by the fact that experiments upon releasing and picking up of fighting aeroplanes from airships have been carried out quite recently.

Commercially, it is certain that their large size gives them an advantage over heavier-than-air craft from the point of view of passengers' comfort, both for steadiness and room to move about. The relatively small aeroplane will always be at a disadvantage in this respect, as even if worked in relays, the passengers' physical endurance will place a definite limitation upon the length of journey that they can undertake. On the other hand, it is equally certain that until experience has proved that such a holocaust as the loss of *R101* is no longer to be feared, insurance rates alone would make the use of airships commercially impossible.

There is a school of thought that now feels that we have contributed our quota to airship development for the present, and as larger airships are being built in the United States, and projected in Germany, we might stand aside and watch those for a period. There are points in favour of this outlook, in that it is impossible to hide general results that are attained, even if it is desired to do so, a state of affairs that there is happily no reason to anticipate at the present. On the other hand, there is that somewhat intangible confidence that comes with actual experience in design, building, or handling, that no interchange of written matter can ever give to a personnel. It has been announced that a Government statement on policy with regard to airship development in Great Britain is imminent. The points we have raised should be given due weight with considerations of economy, unemployment, and other more widely appreciated aspects of the problem.

Constructive Excavation.

The Palace of Minos: a Comparative Account of the Successive Stages of the Early Cretan Civilization as illustrated by the Discoveries at Knossos. By Sir Arthur Evans. Vol. 3: *The Great Transitional Age in the Northern and Eastern Sections of the Palace: the most Brilliant Records of Minoan Art and the Evidences of an Advanced Religion.* Pp. xxiv + 525 + 24 plates. (London: Macmillan and Co., Ltd., 1930.) 105*s.* net.

SIR ARTHUR EVANS began to excavate at Knossos in the winter of 1899–1900, and his annual campaigns have been almost without intermission, except during the War. The first volume of this account of the results appeared in 1921, the second in 1928; and there is still to be a fourth, and the much-needed index besides. Even this, however, apparently, will only bring the story of the Palace down to the moment of its destruction. What happened after that "final catastrophe" is nevertheless part of the history of the site, and an important phase in the transition from Minoan to classical Greek civilisation: and it is to be hoped that, in some way or other, the very large mass of evidence which the site affords may eventually be made available, however inferior in artistic performance the later occupants may have been.

The account of the successive systems of Minoan writing, to which occasional allusion is made here, is likewise reserved for the second and third volumes of "Scripta Minoa", of which the first was published in 1909.

Following the convenient general programme, adopted in vol. 2, of an orderly progress through the Palace buildings, the present instalment leads us first (§§ 68-74) through the "North-west Insula", north of the central court and west of the seaward entrance; next (§§ 75-7) to the "North Entrance" itself, with its flanking porticoes and fragmentary reliefs of bull-hunting scenes; and then southwards along the east side of the central court, past the "East Postern" (§§ 78-9), and "Corridor, Portico, and Stairs" (§ 80), into the "Domestic Quarter" (§§ 81-2) with its "Hall of the Double Axes" (§ 83), "Queen's Megaron" (§ 84) and "East Treasury" (§§ 85-7): finally (§§ 88-9) the construction and relief-fresco decoration of the "Great Hall" take us above the "Domestic Quarter" back to the level of the Central Court. For the whole of this eastern wing of the Palace lay deeply plunged in the steep eastern slope of the neolithic 'tell' on and around which the later structures were accumulated: a protected position which accounts in great measure for the remarkable state of preservation in which the lower floors were found. Of the "Great Hall", indeed, only a few blocks can be identified; but this stood on top of no less than four stories of corridors and chambers, connected by staircases, ventilated and fairly well illuminated by light-wells, and supplied by gravity with water from cisterns or conduits somewhere up aloft.

It is necessary to insist on this elaboration of structure to appreciate the extent to which excavation has had to be supplemented here by thorough and durable reconstruction. Minoan builders made much use of timber framing as well as of posts, lintels, jambs, and floor-joists. When the Palace was wrecked, these lasted long enough to allow rainwash and debris to fill completely the lower rooms and a good part of the first floor. But in time decay set in; floor slabs settled down on the filling below them; but lintels and timber-courses left cavities and disintegrated walling, which only remained erect because it could not fall sideways. The risks, as well as the problems, of excavation must have been serious; and it was only when the same Cretan climate began to attack modern substitutes, that timber gave place to iron girders, and iron in turn to ferro-concrete (p. 288), strong enough, as the event showed, to resist even so severe an earthquake as that of 1926. Through this chapter of accidents, Knossos opens a new period of the scientific exploration of antiquity, and Minoan civilisation becomes appreciable as an organic whole, as Græco-Roman life is revealed in the *nuovi scavi* at Pompeii.

These architectural discoveries are, however, only the plot or framework of the narrative. Borrowing a literary technique, rather from saga than from the modern novel—for the topics and episodes outnumber those of the "Old Wives' Tale"—Sir Arthur Evans has succeeded with remarkable ingenuity in communicating, as he leads us round his Palace, the kind of incidental commentary on the contents, as well as the framework, which a Minoan occupant and connoisseur might have given to a guest from contemporary Mycenæ. Room by room, something strikes the attention—as it struck the spade—and halts the party. In the "Corner Sanctuary" (§ 69) it is the spiral fresco on the ceiling and the lifelike miniature painting on the walls, earlier, of course, than the furniture, which has been accumulated gradually since the room was last decorated: and this leads on to dance-scenes and occasions for dancing, through the ages, to the *pentozális* and *siganós* which they are going to dance in Cretan villages in the twentieth century—and

with much the same song accompaniment, for all its Venetian name; and so on to siege scenes and the silver cup from Mycenæ; to comparison between fresco painting and the 'metal-painting' of the 'lion-dagger', and the Homeric 'Shield of Achilles'; to religious scenes and the 'Ring of Nestor'.

Through all this, one recurrent thought leads on to the supreme instance of such dependence of Minoan *bijouterie* and *klein-kunst* on inspiration from the Palace frescoes and reliefs, namely, the bull-hunting scenes of the North Entrance, all but vanished, yet perpetuated in the 'Vaphio cups' (§ 75) and the British Museum's fragments from the Treasury of Atreus (§ 76); and we come to know what is lost, the more vividly, through discussion (§ 77) of the technique of the Minoan 'taureador', so far beyond that of modern 'rodeo' experts, yet surely vouched for by the consentient evidence of scores of episodes, on gems and other works of popular art. There is still a good deal to be made out about the details: Figs. 150 and 158, for example, tell more than even Sir Arthur has seen.

Similarly, the wonderful ivory figures from the "East Treasury" (§§ 86-7) lead to reconstruction of what must have been a superb Minoan plaything—if indeed it was not of more solemn use—and to the identification of the "Boston Goddess" and her 'migrated' Boy-God, as central pieces from this composition. Without necessarily accepting all that is suggested about the "older matriarchal stage of social development", we have here, at a very high power, religious beliefs and feelings about the order of Nature and its meaning for social beings; and remarkable anticipations of elements and incidents in Christian legend, to which, as might almost have been foretold, the mysterious gold rings of Thisbé are principal contributors. To the history of these rings, Sir Arthur has a little more to add (p. 471), and a notable corroboration of one of the queerest of the topics on them. He has also valuable confirmation (p. 420) of the authenticity of the "Fitzwilliam Lady"; if her actual bully-beef complexion was meant to be powdered and rouged. Will Sir Arthur essay reconstruction here too?

It is only because such a volume as this is not likely to be reprinted that a few slips of the pen are noted in conclusion. On p. 258 (l. 6 from bottom) "later" should be "earlier"; on p. 289, n. [2], "N.W." seems required by the context; on p. 183 n., "1906" should be "1896": p. 323, "convex" fluting should be "concave"; p. 386, the monolith bathroom is at Tiryns, not Mycenæ; p. 391, "Margaret" should be "Harriet"; p. 439, l. 40, "of" should be "by"; p. 525, l. 23, "about" should be "above": and Fig. 307 is more nearly double than treble scale. John L. Myres.

Geological Survey of the Scottish Coalfields.

Geological Survey, Scotland. The Economic Geology of the Ayrshire Coalfields. Area 3: *Ayr, Prestwick, Mauchline, Cumnock, and Muirkirk.* By V. A. Eyles, J. B. Simpson, and A. C. MacGregor. Pp. viii + 175 + 3 plates. (Edinburgh and London: H.M. Stationery Office, 1930.) 4*s.* net.

THE Geological Survey of Scotland is continuing the excellent work which it has commenced in issuing memoirs describing in detail the geology of the districts of economic importance, more particularly of the various coalfields. Whatever faults may be found with this work of the Survey, it cannot be accused of undue haste, for the immediate precursors of the present volume were published so far back as 1925. The present memoir is the third of the series which has been issued under the general title "Economic Geology of the Ayrshire Coalfields". The first two of these dealt with north Ayrshire, whilst the present volume deals with the northerly portion of central Ayrshire.

The work is very complete; the first chapter is a general one dealing with the general geological succession of the area and giving a sketch of the geology of the district. It is shown that although important coal seams occur in the Carboniferous Limestone, more especially in the central group of the three into which this series is divisible, the most important division from the economic point of view consists of the Coal Measures. These are divided into two groups, the so-called barren red measures and the productive measures, which overlie the former group. In these red measures, coal is practically absent, except for a few thin seams towards the base of the group. Its dark beds, frequently dark red or purple as their name implies, form a very distinct contrast to the grey, or at any rate light-coloured, beds of the productive coal measures. The New Red Sandstone overlying the barren red measures is briefly described, as also are various intrusive igneous rocks, whilst the superficial recent deposits are briefly referred to. It may be noted that this preliminary chapter closes with a few historical notes of very decided interest in the economic history of Great Britain.

The next chapter describes the Pre-Carboniferous

rocks, namely, the Silurian and Old Red Sandstone; and the following chapter is devoted to the Calciferous Sandstone, which here forms the lower part of the Carboniferous series. The next four chapters describe in detail the Carboniferous Limestone series in different portions of the area discussed, describing in detail the Lower and Upper Limestone group and more particularly the Limestone Coal group in each section. The presence of ironstone is more than once referred to; but it is, unfortunately, only too evident from the descriptions given that the ironstone of this portion of the coalfield is practically worked out. The next chapter describes the Millstone Grit in quite sufficient detail; and the next five chapters are devoted again to a description of the Coal Measures in various sections of the area here discussed, special care being taken to describe the igneous intrusions in each case.

The following chapter deals with a very interesting subject, namely, the Permian rocks of the Mauchline Basin and the coalfield concealed under these rocks. The authors conclude that there is no doubt that a very large field of unworked coal exists within the coal measures concealed beneath the Permian rocks, and that it is very probable that three important seams occur in workable thickness throughout the greater part of this concealed coalfield. It is shown that all the seams are likely to be thickest in the south-east, where they lie at distinctly greater depths than at the other end of the coalfield. The authors consider the possibility of some of the coal being more or less burnt by igneous rocks; but hold that the chances of their being thus burnt are considerably less on the east and north sides than on the western side, and they therefore conclude that it will probably be more profitable to open this concealed coalfield from the south-east rather than from the north-west.

There is a very short chapter dealing with superficial deposits, which are here of very little importance; whilst a final chapter is devoted to other minerals of economic importance, namely, building stones, road stones, etc., clays of various kinds, barytes, ores of lead, iron, copper, and antimony, and graphite, whilst finally a few words are devoted to what has been described as a deposit of china clay. It can only be said that this last section rivals the famous chapter on "Snakes in Ireland". In an appendix there is a short glossary of the mining and technical terms used in this memoir, which will no doubt be found useful. It may, however, be suggested that a comprehensive glossary dealing with the whole series of the Ayrshire coalfields, or even with the whole of the Scottish coalfields, might be preferable, would save a large amount of needless repetition, and would probably be more generally useful.

Like the rest of the series, this volume is well prepared and illustrated by a number of plates and figures. The work was undoubtedly worth waiting for; but it is difficult to see why the period of waiting should have been so protracted.

Blast Furnace Practice.

Blast Furnace Practice. By Fred Clements. Vol. 2: *Design of Plant and Equipment.* Pp. 509. Vol. 3: *Operation and Products.* Pp. 400. (London: Ernest Benn, Ltd., 1929.) 63*s.* net each vol.

WITH the publication of these two massive volumes, Mr. Clements has completed the task which he set himself, of presenting a complete account of modern blast furnace practice based on a comparison between the principal plants in Great Britain and abroad. The amount of labour involved has been very great, and all metallurgists must be grateful for the mass of data thus made available, and for the pains taken by the author to present them in the form of tables and diagrams. The folding tables contained in pockets at the end of each volume in themselves represent an enormous labour, and provide a comprehensive survey of existing practice. Such surveys are naturally soon out of date, as furnaces are continually being rebuilt, and some alteration of practice is sure to occur. On the whole, however, blast furnace practice remains, except for minor details, comparatively unchanged over long periods, although practice in different countries varies widely. Moreover, in spite of the frequent announcements of the success of various direct methods which are to supersede the blast furnace, there is no immediate indication of iron or steel being made from the ore in any substantial quantity without passing through this apparently crude but nevertheless efficient apparatus. This work, therefore, the most complete yet attempted on the subject, is likely to be useful for years to come.

The second volume is concerned with the actual construction of the furnace, the character of the lining, the appliances for charging and for handling the iron and slag, and also with the subject of the blast and the stoves and blowing engines. The drying of the blast, by means of silica gel, which one might expect to find here, was actually described in the first volume. There is, indeed, a certain arbitrariness in the arrangement

of the matter, and as each volume has a separate index, it occasionally needs a little trouble to find information on a point which does not have a chapter to itself. The third volume, for example, opens with chapters on the calculation of the burden and on the control of temperatures, followed by others on operating problems, but chapters on economics and on such minor subjects as the provision of ambulances and welfare work are interposed between these and the later accounts of the cleaning of blast furnace gas and the utilisation of by-products. Within the limits of each chapter, however, the arrangement of the matter is usually logical, and the expression is clear throughout, the writing being pleasantly free from the jargon too commonly found in books on a highly technical subject. The admirably clear diagrams, again, are a feature which cannot be too highly commended.

As was remarked in the review of the first volume, the weakest part of the work is its treatment of the chemical reactions in the furnace. This defect is also seen in the last volume, in the account of the use of slag for the manufacture of cement, where it would have been interesting to see references to modern work on the nature of cements, on which a very extensive literature exists. The utilisation of slag is a subject of great importance. Where the texture of the slag is such as to make it suitable for use in tar-macadam roads the problem has been solved, but not all blast furnace slags have such a texture, and the manufacture of cement provides a possible outlet, the high qualities of a properly made blast furnace Portland cement having been amply demonstrated.

Chemists should find much to interest them in a study of the blast furnace, in which a number of balanced reactions of a complex kind proceed continuously on an enormous scale. The work of Bunsen, Playfair, and Lowthian Bell placed that study on a scientific basis, but it has been strangely neglected since, although many laboratory studies of the simpler reactions between the oxides of iron and those of carbon have been undertaken. The recent work of Bone has shown how remarkable are some of the reactions, and how fully they deserve the attention of chemists. The elaborate treatise of Clements will furnish them with ample information as to the conditions under which those reactions proceed on the large scale, and much that is suggestive should be found in its pages. The practical metallurgist, on the other hand, will value a work which, if showing some minor defects, has the great merits of clear presentation and remarkable thoroughness. C. H. D.

Our Bookshelf.

Photographisches Praktikum für Mediziner und Naturwissenschaftler. Herausgegeben von Dr. Alfred Hay. Pp. x + 531 + 3 Tafeln. (Wien: Julius Springer, 1930.) 39 gold marks.

THIS handbook is the work of sixteen contributors, each dealing with some application of photography in medical and semi-medical work. The range covered is very considerable and dealt with in great detail. The illustrations are very well reproduced, as might be expected in such a book, but do not occupy an undue proportion of the space. It is sometimes urged against photographic recording that the final result often exaggerates unwanted detail and suppresses the points required. It is true that the camera and plate are not capable of selecting intelligently what the observer wants, but a study of this volume shows that a great deal can be done to attain this end.

Besides chapters devoted to record work pure and simple, such subjects as the electrocardiograph, the photographic recording of muscle movements, and the photographic side of X-ray work are dealt with.

The work is concerned primarily with medicine and the related sciences, and indeed it is rather difficult to justify the "Naturwissenschaftler" of the title. This is apparently the reason for there being no mention of the photographic plate as a measuring instrument. The technique of photographic photometry is very complex, as so many precautions are essential before the density of the image can be relied on as a measure of the intensity of the incident radiation.

The volume is essentially a practical handbook for use as reference, but the two first chapters are devoted to the optical basis of the camera and the physical and chemical properties of the light-sensitive material respectively. The latter is written from a practical point of view, and is little more than a series of directions. No attempt is made to explain the reactions of silver bromide which have been discovered in recent research. This is to be regretted, as much of this work throws considerable light on the questions of exposure, development, etc. Photography has developed so long on purely empirical lines that it is still not realised that there is a substantial basis of theoretical knowledge which can be of value in most practical applications.

A Practical Treatise on Single and Multi-Stage Centrifugal Pumps. By Raymond Defeld. Translated by C. W. Olliver. Pp. x + 221 + 42 plates. (London: Chapman and Hall, Ltd., 1930.) 21*s.* net.

To the British manufacturer of centrifugal pumps, as well as to the student who is specialising in the subject, the appearance of the translation of a volume written by a leading technical official of a well-known Continental firm can scarcely fail to be of interest, if only for the opportunity it should afford of comparing British and foreign practice in various points of detail and design. The author is chief engineer of the Ateliers de Constructions

Électriques de Charleroi, more commonly known as the A.C.E.C., and he is also professor of hydraulics at the University of Charleroi: two outstanding qualifications which should admirably equip him for the preparation of a manual of sound practical value.

The translator's preface claims that Prof. Defeld has made a life-study of the problems connected with centrifugal pumps. So much, indeed, may be readily conceded, and the volume is welcome as the contribution of an acknowledged expert. It is received as a standard work in Belgian universities. At the same time, without being unduly captious, perhaps we may be permitted to suggest that, as a treatise, the treatment is somewhat uneven and the style concise to the point of abruptness. The book, in fact, may not inaptly be described as a specialised note-book, better suited for reference purposes to the expert and advanced student than for guidance to the beginner, despite the fact that the leading principles of the subject are demonstrated, though somewhat summarily, in the early chapters. As might be expected (though the feature has obvious drawbacks), the illustrations, which are very profuse and not free from redundancy, are chiefly drawn from the products and installations of the A.C.E.C. The translator has provided what seems to be a very satisfactory rendering, and the publishers have produced an attractive volume.

B. C.

Grundlagen der Analysis (*das Rechnen mit ganzen, rationalen, irrationalen, komplexen Zahlen*): *Ergänzung zu den Lehrbüchern der Differential- und Integralrechnung.* Von Prof. Edmund Landau. Pp. xiv + 134. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1930.) 9·80 gold marks.

MANY books on analysis have an introductory chapter on the elementary theory of number, but it is rarely sufficiently detailed to provide a complete logical account based on a few clearly stated axioms. The present work by the eminent professor of mathematics at the University of Göttingen occupies a unique position in so far as it aims at giving a rigorous and complete deduction of the properties of numbers, up to and including complex numbers, from the five axioms of Peano, and that, too, by elementary methods, such as a student should be able to understand at an early stage of his university course.

There are five chapters, dealing in succession with natural numbers, fractions, sections (*Schnitte*), real numbers, and complex numbers. Each chapter gives, in strictly logical order, the definitions and propositions requisite for the proofs of the theorems concerning the application of the fundamental arithmetical operations of ordering, addition, and multiplication to the numbers with which it is concerned. The last chapter, in addition, gives the definitions and theorems relating to subtraction and division and to sums, products, and powers of complex numbers. The book undoubtedly fills a gap in the list of mathematical books, and should prove exceedingly useful to every reader who feels the need of a clear and rigorous foundation for mathematical analysis.

Systematic Crystallography: an Essay on Crystal Description, Classification and Identification. By T. V. Barker. Pp. xi + 115. (London: Thomas Murby and Co., 1930.) 7*s.* 6*d.* net.

IT is clearly desirable, whether one looks forward to the use of goniometric methods as an everyday means of identification or not, that a research worker in one laboratory should issue the results of his study in exactly the same form as an independent worker in another. But in the anorthic system, the odds against an identical treatment, even in relatively simple cases, are at least fifty to one. Yet it requires only a little care in the choice of the simplest possible indices, aided by a few rules and conventions no more unreasonable or difficult to remember than the convention that the axial angle β of a monoclinic crystal is the obtuse angle, and the odds may be reversed. The necessary rules, and the method of their application, Dr. Barker has set forth clearly. Once given the uniformity of description which would be consequent on a universal adoption of this system, the preparation of determinative tables of crystals, classified by their angles and symmetry, is relatively simple, and a specimen of such a table is given, covering some hundred substances. That such tables are of practical value is shown by Dr. Barker's successful identification of nine substances chosen from this hundred, by their aid alone. It is perhaps not too much to suggest that it is the duty of every crystallographer to study and adopt the proposed conventions—or to put forward better ones instead.

Air Ministry: Meteorological Office. British Rainfall 1929: the Sixty-ninth Annual Volume of the British Rainfall Organization. Report on the Distribution of Rain in Space and Time over the British Isles during the Year 1929, as recorded by over 5000 Observers in Great Britain and Ireland. (M.O. 325.) Issued by the Authority of the Meteorological Committee. Pp. xix + 298 + 4 plates. (London: H.M. Stationery Office, 1930.) 15*s.* net.

THIS volume, the sixty-ninth of a valuable series, gives a full account of the rainfall of the year 1929 on the basis of records from 5180 stations. It includes maps, tables, and descriptive matter showing the distribution of rainfall each month and for the whole year and its relation to the average, together with studies of heavy falls of rain on particular days, of the number of days with rain, and of well-marked spells of wet and dry weather during the year. There are also records of evaporation and of percolation through the soil.

The period from January to September was drier than any similar period in the last sixty years; but that from October to December was the wettest on record for the period. In fact, an enormous quantity of rain fell during this period in the south-west of England and South Wales.

A short article at the end of the volume deals with the rainfall of Pembrokeshire, and there is another special article on the shielding of rain-gauges.

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.*]

Magnetic Hysteresis on Weber's Theory.

IN his recent valuable review of the development of the subject of magnetism in discontinuous media [1] Prof. McKeehan makes the statement that the theory, as given in the papers to which he is there referring, "makes no provision for that magnetic hysteresis which is the distinguishing feature of ferromagnetism". This statement is literally quite correct in so

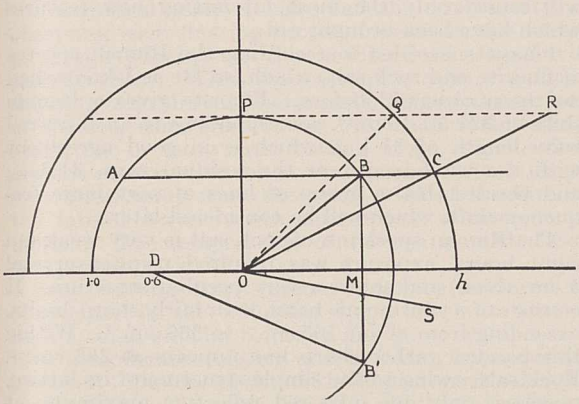

FIG. 1.

far as there was no attempt made in these papers to deal with the subject of hysteresis. But it would be misleading if it were taken to imply that Weber's theory cannot give an account of the phenomena of hysteresis. The existence of directions of equilibrium for magnetisation, alternately stable and unstable, under the Weberian internal field, compel phenomena of that type.

A complete discussion, even for the most important case of cubic crystals only, though of great interest, would be unsuited to the columns of NATURE, yet sufficient evidence as to the general validity of the

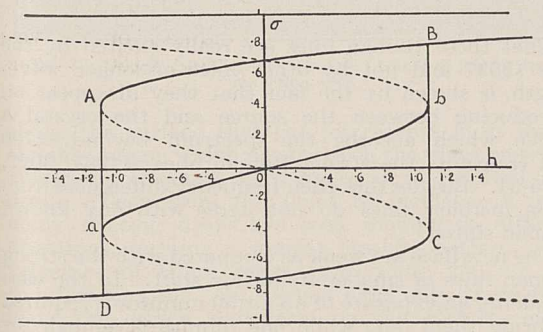

FIG. 2.

theory may be afforded by the accompanying diagrams, which refer to magnetisation parallel to a face plane of a cubic crystal.

Fig. 1 shows a simple geometrical construction which is applicable to this case. The two circles have radii 1 and h respectively, where h is the magnitude of the external field expressed in terms of the maximum value, taken as the unit of field strength, of that component of the internal field which is transverse to the direction of magnetisation. The lines PQR, ABC, and Oh are all drawn in the direction of magnetisation, and OS is in the direction of a crystalline axis of stable magnetisation. If $hOS = \theta$, and $OBA = 4\theta$, while OC is in the direction of the external field, with $COS = \theta_0$, the construction gives $OCA = \theta_0 - \theta$, and corresponds to stable magnetisation. DB' represents the internal field, the component MB' of which is

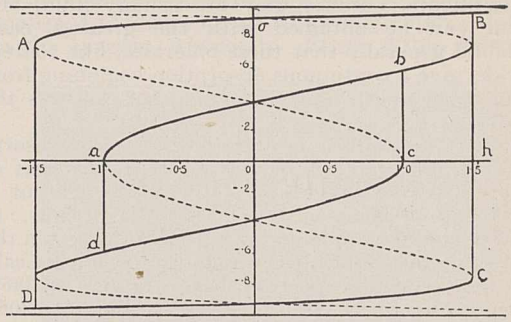

FIG. 3.

balanced by the component MB of the external field. OM gives the fractional magnetisation, σ, in the direction of the external field. If h be increased so that OC becomes OR, we have $\theta = \pi/8$, and instability is just reached.

In Fig. 2 the curve of magnetisation, $BAOCD$ is shown for the cases $\theta_0 = 0$ and $\theta_0 = \pi/4$, the equation being

$$h = 4\sigma(1 - 2\sigma^2).$$

The curve for the reverse field is also shown. Unstable stretches are dotted, and the hysteresis loop is $ABCD$. So long as h remains less than 1·1, hysteresis does not appear.

In Fig. 3 similar data are exhibited under the condition $\theta_0 = \pi/8$, the equation being

$$h = \frac{1 - 8\sigma^2(1 - \sigma^2)}{\sqrt{1 - \sigma^2}}.$$

So long as $h < 1$, no hysteresis appears. If $h > 1 < 1{\cdot}466$, approximately, the hysteresis loop is $bacd$, and the magnetisation oscillates in direction between the two mutually perpendicular axes $\theta = 0$, $\theta = \pi/2$. If h exceeds the preceding upper limit, the hysteresis loop $BADC$ is described, and the direction of magnetisation oscillates between $\theta = 0$ and $\theta = \pi$.

These results apply under the presumptions that there are no thermal motions, and that the atomic magnets can be regarded as ideal.

W. PEDDIE.

University College, Dundee,
Mar. 21.

[1] "Review of Modern Physics", 1930, p. 492.

Absorption Spectra of Saturated Chlorides of Multivalent Elements.

FRANCK and his co-workers have shown that the vapours of alkali halides show a continuous absorption spectrum beginning from a long wave-length limit and extending towards the ultra-violet. He interpreted the absorption spectrum as follows: if we take a substance like sodium chloride the valency electron of Na in the normal state may be supposed to pass over completely to Cl and the combination consists of Na^+Cl^-. Such a combination is called ionic. When light falls on sodium chloride vapour, the electron passes over from Cl^- to Na^+, the molecule thus splitting

into Na and Cl. Franck obtains the heat of formation Q of NaCl from atomic Na and atomic Cl with the aid of a Born cycle and finds that $Q = Nh\nu$ where ν = frequency of the beginning of continuous absorption.

The absorption spectra of saturated halides of multivalent elements have been studied in this laboratory for some time past, and yield results of general interest. The chlorides of tetravalent elements, CCl_4, $SiCl_4$, $TiCl_4$, and $SnCl_4$, are the easiest to investigate, because they are usually fluid, and vapour can be obtained with the greatest ease. We found generally that these chlorides, like sodium chloride, give a continuous absorption beginning from a long wave-length limit and extending towards the ultra-violet.

At first the frequency of the beginning of absorption seemed to have no connexion with the heat of formation in the process $M + 4Cl = MCl_4 + Q$, but it turned out ultimately that $Nh\nu = Q/4$. Thus, to take a definite example, in $SnCl_4$ the value of Q in the process $Sn + 4Cl = SnCl_4 + Q$ is found to be 306 gm.cal., while the absorption spectrum begins from $\lambda = c.$ 3860, corresponding to 74 gm.cal., which is about $\frac{1}{4}$ (306). In CCl_4 absorption begins at $c.$ $\lambda = 2400$, corresponding to 118 gm.cal., while Q is nearly four times as large, namely 464 gm.cal., provided the heat of vaporisation is taken to be 282 gm.cal. as proposed by Fajans.

The explanation is quite simple. The four chlorine atoms may be supposed to be symmetrically distributed about carbon or tin, and the whole energy of formation is equally shared by the four chlorine atoms. The effect of light is to remove the electron from one Cl ion to the carbon shell, thus splitting CCl_4 into CCl_3 and Cl.

The relation may be expected to be generally true. The vapour of the saturated halide of an n-valent atom is expected to show beginning of continuous absorption at $\nu = Q/nh$ where Q is the heat of formation in the process $(M) + n(Cl) = (MCl_n) + Q$. It can be shown from considerations of a Born cycle that

$$Q = \lambda_M + \frac{n}{2}D_{Cl_2} + R - \lambda_{MCl_n},$$

so that
$$Qn = \tfrac{1}{2}D_{Cl_2} + \frac{R}{n} + \frac{\lambda_M}{n} - \frac{\lambda_{MCl_n}}{n}$$

where
$$[M] + \frac{n}{2}(Cl_2) = [MCl_n] + R.$$

D_{Cl_2} = heat of decomposition of Cl_2, and λ_M, λ_{MCl_n} are the heats of sublimation of the element and the chloride respectively. These are very often not known. But Messrs. Deb and Mahanti in this laboratory have extended the investigation to the magnesium and aluminium halides (divalent and trivalent) and have found good agreement with theoretically predicted values, provided the assumed values of λ_{MgCl_2}, etc., which are yet unknown, prove to be correct. But no agreement has been found in the case of $HgCl_2$, which seems to behave like HCl or AgCl, which, according to Franck, do not conform to the type called ionic binding, but to atom-binding.

A. K. DUTTA.
M. N. SAHA.

Physical Laboratory,
University of Allahabad,
Mar. 20.

Raman Spectra of Crystals.

I HAVE been investigating the Raman effect in a number of crystals, using the same method of excitation which proved to be particularly successful with gases.[1] The primary source consists of a powerful water-cooled mercury arc, which gives an extremely intense and sharp resonance line λ2537. The advantages of this method are: (1) the ratio of the intensity of the line λ2537 to the other mercury lines in the ultra-violet is so large that in a spectrogram of moderate exposure all the Raman lines are excited by the former radiation; (2) a short exposure is required (10 minutes to three hours); (3) a wide range of frequency shifts is available (about 20,000 cm.$^{-1}$); (4) the exciting radiation can be easily absorbed by a filter of mercury vapour between the substance and the photographic plate, thus allowing the observation of modified frequencies in the immediate neighbourhood of the primary line.

In the Raman spectra obtained by this method, many new faint lines are observed in almost any crystal which has been tried, and the intense lines can probably be measured with more accuracy than has hitherto been done, on account of the large dispersion which it is possible to use. But here I will report only the most interesting new features which have been brought out.

I have succeeded in recording the Raman spectra of fluorite and rock salt, which, so far as I know, had not been observed before. Fluorite gives a Raman shift of $321{\cdot}5 \pm 1$ cm.$^{-1}$, corresponding to an infra-red wave-length of 31·1 μ, which is in good agreement with the wave-length of the residual rays, 31·6 μ; and besides this, a group of lines of very large frequency shift, which will be considered later.

The Raman spectrum of rock salt is very weak (an eight hours' exposure was required, using a crystal 5 cm. thick) and shows a very peculiar structure. It consists of a continuous band, with fairly sharp limits, extending from about 165 cm.$^{-1}$ to 365 cm.$^{-1}$. Within this band, a rather sharp line appears at 235 cm.$^{-1}$. Rock salt, owing to the simple structure of its lattice, possesses only one infra-red reflection maximum, at 52·5 μ. This does not coincide at all with the frequency of the Raman line.

A still more peculiar phenomenon is exhibited by calcite and fluorite. These crystals show, besides the ordinary Raman lines, a group of lines with a very large frequency shift, much larger indeed than any which has been observed so far in the Raman effect. The following table gives the numerical values of $\Delta\nu$ in cm.$^{-1}$ (± 2 cm.$^{-1}$):

Calcite.	Fluorite.
7270·3	7255·8
7345·2	7273·3
7395·0	7285·4
7455·5	7297·6

That these Raman lines are really excited by the line λ2537 and not by other lines of longer wave-length, is shown by the fact that they disappear on introducing between the source and the crystal a screen which absorbs the spectrum beyond λ2700 and transmits the strong Raman lines λλ2967, 3022, 3125-31. Besides this, their frequency differences from these mercury lines do not agree with any known Raman shifts.

The new lines are weak as compared with the strong Raman lines of smaller frequency shift. In the case of calcite, an exposure of about 30 minutes is required to bring them out, while one minute is enough for the strongest line, $\Delta\nu$ 1086 cm.$^{-1}$.

I have not been able to find a reasonable explanation for these Raman lines. It is very unlikely that they should correspond to vibration frequencies of the crystal, since such high fundamental frequencies are never found in molecules or crystals, even when containing hydrogen atoms; and the occurrence of higher harmonics in Raman effect without the lower harmonics showing at all seems even more improbable. I am rather inclined to attribute the new lines to

electronic transitions, although the existence of such levels in CaF_2 and $CaCO_3$ seems rather strange.

I may add that analogous lines have been looked for unsuccessfully in ice, quartz, rock salt, gypsum, anhydrite, aragonite, and barite.

F. RASETTI.

Physical Laboratory of the University,
Rome, Mar. 18.

[1] *Phys.* Rev. **34**, 367; 1929. *Zeits. f. Phys.*, **61**, 598; 1930. *ibid.*, **66**, 646; 1930.

Liquid Drops on the Same Liquid Surface.

As a confirmation of L. D. Mahajan's view that water is a suitable liquid for the formation of liquid drops floating on its own surface,[1] I can adduce two observations, the first of which is analogous to his observations at Den Kund.

For several years, I have had the opportunity of observing such floating drops of water in the Strait of Trogir (Traù), on the seaboard of Jugoslavia (Adriatic Sea). When the sea is quite calm, the drops dripping from the oar-blades and falling on the surface of the sea, sometimes throw out, from their falling point, one or more such floating drops, which, after a quick motion, last for several seconds. Such drops sometimes spray from the acute crest of the first of the lateral waves which accompany a steamer in motion. The temperature of the sea in such cases was probably 18°-23° C.

Such floating drops (primary) can be produced in abundance in the following way: From a nozzle, with a small circular orifice, a fine jet of water issues with a moderate velocity and is falling on a surface of water. The orifice should be kept at such a height

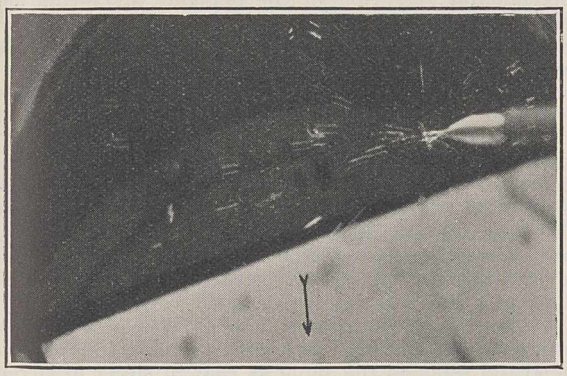

FIG. 1.—Velocity of efflux, 86·6 cm./sec.; height of jet, 0·7 cm.; reduction, 0·68.

above the surface that the jet reaches it in its instability range, which lies between the place where its vibrations originate and where it is resolved into drops. Then from the point of incidence a great many floating drops are seen moving in different directions, forming a regular fan-like pattern. The velocities of efflux range from some 250 cm./sec. to a few mm./sec. In the last case, only single drops leave the orifice, and form on the surface—either directly or coalescing from two—uncommonly large drops (by estimation up to 6 mm.), which last about 3 seconds. In my experiments, the diameter of the orifice was 0·5 mm., while the height of the falling jet was from 0·5 to 1·5 cm., and they were performed at room temperature.

The smaller the terminal angle of the jet or the greater the velocity of efflux the narrower is the fan of moving drops. With fairly high velocities and rather small angles (about 45°) the fan grows narrower to some 20°-30° or gets reduced only to one ray of the drops. In this case, the greater part of the falling jet reflects in the plane of incidence and forms a low parabola, consisting of dense drops, which, after a renewed fall on to the surface, proceed in a straight direction. In the case of vertical or nearly vertical incidences and of velocities smaller than 120 cm./sec. the fan of the drops comprises 360°, and the drops spray fan-like in all directions.

The average diameter of a drop is 2 mm. It is smaller if the velocity of efflux is greater. It lasts, on the average, 2 seconds. Single drops, especially

FIG. 2.—Velocity of efflux, 89·1 cm./sec.; height of the jet, 1·1 cm.; reduction, 0·70.

those which have returned from the wall of the vessel, lasted up to 5 seconds.

The photographs reproduced herewith have been made from a nearly vertical position, while the surface of water was obliquely lit by the sun or arc-light. They represent these drops in motion (time of exposure 0·04 sec.). An arrow shows the incidence of light. Each drop in motion showed, above the dark base, as a pencil of parallel lines, which corresponds to the optical images, as formed on the drop.[2] Three parallel lines regularly correspond to one drop. These are well seen on the drops which move more or less perpendicularly to the incident light. On the side facing the source of light there appear two lines very near each other, while the third is somewhat farther away. Their relative intensities are changeable. Often, also, the third line is double. Bright lines near the point of incidence of the jet usually show a periodical granulation. This can be ascribed partly to the vibrations of the drop, owing to which it periodically changes shape, partly to the jumpy motion. Such granulation is well shown on the under-exposed photographs (Fig. 2). That these are really drops, and not bubbles, can be seen from the fact that they throw a shadow on to the white part of the bottom of the vessel.

The above-described phenomenon can be shown by experiment with both distilled and tap water. Success depends on the freshness and cleanness of the surface of the water used. Even the least traces of grease make success impossible. The very touch of the surface with the fingers lessens the range and life of the drops.

The drops are not reflected at the wall of the vessel itself, but return before coming to it. Drops of small velocity return at a distance of nearly 1 cm. from the wall of the vessel. This distance decreases with increase in the velocity. The drops seem to return owing to the motion along the slope of the surface, which slowly ends in the angle of contact.

As to the origin of this phenomenon, it should be kept in mind that the jet in its state of instability breaks up into drops on the vibrating surface at the

point of incidence. Here the drops reflect in various azimuths, according to the momentary position of that part of the surface on to which they fall.

M. KATALINIĆ.

Physics Institute,
University of Zagreb, Jugoslavia,
Mar. 20.

[1] L. D. Mahajan, NATURE, **126**, 761; 1930.
[2] M. Katalinić, *Zeit. f. Physik*, **38**, 511; 1926.

University Entrance Scholarships for Science.

I HAVE read with great interest the recent correspondence in the *Times* on science in scholarship examinations and the comments upon it in the leading article in NATURE of Mar. 28. I should like to present a point of view rather different from any which have hitherto been put forward and to support it by a number of facts which, in my opinion, have not yet received the attention which they deserve. I believe that the science specialist at school does devote a reasonable amount of time to literary subjects and does leave school with a satisfactory interest in literary culture, whereas the humanist devotes little or no time to the study of science and leaves school with an attitude of condescension towards it, which savours of intellectual snobbery and does little credit to the type of education which he has adopted.

In support of this view, I propose to outline the typical preparatory and public school education of both an intending science scholar and a classical scholar. The latter usually commences Greek at his preparatory school, so he begins some measure of specialisation at the age of about eleven. He then spends the first two years of his public school career on a course of 'general education', which includes six periods a week of Greek and only three periods a week of science. Having taken the School Certificate, he then commences specialisation in earnest and the time which he now devotes to science is reduced to one or two periods a week for the rest of his time at school, or perhaps only for the first year of specialisation. I should add that, whereas the classic does only three periods a week of science in his course of general education, intending specialists in modern languages or history do some seven periods a week. The future science scholar, on the other hand, arrives at his public school having done little or no science and spends his first two years on precisely the same course of work as the intending modern language or history specialist. He is, quite rightly, not allowed to specialise at all until he has passed the School Certificate, and even then his course includes some eight periods a week of literary subjects. The same thing is also true of the poorer boys, who appear to be the chief concern of the headmaster of Charterhouse; these boys will be at the day schools, and it is laid down in the Board of Education Regulations for Advanced Courses in Science that from one-quarter to one-third of the time must be devoted to literary subjects. I think that the statistics which I have quoted are typical and they show quite clearly that it is the classical scholar who is the real culprit in this matter of premature and narrow specialisation.

If we now turn to the attitude shown by the specialist to subjects other than his own after he has left school, I feel that the facts again point the finger of accusation at the humanist rather than the scientist. In this respect I would venture to add my testimony to that of Prof. A. V. Hill in defending the interest taken by the professional scientist in art and literature, while the interest of the mathematician in music is proverbial. But the classic has little interest in, and perhaps even less knowledge of, scientific culture. In fact, so narrow is his interest in even Greek culture, that when the Oxford University Press wish to publish a book on the "Legacy of Greece", they invite scientists such as Dr. Singer to write those sections of the book dealing with the distinguished contributions of that civilisation to the various branches of science. The headmaster of Charterhouse states in his letter that science is destined to play an ever-increasing part in the affairs of the State, and in recent years leading articles in NATURE have deplored again and again the reactionary attitude of the Civil Service to scientific research and its introduction in State departments and the Services. It is surely not without significance in this respect that the large majority of Civil servants have had a classical or humanist education.

In conclusion, I venture to hope that no more will be heard of the dangers of premature specialisation in science, which, I think I have shown, are grossly exaggerated, but that attention will be turned to the far more urgent problem of ensuring that all specialists in the humanities shall devote at least four periods a week to science. For, until this is done, I shall continue to maintain that it is they, and not the scientists, who are the real offenders in this matter of specialisation.

A. W. BARTON.

Repton School,
Derby.

Conditions of Silver Chromate in Gelatine Hydrolysed and Electrodialysed to Different Extents.

IN a series of papers, Dhar, Chatterji, and collaborators have shown that if a reaction between two salts giving rise to an insoluble product is allowed to take place in gels, the insoluble substance exists in colloidal condition in the gel and the formation of Liesegang rings is due to the coagulation of the colloid. It has been shown, however, by Williams and Mackenzie[1] and Bolam,[2] that the insoluble substance produced by the reaction between two salts exists in supersaturated condition in the gel, and their results support the theory of the formation of Liesegang rings proposed by Wi. Ostwald.[3] Experiments have been carried out by us to study the condition of silver chromate in gelatine hydrolysed (by heating) and electrodialysed to different extents, by determining the contact potential of pure silver in a mixture of $N/100$ silver nitrate, $N/100$ potassium chromate, and 3 per cent gelatine.

So long as the mixture remains yellow and there is no visible precipitation of silver chromate, the contact potential remains the same as that of silver in silver nitrate of the same concentration as in the mixture; but with the appearance of the precipitate, the contact potential gradually decreases and tends towards a limiting value. The general conclusions from the measurements of contact potential can be summarised as follows:

(1) More than 95 per cent of the silver chromate remains in the ionic condition in the gel. (2) The power of gelatine to inhibit the growth of crystallisation centres decreases with the progress of hydrolysis. (3) The inhibitive power of gelatine increases with the progress of electrodialysis. (4) The inhibitive power of gelatine is closely associated with its pH, and the smaller the pH of gelatine the greater is its inhibitive power. (5) The solubility of silver chromate in unhydrolysed gelatine is not increased by decreasing its pH. (6) The solubility of silver chromate in gelatine increases with an increase in the degree of its hydrolysis.

It is also found by varying the concentrations of the reactants (silver nitrate and potassium chromate) that the precipitation of silver chromate follows the usual

rules of solubility product. On subjecting the mixture of silver nitrate and potassium chromate in gelatine to cataphoresis, silver chromate formed by the interaction is not found to carry any charge (either in the yellow mixture before the appearance of the precipitate or in the reddish turbid mixture after some precipitate has appeared). These results, therefore, show that most of the silver chromate in gelatine in these experiments is in ionic and not in colloidal condition.

Similar experiments have also been carried out by allowing silver nitrate and potassium chloride to react in gelatine. It is found that in this case whatever fall in the contact potential is to take place, occurs as soon as silver nitrate in gelatine and potassium chloride in gelatine are mixed, the process not being gradual as in the case of the mixture of silver nitrate and potassium chromate in gelatine. Most of the silver chloride in gelatine exists in a condition other than ionic.

It is considered that the results obtained from a study of the precipitation of sparingly soluble substances, such as silver chloride, which do not form Liesegang rings in gelatine, should not be applied to explain the condition of sparingly soluble substances, such as silver chromate, which do form Liesegang rings in gelatine. There is a difference in the function of the gelatine in the two cases.

The results will be discussed elsewhere in detail.

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B. N. DESAI.

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[1] *Jour. Chem. Soc.*, **117**, 151; 1920.
[2] *Trans. Far. Soc.*, **24**, 463; 1928: and **26**, 133; 1930.
[3] *Zeit. f. physik. Chemie*, **23**, 365; 1897. "Lehrbuch. d. allgem. Chemie", second edition, vol. 2, p. 778; 1899.

Explosions of Hydrogen Sulphide–Oxygen Mixtures.

IN the course of an investigation of the kinetics of the reaction between hydrogen sulphide and oxygen at temperatures just below, and up to, that of ignition, an interesting phenomenon concerning the explosion has been observed, which, although in the light of certain recently discovered chain reactions may not be without parallel, yet seems sufficiently striking to warrant mention here.

In a cylindrical glass reaction vessel, 3·5 cm. in diameter, hydrogen sulphide–oxygen mixtures appear to ignite above about 220° C., though the ignition temperature of course varies somewhat according to the total pressure and relative proportion of the gases used. In a similar vessel, 1·1 cm. in diameter, no ignition could be observed at 300° C.

In a cylindrical vessel of intermediate size, namely, 1·5 cm. in diameter, ignition sometimes occurred using higher pressures at 260° C., but generally not below about 270° C. The first fact of interest is that the explosions under these conditions were never complete, although when explosion did occur the oxidation was in accordance with the equation

$$2H_2S + 3O_2 = 2H_2O + 2SO_2.$$

An induction period of some seconds (or minutes) always preceded an explosion. As an example of this, 150 mm. hydrogen sulphide and 300 mm. oxygen were introduced in this order into the glass vessel at 280° C. After 8 seconds induction period (no pressure change) sudden explosion occurred with a pressure decrease of 45 mm. If complete explosion had occurred the pressure decrease would have been approximately 75 mm. During the 5 minutes following the explosion a rapid reaction occurred with 30 mm. pressure decrease. In this way the hydrogen sulphide surviving the explosion was finally burnt up in a rapid change. On the other hand, if the oxygen–hydrogen sulphide ratio is increased the rapid reaction following the explosion may give way to additional explosions. Thus at 280° C.:

(1) Hydrogen sulphide, 100 mm.; oxygen, 400 mm.

0 m. 3 s.	exploded.	. 25 mm.	pressure decrease.
0 8	exploded again	15 mm.	,, ,,
0 15	,, ,,	10 mm.	,, ,,
		Total 50 mm.	pressure decrease.

(2) Hydrogen sulphide, 196 mm.; oxygen, 404 mm.

0 m. 5 s.	exploded, 25 mm.	pressure decrease.
0 15	exploded again, 16 mm.	pressure decrease.
0 20	measurable reaction starts.	
0 50	additional pressure decrease	10 mm.
1 27	,, ,, ,,	20 mm.
2 18	,, ,, ,,	30 mm.
3 20	,, ,, ,,	40 mm.
5 35	,, ,, ,,	55 mm.
	Total decrease of pressure	96 mm.

It is very striking that so many as five successive and quite well-marked explosions have been observed with the same mixture, each being preceded by an induction period which lengthens as the mixture is used up. The rise in temperature consequent upon an explosion is never more than 1° C.

The nature of the phenomenon and the conditions under which it occurs are to be further examined. Meanwhile, a detailed report of the characteristics of the reaction as a whole is in the press; in this a closer discussion of the facts is given.

H. W. THOMPSON.

St. John's College, Oxford,
April 1.

Plankton Changes on the Coast of Ecuador.

DURING the month of February of this year an unusual phenomenon has been observed in connexion with the coastal waters of the Pacific from the headland of Santa Elena to the north of Esmeraldas, Ecuador.

The normal blue and clear waters of the ocean along the littoral zone have been replaced by turbid, yellowish brown lenses of water which emit a most disagreeable and fœtid odour, suggesting stagnant swamp conditions. These discoloured patches, which occur not only along the shore-line but have also been reported in the steamship lanes from Panama southwards, indicate that they have been possibly induced by the equatorial current from the north (El Niño) which, at this time of the year, is found in close association with the cooler Antarctic Current (the Humboldt). The latter, as is well known, impinges upon the greater part of the west coast of South America during many months of the year.

An examination of the discoloured water under the microscope has revealed the fact that it is full of plankton material (the greater part consisting of spores of marine algæ), and there is no suggestion of mud or other sedimentary detritus.

The idea has been put forward that the normal plankton of the Humboldt Current has succumbed owing to the higher temperature of the equatorial current; on the other hand, it is just possible that the sudden increase in temperature of these waters, caused by the influx of the warm water from the north, may have been responsible for an abnormal

fructification of the larger marine algæ, with a consequent dissemination of spores in sufficient numbers to discolour the water. Whatever be the cause, however, the phenomenon is unusual, and has never been noticed by me before during eight years' residence in this part of South America.

GEORGE SHEPPARD.

State Geological Department,
Ecuador, Feb. 26.

Disease in Nature.

IN the review of "The Science of Life", by Wells, Huxley, and Wells, there is a statement on p. 479 of NATURE of Mar. 28, "we are prepared to defend the thesis that wild Nature (that is, apart from man's interference) is characteristically marked by exuberant positive health, while in civilised society diseases are rife and sub-health is becoming almost normal!".

The statement is very attractive but, in so far as it refers to plants, is erroneous. We are only too well aware of the diseases of crops, but the factors which enter into the problem are not sufficiently understood for us to be able to distinguish clearly between the disease of a crop and the disease of individuals. It is a truism that there is a greater opportunity for the spread of disease in crops than in Nature; further, until recently, the cultivation of varieties of crop-plants immune to a particular disease received scant attention.

The suggestion that trees, herbs, and shrubs growing in their natural habitats are invariably in good health is wide of the mark. While it is customary to assume the prevalence of fungal attack in tropical vegetation as visualised by popular writers, it is not perhaps realised that British flowering plants, probably without exception, are parasitised by one or more fungi. This parasitism is obviously of different degrees of severity, but it is so general that it has to be taken into account in intensive ecological investigation.

J. RAMSBOTTOM.

British Museum (Natural History),
Cromwell Road, London, S.W.7,
Mar. 30.

No one can doubt that infection with parasites and predatory microbes is common in wild Nature, both among plants and animals, but that is not tantamount to saying that disease is common. For disease, whether constitutional, environmental, functional, or parasitic, means disintegrative or deteriorative disturbances of the normal balanced metabolism of the organism. Speaking of animals some years ago, the late Sir Ray Lankester said that he knew with certainty of only one microbic *disease* in wild Nature—a bacterial disease of sandhoppers. Many parasites—if not most—seem to do little harm to their host, unless that becomes somehow enfeebled, for example, by man's over-crowding or over-sheltering. In many cases, the parasite establishes an innocuous *modus vivendi* with its host, though it may become harmful if man transfers it to a new hospitality. Moreover, many so-called parasites (the concept has become woolly) are really predatory organisms devouring the plant or animal from within, as a beast of prey does from without. Such predatory intruders may destroy the victim, but they do not bring about disease. All evidence from crops and plantations and the like must be excluded as irrelevant to my point that wild Nature is characteristically marked by exuberant positive health. But this is not to be taken as a dogmatic assertion that there is no disease in wild Nature, and Mr. Ramsbottom's expert caveat is very welcome.

THE REVIEWER.

Extraction of Insulin.

IN some earlier experiments it was found that insulin was precipitated quantitatively from commercial preparations by means of sulphosalicylic acid, and it appeared to us that this fact might form the basis of a method for the extraction of insulin which would obviate the use of large quantities of alcohol.

The following is an outline of the technique eventually employed: Bullock's pancreas, frozen immediately upon removal from the animal, is minced and allowed to thaw out in about two-thirds its weight of 20 per cent sulphosalicylic acid. After two hours the whole is filtered in a hydraulic press and the comparatively dry residue covered with acetone and left to dehydrate overnight in the cold. The almost water-free residue is now extracted in a Soxhlet with acetone and finally dried rapidly in a current of air at 40°. The active principle can now be extracted from the powdered fat-free residue by 75 per cent alcohol containing about 0·5 per cent of hydrochloric acid. The aqueous-alcoholic solution of insulin hydrochloride is concentrated in the usual way and the product precipitated with acetone. We obtained about 2 gm. per kgm. of minced pancreas. A solution of 0·1 gm. of this substance produced, by subcutaneous injection in a 2 kgm. rabbit, hypoglycæmic convulsions in five and a half hours.

This method, whilst not entirely dispensing with the use of alcohol, requires much less than those in which *fresh* pancreas is extracted. We have not explored the conditions for obtaining maximum yield, nor have we the time to do so, but we give the foregoing details of a method which, we venture to think, may prove to be of interest to those more actively engaged in the manufacture of insulin.

P. G. MARSHALL.
B. P. WIESNER.

The Macaulay Laboratory,
Department of Animal Genetics,
The University, Edinburgh.

Identification of the Plant called 'Narthex'.

IN NATURE of June 21, 1930, p. 920, Mr. Henry Balfour inquired as to the nature of the plant called 'narthex' by the present inhabitants of Lesbos. Through the kindness of Miss Winifred Lamb, who has been excavating there, it has been possible to identify it with *Ferula communis*, which is the giant fennel and, like a reed, has a hollow stem.

This, however, does not definitely solve the point at issue. Dr. G. F. Hill points out to me that some of the Cyrenaic coins have represented on them a *Silphium*, which is now extinct and which probably also had a hollow stem. For further information the Catalogue of the Greek Coins of Cyrenaica (British Museum), by E. S. G. Robinson (1927), p. ccli, can be consulted.

N. EUMORFOPOULOS.

University College,
Gower Street, London, W.C.1.

THE definite identification of νάρθηκα, as used by modern Lesbians, with the giant fennel, *Ferula communis*, is interesting, and seems to dispose of Theodore Bent's identification of it with a reed. The dry pith inside the fennel stalk would, when ignited, continue to smoulder gently inside the protective casing of the stalk, which would prevent the wind causing the pith tinder to be too rapidly consumed. Bent's explanation of the νάρθηξ as serving to prevent the smouldering tinder "being blown out", is clearly erroneous. I desire to thank Mr. Eumorfopoulos for his note upon my communication of June 21, 1930.

HENRY BALFOUR.

Isomorphism and Chemical Homology.

IN NATURE of Dec. 13, 1930, p. 916, is a communication by Prof. Willy Lange, of Berlin, referring to a letter by me [1] on this subject. The misunderstanding can be easily cleared up. Dr. P. B. Sarkar has been working in this laboratory for a long time on the chemical homology and isomorphism of complex ions, and his first paper on the subject, on the homology of fluoberyllates and sulphates, was published in 1929.[2] In continuation of this work, and proceeding on the basis of Goldschmidt's principles of isomorphism, he was investigating the possible cases of isomorphism among the inorganic complex radicles or ions. It was a pure accident that he should have been working on the isomorphism of monofluophosphates and sulphates when Prof. Lange's paper appeared in the *Berichte* of the German Chemical Society. As in this paper only the simple monofluophosphates and sulphates were described, and crystallographic investigation only of the same was promised, it was not considered necessary to give up that part of Dr. Sarkar's work which dealt with the isomorphism of double monofluophosphates and double sulphates, and even then a year was allowed to pass by in awaiting further communication on the subject by Prof. Lange. As nothing appeared in the interval giving any indication on Prof. Lange's part that he would extend his work in this direction as well, I did not consider it justifiable to withhold the publication of this part of Dr. Sarkar's work any longer. Prof. Lange's petition to the Notgemeinschaft der deutschen Wissenschaft on April 29, 1929, regarding the formation of alums by the fluophosphates did not appear in any scientific journal or abstracts, and hence could not attract our notice.

However, I deplore the omission of Prof. Lange's name in my note, which was not made with any desire to claim priority ; complete recognition of his work will be made when Dr. Sarkar's work is published in full.

P. C. RÂY.

University College of Science and Technology,
Calcutta, Mar. 3.

[1] NATURE, Aug. 30, p. 310.
[2] *Jour. Indian Chem. Society*, vol. 6, No. 6; 1929: and NATURE, Sept. 28, 1929, **124**, p. 480.

The Karoonda (S.A.) Meteorite of Nov. 25, 1930.

FOLLOWING on my letter of last week [see NATURE, Mar. 14, p. 402] concerning the Karoonda meteorite, I now enclose a brief report by Mr. A. R. Alderman, of the Geology Department, University of Adelaide, giving the results of a petrographical and chemical examination made by him of the substance of the meteorite.

The final results of the chemical analysis will not be available for some months.

KERR GRANT.

The University of Adelaide,
Adelaide, Feb. 13.

The dark greyish interior of the meteorite consists of a dull ground-mass relieved by numerous black chondrules and spangles of a brassy mineral which is probably troilite (ferrous sulphide). The chondrules are very hard and compact and may quite easily be rubbed away from the friable ground-mass by the fingers.

Undoubted metallic nickel-iron is present in such small amount as to be indistinguishable in the hand specimen.

A rough microscopical examination reveals that olivine is by far the most important mineral in the ground-mass. Some hypersthene is also present.

The chondrules consist of these minerals with a good deal of glassy material. Minute granules of nickeliferous iron are but rarely seen, but grains of an opaque brassy mineral are of very variable size and are apparently troilite.

The chemical analysis (not yet completed) is in agreement with the mineral composition. Silica is very low, about 34 per cent, whereas in the silicate material ferrous iron is present in greater amount than is magnesia.

An accurate estimate of the percentage of metallic material is not yet available, but it seems probable that metallic iron constitutes less (possibly much less) than 0·3 per cent of the specimen analysed. Nickel is of the order of 0·03 per cent.

Medicinal Cod Liver Oil.

IN our recent Report to the Empire Marketing Board on the Relative Values of Cod Liver Oils from Various Sources (E.M.B. 35), noticed in NATURE of April 4, p. 538, an unfortunate blunder has arisen during the revision and proof-reading of the introductory chapter.

Reference 6 on page 9 is incorrectly given and should, of course, refer to the important paper by Prof. Steenbock and his colleague Dr. Boutwell in the *Journal of Biological Chemistry*, vol. 42, p. 131 ; 1920.

Immediately our attention was directed to the error we wrote to Prof. Steenbock expressing our great regret and, although he desired that we should give no further attention to the matter, we feel that we must override his wishes and make public our correction of the mistake.

On the same page the reference to Prof. E. Mellanby's pioneer researches on the causation of rickets might suggest that his results were not published before 1921. We were, of course, well aware of his earlier contributions to the subject but thought it better, in a brief summary, to refer the reader to the full account of his earlier work which was published by the Medical Research Council.

We would like to express our apologies to these distinguished investigators.

J. C. DRUMMOND.

University College, London.

T. P. HILDITCH.

University of Liverpool,
Mar. 25.

Atomic Weight of Krypton.

WHILE measuring the dielectric coefficient of a particularly pure sample of krypton, it occurred to me that a density determination would be of interest in view of Aston's recent statement that the accepted value of the atomic weight appeared from his measurements on the relative quantities of the isotopes to be much too low.

I made a comparison of the densities of krypton and oxygen by means of the microbalance and found that at 25° the pressures at which the two gases had equal densities were 301·15 mm. and 787·8 mm. If the compressibility corrections were proportional for the two gases, the atomic weight of krypton would be 83·71, while using the most probable value for the compressibility of krypton which I calculated in 1910, the figure reduces to 83·62.

While these results must not be considered final, it appears highly probable that Aston's figure 83·77 is more accurate than the accepted 82·9.

H. E. WATSON.

Indian Institute of Science,
Bangalore, India, Mar. 17.

The New Crystallography.

By F. I. G. RAWLINS.

THE attraction which the study of crystals has always exerted, not only upon the scientific worker but also upon a wider circle, is in no danger of abating. The time is perhaps appropriate to discuss a number of developments which have come about during, roughly, the last five years. So far as the crystalline state itself is concerned, the chief change has been one of classification; it is not necessarily the crystal system which determines much of our present-day knowledge, but rather the atomic environment. Thus, in rock salt, each atom (or more strictly, ion) of sodium is surrounded by six ions of chlorine at the corners of an octahedron, and conversely. From the experimental point of view, this advance must be placed to the credit of the X-ray workers; it has only comparatively recently been recognised, however, that upon the structures thus established it was possible to build up a systematic chemistry of the solid state, based upon the conceptions of environment, ionic size, and ionic deformability.

It has come about that a considerable part of the subject of crystallography is concerned with the question: Given the structures of a large and increasing number of elements and compounds, how much can be deduced about their physical and chemical properties? And again, one asks what kind of experiment is most likely to provide this information, and whether it is essential to work with crystals at all in some instances. These queries are easily seen to reduce to this: whether it is desired to know something about the crystalline lattice, or whether it is the components of the lattice that are the more important. Research of the former kind obviously needs actual crystals, whereas the latter may be able to make some progress in states of matter wherein lattices, as ordinarily understood, do not exist: for example, solutions and even gases. Clearly, the new crystallography will trespass upon the preserves of many neighbouring sciences.

The Union of Ions into Crystals.—From a logical point of view, it is not altogether fortunate that so much attention has been given for so many years to the morphology of crystals as such. A more fundamental way to proceed would be to consider a free atom of an element A at some distance from a free atom of some other element X, and to follow the course of events in which all the A's and all the X's are bound so that the assemblage $\Sigma[A, X]$ is in equilibrium, at a temperature such that the components A and X are constrained to fulfil certain definite geometrical conditions with respect to each other. Stability will ensue for that particular configuration of $\Sigma[A, X]$, say $S[A, X]$, for which the energy is a minimum. In other words, the arrangement $S[A, X]$ represents a crystal.

This view has led to some very interesting results in a series of experiments upon the alkali halides. The ionic refractivity, which depends upon the deformability already mentioned, can be measured in the free state, R (free ions), and in the crystalline state, R (solid). Now, cations and anions behave very differently in the presence of each other. Anions are consolidated, or rendered more rigid, by neighbouring cations, because in addition to the attraction of the nucleus of the anion for its own electrons, there is added that of the positive cation. A similar argument shows that just the reverse holds for a cation under the influence of an anion—the distortion or deformability increases. Hence, in the former case the refractivity decreases, and in the latter it rises. Thus the union of ions to form a crystal will bring about a net decrease in refractivity when the consolidating effect of cations upon anions preponderates over the loosening effect of the anions upon the cations, and vice versa. For most of the alkali halides the difference R (solid) $- R$ (free ions) is negative, which corresponds to a net consolidation when the crystal is formed out of the appropriate free ions. Only for potassium and rubidium fluorides (KF and RbF), in which a large ion is paired with a small ion, is a net loosening indicated. A balance is approximately obtained for sodium fluoride (NaF) and rubidium chloride (RbCl): the experimental accuracy is not high enough to detect very small differences in the refractivities.

In aqueous solution the refractivity is found to vary with concentration in a manner which suggests that at high concentrations the ions approach each other nearly as closely as in the crystal lattice; they are in direct contact, with no intervening water molecules. Other examples of relationships between crystals and solutions will occur later; they have been fairly extensively studied by spectroscopic methods.

Crystal Thermodynamics.—Strictly, thermodynamic reasoning is independent of a mechanism, and in this sense its application to crystal lattices and the particles composing them is not very obvious. Nevertheless, an extension of its proverbial boundaries has extended our grasp of the energetics of the solid state. To show how this has happened, two examples, characteristic of the most modern work, will be discussed. In the first, one is dealing with a sub-lattice property, and in the second, with a lattice property. Consideration in this particular order will serve to stress the general outlook of this article; the units composing a crystal are, from this aspect, of prior importance to the particular way in which they may be grouped.

The quantum theory, applied to gaseous molecules, has been fruitful in unravelling the complexities of rotational and vibrational motion. The latter has long been recognised to be characteristic of the solid state also, but it is only very recently that the possibility of molecular rotations in crystals has been seriously considered. The work is for the most part theoretical, and based upon suitable applications of the wave mechanics to diatomic molecules. The wave equation appears in the form of Mathieu's equation, and the corresponding energy levels are generally readily deducible.

Analysis shows that two extreme cases may be discerned; one in which the energy equations are those of the quantised harmonic oscillator, while the other approaches the value for the rotator. The next step is to obtain a discriminant, in terms of measurable quantities, for the transition between oscillational and rotational motion. The inequalities

$$n+1<\beta\nu/4\theta \text{ (oscillational)},$$
and $$n+1>\beta\nu/4\theta \text{ (rotational)},$$

provide, on certain assumptions, the criterion desired, for the quantum state n and frequency ν. The factor θ depends upon the moment of inertia, which is readily forthcoming from spectral data, while β is a constant. Another, and in some respects a simpler analysis, demonstrates that rotation may be expected at temperatures greater than $2V/k$, and oscillation for values less than this fraction (V is a characteristic quantity in the potential function for the particular molecule considered, and k is Boltzmann's constant). The probability that a molecule will rotate is capable of approximate calculation, yielding $P=e^{-2V/kT}$, where T is the temperature.

The expressions in terms of n and θ can conveniently be combined into the equation $n_0+1=\beta\nu/4\theta$, where n_0 is the particular value of n, which is on the borderline between the rotational and vibrational states. For hydrogen (H_2), with its small moment of inertia, $n_0+1\sim0{\cdot}4$, whereas for iodine (I_2) $n_0+1\sim350$. From these figures, it follows that the molecules in solid hydrogen are rotating even in the lowest quantum states, whereas in iodine no molecules are rotating in the crystal, since melting occurs for $n\sim12$.

The ammonium salts provide an interesting example of substances for which the transition from rotation to vibration may be expected to set in well within the solid range. A temperature of about 240° absolute is indicated by the theory. Observations of the heat capacity as a function of temperature have shown that in a number of substances there is a finite range of temperature over which the relative numbers of molecules in either state is undergoing a progressive change.

The second contribution, already alluded to, concerns the form of the specific heat curve (particularly at low temperatures) as a function of the crystal symmetry of the substance. If one assumes that the usual Debye equation represents the facts for the cubic system, then, as materials of decreasing symmetry are examined, instead of following the 'ideal' curve (convex upwards), an approximately straight line results. The sequence is well seen in the series zinc sulphide (cubic), zinc oxide (hexagonal), cupric oxide (triclinic). The importance of this effect is that the specific heat is influenced by the atomic environment, a typical lattice property.

Crystal Spectra.—As in the thermodynamical matters already discussed, it is convenient to divide crystal spectra into two main classes, those of ionic (or even sub-ionic) origin, and those for which the lattice, or at least parts of the complete lattice, are responsible. In dealing with the former, one is tempted to make a yet finer distinction between the types of spectra in which ions, or groups of ions, are concerned (in contradistinction to the swinging of large portions of the whole lattice), and phenomena which have their seat within the ion itself: that is, transitions of an electronic nature. Spectra arising from these three causes may be expected to appear at increasing wave-length as the mass of the unit concerned increases. Thus, sub-ionic (electronic) absorption spectra in crystals may occur in the visible region, and are closely connected with the nature of colour. Inter-ionic spectra are found in the near infra-red (between about 1μ and 30μ); lattice spectra are revealed at a wave-length some ten times greater, and are usually detected by the method of residual rays, or some system involving focal isolation. Oscillations of approximately these frequencies are those encountered in the theory of specific heats already mentioned.

In electronic crystal spectra, restricted in the main to salts of the rare earths and those of the transitional elements, one is confronted with a problem of great complexity, intimately connected with electronic levels and the magnetic properties of ions with incomplete electronic shells. There is little doubt that the sharpness of the bands in the visible region is attributable to the high electrostatic shielding and weak coupling between the electrons belonging to neighbouring ions. Information of value to chemists may well be obtained by studies of this kind.

Somewhat similar investigations have produced some illuminating results when the absorption spectrum of an ionic group like MnO_4 is examined in a crystal and in solution. The effect of dissolving, say, potassium permanganate, in water is to slow down the oscillations characteristic of the group, owing to the outward pull of a solvent of high dielectric constant ($=80$): solution in ethyl acetate (D.C. $=6$) allows the MnO_4 group to contract to almost the same dimensions as it has in the crystal lattice of potassium permanganate. In other words, the surrounding molecules of ethyl acetate have much the same effect upon the MnO_4 tetrahedron as the ions of potassium in the solid state.

It is natural to infer from this that much might be gained by careful study of the dielectric constants of crystals, especially at temperatures immediately below the melting point. Much the same applies to observations of absorption spectra in crystals at different temperatures. A promising start has already been made at the low temperature end, but the technical difficulties are great, and the results will need much skill to interpret.

No attempt has been made to discuss the Raman effect in relation to crystal physics and crystal chemistry: already the literature is voluminous, and the significance of some of the results by no means clear. The method is certainly of great value. Statistical mechanics may be expected to play a considerable part in the future development of the new crystallography; in fact, all the resources of modern science can contribute something to our knowledge of the solid state.

The First Sugar of Photosynthesis and the Rôle of Cane Sugar in the Plant.

PHOTOSYNTHESIS, upon which all living organisms depend directly or indirectly for their existence, is still imperfectly understood. We know that the green plant takes in its carbon in the form of the carbon dioxide of the air, and we also know that carbohydrate appears in the leaf, as the result of the fixation of the carbon through the action of the sun's rays with the chlorophyll. The intermediate stages are still a matter of conjecture.

The formaldehyde hypothesis of Baeyer put forward so long ago as 1870 still awaits clear proof. Supposed conclusive evidence in its support has from time to time been advanced; but on critical examination has proved unacceptable. This has happened in a recent attempt to establish the validity of the theory. Klein and Werner [1] using the delicate test of dimedon for aldehyde were in a measure convincing. Barton-Wright and Pratt,[2] however, in repeating and checking their work, now show that the formaldehyde detected in the experiments is due to the action of light on carbon dioxide and bicarbonates, and is independent of the photosynthetic mechanism of the living plant. They sum up the matter thus: "Although the formaldehyde hypothesis has the merit of simplicity, which has probably been the prime cause of its wide popularity, no work has as yet convincingly shown that formaldehyde is produced normally in the green leaf or that it plays any part in the photosynthetic process of the living plant".

This statement is perhaps a little too sweeping. As formaldehyde is toxic to the plant, it is scarcely to be expected that it should accumulate in the free state in an appreciable amount under normal conditions. It may be assumed that, as soon as the reduction of the carbonic acid takes place, the aldehyde formed is at once polymerised to sugar.

The important work of Baly on photosynthesis *in vitro* is here relevant. He has shown recently [3] that when a solution of carbon dioxide is exposed to ultra-violet light, formaldehyde is first formed and then sugar. But when a coloured catalyst, such as cobalt or nickel carbonate, is present, the action takes place in ordinary light with the direct production of sugar, no aldehyde being detected. Something analogous may therefore take place in the green leaf. The magnesium of the chlorophyll may be the active metal concerned. Hence on such a supposition it will be futile to search for free aldehyde in assimilating leaves.

In respect of the generally accepted view that some form of carbohydrate is the final product of carbon assimilation, the question as to the exact nature of this is still not completely answered. The classical experiments of Sachs conducted from 1862 onwards proved conclusively that the starch grains, which appear on the chloroplasts of the leaf when exposed to light, are the direct result of the fixation of carbon. Starch thus became known as the first visible product of assimilation. It was assumed that sugar, probably glucose, preceded the formation of starch.

Brown and Morris were the first to undertake elaborate estimations of the carbohydrates contained in foliage leaves. From their investigation of the carbohydrates in the leaf of the garden nasturtium (*Tropæolum majus*),[4] they concluded that cane sugar (sucrose) is the first carbohydrate to be set free in photosynthesis. This was an unexpected and novel idea, as sucrose, being a disaccharide, had hitherto been regarded more in the light of a reserve carbohydrate. They essayed a formidable task—a pioneer effort to estimate separately in the leaf four sugars (sucrose, maltose, dextrose, and levulose) as well as starch. The hydrolytic product of the starch complicated the issue. Monocotyledons, as a whole, in contrast to dicotyledons, form little starch in their leaves in normal circumstances, and some none at all. In following up Brown and Morris's work, Parkin, in order to simplify the problem, chose one of the latter, namely, the snowdrop.[5] He found he had only three carbohydrates with which to deal, namely, sucrose and its two hexose derivatives, dextrose and levulose. He interpreted his results likewise in favour of sucrose being the first sugar liberated, and he regarded the two hexoses as arising from it through inversion.

The Rothamsted workers, Davis, Daish, and Sawyer, were the next to take up the subject. They advanced this side of biochemistry considerably by pointing out weaknesses in former methods and by elaborating new ones of extraction and analysis. They investigated in detail the carbohydrates of the mangold and potato leaf,[6] and in their conclusions also support the view that sucrose is the first sugar of photosynthesis.

Now the pendulum is swinging the other way. Two important papers, by Clements [7] and by Barton-Wright and Pratt,[8] published last year, both favour the view that glucose (dextrose) is the first sugar to be liberated—a view, of course, more in harmony with Baeyer's hypothesis and also with chemistry generally. These investigators have carried out estimations at hourly intervals during both day and night—an advance upon what has been previously attempted.

Clements, an American worker, took for his research the leaves of the sunflower, the potato, and *Soja max*. Barton-Wright and Pratt, of Great Britain, selected the daffodil, which normally does not produce starch in its leaf. Their results are therefore comparable with those of Parkin on the snowdrop. In some respects they confirm the latter's work, though as regards the first sugar of photosynthesis they argue cogently for the opposite view.

Methods of analysis are naturally of prime importance in work of this kind. Each fresh investigator generally manages to bring to light flaws in previous methods. The Rothamsted workers with all their care are shown by Barton-Wright and Pratt to have overlooked a point which may have seriously prejudiced their figures for the hexose sugars. They find that the alcoholic

extraction method used by Davis, Daish, and Sawyer results in the formation of appreciable amounts of aldehyde, and this affects considerably both the cupric reduction and the optical rotation.

Such work as has been quoted sheds no light on the exact position of the various sugars in the leaf. Strakosch some years ago applied certain microchemical tests to the assimilating leaf, and found hexose as the only sugar present in the palisade cells; but the reliability of his method is open to question. The work of Weevers on variegated leaves, published in 1924, is probably of greater value in support of the glucose view. He found both hexose sugars and sucrose in the green parts, but only sucrose in the white portions of the leaf.

The balance of evidence at the present time would seem to be in favour of the original supposition that glucose is the first sugar to be set free in photosynthesis. On the alternative view, the two hexose sugars are easily accounted for as the inversion products of the sucrose. But on the assumption that glucose appears first, then one has to imagine that part of it is first changed to fructose (levulose), and that from these two hexoses sucrose is synthesised. If these transformations do take place in the leaf, we are at present quite ignorant as to the means by which they are brought about.

Whatever may be the carbohydrate sequence in photosynthesis, there is cumulative evidence pointing to cane sugar as of wide, if not of universal, distribution among the higher plants. Apparently it is of fundamental importance, since no matter what form the carbohydrate may take in the seed or reserve organ, sucrose soon makes its appearance on germination. The evidence is increasing that carbohydrate can travel largely in this form. Mason and Maskell's important work on the cotton plant [9] favours this. Then, again, as a rule, leaves when fed with sugar solutions form starch more readily from sucrose than from any other sugar. Notwithstanding this apparent desire of the plant to have its carbohydrate in the form of sucrose for circulatory and metabolic purposes, there is no important reserve carbohydrate which yields cane sugar directly by enzymatic action!

In view of the fact that starch, the commonest of reserve carbohydrates, yields maltose when acted upon by its enzyme, diastase, this disaccharide rather than sucrose might have been expected to be chiefly evident in plant tissues; but it is not so. It may be that a non-reducing disaccharide is desired. Maltose has reducing properties, but sucrose has not. Then it has been suggested that the two hexose sugars, dextrose and levulose, which arise from the sucrose through inversion, may play different rôles in metabolism. Further, it is possible that these hexoses are more active when in the nascent state, that is, at the moment of their formation from sucrose through hydrolysis. This would account for cane sugar being found in meristematic tissue, upon which Priestley [10] laid stress a few years ago. J. P.

[1] *Biochem. Zeit.*; 1926.
[2] *Biochem. Jour.*, **24**; 1930.
[3] *Proc. Roy. Soc. London*, 1927 and 1929.
[4] *Jour. Chem. Soc.*; 1893.
[5] *Biochem. Jour.*; 1911.
[6] *Jour. Agric. Sci.*; 1916.
[7] *Bot. Gaz.*, vol. 89.
[8] *Biochem. Jour.*, vol. 24.
[9] *Ann. Bot.*; 1928.
[10] *New Phytologist*; 1924.

Obituary.

PROF. HUGH RYAN.

BY the death on Mar. 27 of Prof. Hugh Ryan at the age of fifty-eight, Irish chemists have sustained a loss which they will feel for many years to come.

Hugh Ryan was educated at Blackrock College, Dublin, and received his earlier chemical training under Prof. A. Senier in Queen's College, Galway. Graduating in 1895, he obtained the M.A. degree, with gold medal, in 1897, and then proceeded to Berlin, where he engaged in research under Emil Fischer and Siegmund Gabriel. Returning to Dublin in 1899, he was appointed professor of chemistry in the Catholic University School of Medicine and in University College, St. Stephen's Green, Dublin. In the same year he was awarded the D.Sc. degree and appointed fellow of the Royal University of Ireland. On the foundation of the National University of Ireland in 1908, Ryan became professor of chemistry in University College, Dublin, a position which he occupied until his death. In 1924 he was appointed Chief State Chemist in the Irish Free State and was responsible for the organisation and control of the State Laboratory.

Throughout the entire period of his association with university teaching, Ryan devoted a large part of his time to research and published more than seventy papers. In his earlier work, influenced by his period with Fischer, he was engaged on the synthesis of glucosides. His researches in this direction, carried out under the most discouraging conditions, display his extraordinary enthusiasm and skill as a chemist. With the erection of the new buildings of University College, Dublin, under the Irish Universities Act of 1908, he had, for the first time, adequate laboratory equipment, and his remarkable powers as an organic chemist were given fuller scope. There followed a series of researches on the constitution of certain waxes and the preparation of a number of compounds allied in character to the colouring matter of turmeric. Further papers dealt with the synthesis of natural organic colouring matters and the preparation of derivatives of diflavone, diflavanone, and dicoumaranone. At the request of Nobel's Explosives Company, he undertook investigations on the mode of action of stabilisers in propellent explosives, the results of which were of the greatest value. Numerous other papers discussed the condensation of aldehydes with ketones and the structure of catechin. Ryan's many activities included a profound interest in Irish peat industries, and on this subject he furnished a very complete report to the Royal Dublin Society.

While his main interests lay in the direction of organic chemistry, the extraordinary breadth of Ryan's knowledge of all branches of chemistry always aroused the admiration of his colleagues, both in Great Britain and Ireland. To Irish men of science his great achievement was that he created in Dublin, from small beginnings and almost unaided, an important school of research in chemistry. The range of his influence in this respect, already widely felt, will be more fully appreciated in the future.

In public and private life Hugh Ryan was a most lovable and sterling character, with a rare simplicity and charity of outlook. His untimely death will cause genuine grief among the many students of science, engineering, and medicine who received instruction from him. J. ALGAR.

WE regret to announce the following deaths:

Dr. T. V. Barker, secretary to the University Chest in the University of Oxford, author of numerous books and papers on mineralogy and chemical crystallography, on April 15, aged fifty years.

Prof. E. P. Culverwell, senior fellow and professor of education in Trinity College, Dublin, who was known for his work on the calculus of variations and mathematical and physical theories of the Ice Age, on April 17, aged seventy-five years.

Prof. J. Lorrain Smith, F.R.S., professor of pathology and dean of the faculty of medicine in the University of Edinburgh, on April 18.

The Ven. J. M. Wilson, sometime canon of Worcester and headmaster of Clifton College, who was a member of a British Association committee on science in schools so long ago as 1866, on April 15, aged ninety-four years.

News and Views.

THE preliminary programme has now been issued of the centenary meeting of the British Association, to be held in London on Sept. 23–30, under the presidency of the Right Hon. J. C. Smuts. So far, of course, only the barest outline of the proceedings is possible, but it is clear already that the meeting is going to be worthy of the occasion. The reception room and offices for the meeting will be in the University of London (Imperial Institute Road, South Kensington). General Smuts will assume office at a meeting in the afternoon of Sept. 23 in the Albert Hall, where the Faraday Centenary Exhibition is being held, and will deliver his presidential address on the same evening at the Central Hall, Westminster. Special tickets will be required for General Smuts's address; arrangements are being made for relaying it to other halls if necessary. Evening discourses will be given by Prof. W. A. Bone (photographic analysis of explosion flames), Sir P. Chalmers Mitchell, Sir Arthur Keith, Sir Oliver Lodge (a retrospect of wireless communication), Sir William Hardy, and Sir James Jeans. The Huxley Memorial Lecture of the Royal Anthropological Institute will be delivered on Sept. 29 by Dr. G. Thilenius, and members of the Association are invited. Various public lectures will be given in certain polytechnic institutions in London. It is expected that receptions will be given on Sept. 24 by the Royal Society, in connexion with the Faraday celebrations, and on Sept. 25 by H.M. Government. Exhibits and demonstrations are again being arranged by the British Broadcasting Corporation. London and its neighbourhood will provide plenty of opportunities for sectional excursions. Down House, Darwin's home for many years and now in the care of the Association, is within easy reach, while an invited party will visit York, the birthplace of the Association, on Sept. 26–27. Preceding the meeting will be a geological excursion to East Anglia on Sept. 16–22, and those wishing to take part are requested to communicate with Mr. I. S. Double, University, Liverpool, as soon as possible.

THE formative influence upon the teaching of science in schools which was exerted by Canon J. M. Wilson, whose death has recently occurred, was evident so far back as 1866, when he was a member of a committee with Dean Farrar, Prof. T. H. Huxley, and Prof. J. Tyndall, appointed by the British Association at its meeting at Nottingham, "To consider the best means of promoting scientific education in schools". The report of this committee was issued in 1867 and laid stress on science as an essential subject in the curriculum, not necessarily to train physicists and chemists but as an effective instrument in mental development. The subjects suggested in the report were elementary physics, elementary chemistry, and botany. Canon Wilson, in a paper on "Teaching Natural Science in Schools", published in 1867, gave an account of methods adopted in introducing science teaching in Rugby School. He selected botany as the best subject for beginning to train boys in scientific method. This was followed by experimental physics. By his choice, he seems to have anticipated the present-day position of botany in the school curriculum, at any rate, from the theoretical point of view. There is much discussion on the position of botany, or elementary biology, in the school curriculum, but there is still much to be done in a practical way. There are comparatively few secondary schools, especially for boys, where science is introduced by botany or biology, as it was sixty-five years ago under Canon Wilson at Rugby. The sole idea in Canon Wilson's mind was to train independent observation and reasoning, not to supply the biology 'demanded' by the first examination for medical and dental degrees and diplomas, which some of our public and secondary schools are now doing with not quite satisfactory results.

ON April 28, one hundred years ago, the eminent mathematician and physicist, Peter Guthrie Tait, was born at Dalkeith. Educated at Dalkeith Grammar School and the Edinburgh Academy, in 1847 he entered the University of Edinburgh and the following year became an undergraduate of Peterhouse, Cambridge. At the age of twenty-one, he graduated as Senior Wrangler, being the youngest on record. He was also Smith's prizeman. Two years later he was appointed professor of mathematics in Queen's College, Belfast, having Andrews for one of his

colleagues. In Ireland he also made the friendship of Sir William Hamilton, through whom he became the great exponent and advocate of quaternions. After four years at Belfast, Tait was chosen to succeed J. D. Forbes as professor of natural philosophy in the University of Edinburgh, and this post he held with great distinction until the year of his death, which occurred on July 4, 1901. His biographer gives a list of 22 volumes and 365 papers written by him alone or in collaboration with others. Most famous of all is the "Treatise on Natural Philosophy", written jointly with Sir William Thomson, afterwards Lord Kelvin, and generally referred to as "T and T¹". This work, it has been said, takes rank with Newton's "Principia", Laplace's "Mécanique céleste", and Maxwell's "Electricity and Magnetism". Other works included Tait's "Thermodynamics" (1868), "Heat" (1884), "Light" (1884), and "Properties of Matter" (1885). He also translated Helmholtz's "Vortex Motion" and Mohr's "Views on the Nature of Heat".

Two volumes of Tait's scientific papers were published in 1898 and 1910, and his biography by Prof. C. G. Knott appeared in 1911. His portrait was painted three times by Sir George Reid and the pictures are to be seen at Peterhouse, the Royal Society of Edinburgh, and the Scottish National Portrait Gallery respectively. As a professor, he was distinguished by his earnest attention to the duties of his chair and by his capacity of inspiring his pupils with both enthusiasm and affection. He was as successful in presenting the elemental or fundamental truths of science as he was in advancing its range and attacking new problems. A keen golfer and able to apply mathematical analysis to the flight of a golf ball, on one occasion when staying at St. Andrews, his guest, Helmholtz, then about fifty years old, wrote: "Mr. Tait knows of nothing else here but golfing. I had to go out with him; my first stroke came off—after that I hit either the ground or the air. Tait is a peculiar sort of savage; lives here, as he says, for the muscles, and it was not till to-day, Sunday, when he dare not play and did not go to church either, that he could be brought to talk of rational matters." With Balfour Stewart, however, Tait published a book on the "Unseen Universe" which, while it called forth praise and censure, fulfilled the authors' purpose to show that the common statement that "Science is incompatible with religion" was baseless. Tait's correspondents included Kelvin, Maxwell, Cayley, Hamilton, and many other scientific men of the Victorian age.

THE Paris correspondent of the *Morning Post* states, in the issue of April 10, that news has been received in Russian circles in Paris that Profs. Michaelovsky and Saposhnikoff have been arrested and exiled to the far north of Russia. The reasons for their arrest and exile are unknown in Paris. Prof. Saposhnikoff is well known in scientific circles in Great Britain and this news will cause much sorrow to his friends here. He was frequently in England and took part in the International Congress of Applied Chemistry held in London in 1909. He also spent considerable time in Great Britain during the War, and for his services at that time he was made a Knight Commander of the Order of St. Michael and St. George. In the early days of the revolution, Prof. Saposhnikoff was imprisoned for several months in Petrograd and his two sons were shot. After his release he held several important posts and visited the Continent and England on official business for the Soviet Government. He was professor at the Michael Ordnance Academy and also at the Institute of Roads and Communications. He was a diligent worker and published much work of scientific value.

PROF. SAPOSHNIKOFF is a pioneer in the chemistry of explosive substances. His work on the decomposition of nitrocellulose and his investigations in connexion with the nitrating properties of nitric acid in sulphuric acid with reference to the vapour tension of the mixture were acknowledged as important contributions by all explosives chemists. He worked on a variety of other subjects of purely scientific interest and was also the author of a number of papers on metallurgy, including investigations on the microstructure and physical properties of alloys. His papers during the period 1903–12 occupy a column in the index of the *Journal of the Chemical Society*. The results of his investigations appeared in Russian, German, and French journals, and since the War he has contributed many papers on scientific and technical subjects, which have been published in Russia. Prof. Saposhnikoff is sixty-three years of age and has a record of highly valuable scientific and technical work which is recognised and appreciated by all scientific workers in Europe. It is little short of disastrous that the world, as well as Russia, should be deprived of the services of a man who is still capable of doing excellent work for the benefit of humanity.

IN our issue of April 18, p. 600, we printed a very brief account of the history of the Paris Observatory, prompted by the reports in the daily press that the Observatory was closing down and that a new national observatory was to be built in the Durance region of Provence. These reports, it seems, are incorrect and we much regret having given them further currency by repeating them. M. Ernest Esclangon, Director of the Paris Observatory, has written explaining the present position and prospects of the Observatory, and we cannot do better than reproduce his words: "Il n'est nullement question d'abandonner l'Observatoire de Paris, bien au contraire. Nous demandons seulement qu'une grande succursale de cet observatoire soit créée en Provence où le ciel est particulièrement beau; cette succursale serait dotée d'instruments puissants et modernes, notamment de grands télescopes. L'Observatoire de Paris garderait toute son importance; un grand nombre de services d'observation y seraient conservés, notamment le service méridien, le service de l'heure, le service des équatoriaux pour les observations d'étoiles doubles; le service des observations solaires installé à Meudon, etc. En outre, l'Observatoire de Paris centraliserait les

documents que les astronomes iraient recueillir dans la succursale en Provence, étudierait ces documents, en tirerait les conclusions ; en un mot, l'Observatoire de Paris, en plus des services d'observation qui y seraient conservés, constituerait comme le cerveau de l'organisation d'ensemble. Mais au surplus, tout cela reste pour le moment à l'état de projet, et aucune décision n'a pu être prise puisque les crédits nécessaires pour cette réalisation ne sont pas encore votés, et qu'actuellement, nous ne disposons pas des moyens pécuniaires indispensables pour mettre ce projet à exécution." We welcome this very clear statement by M. Esclangon and trust that funds will be quickly forthcoming to enable the realisation of the scheme he has outlined.

THE official report on the Hawkes Bay earthquake of Feb. 3 has been received from Lord Bledisloe, Governor-General of New Zealand. The loss of life (212 persons) was due mainly to the fact that the centre of the earthquake—somewhere beneath the Pacific Ocean—was not far distant from two towns, Napier and Hastings, containing between them a population of about 35,000. The shock was felt over a great part of the North Island and the northern district of the South Island, while the area over which material damage occurred extends from near Gisborne on the north to Waipawa on the south, and from Tarawera on the west to the Pacific Ocean. The houses that generally withstood the shock were those of wood or reinforced concrete. Brief but interesting accounts of the Murchison earthquake of June 17, 1929, are contained in the Report of the Dominion Astronomer and Seismologist for the year 1929 and in an article on the "Seismology of New Zealand", published in the *New Zealand Official Year-book* for 1931. The map of the isoseismal lines shows that, except for very small areas in the extreme north and south, the earthquake was felt throughout both islands. The movement along a fault near Murchison raised the ground on the east side about fifteen feet and shifted it about nine feet to the north-west. Recent levellings show that the block is now sinking back somewhat irregularly, a movement that is no doubt responsible for the after-shocks felt so frequently in the central area. Of these, no fewer than 632 were recorded by the end of the year at the Wellington Observatory.

THE annual exhibition of the Television Society was held on April 15 at University College, London. The number of exhibits was greater than in previous years. The trend of development is in the direction of large screens with projection methods suitable for large audiences. The Tuke cup was awarded to R. Wilson and A. A. Waters for an excellent television equipment with a mirror drum receiver and screen projector. In this system the person being televised is not dazzled by excessive light, and he can be seen at the same time as the image on the screen. It worked very satisfactorily, and the receiving set is small and quite ornamental, which we consider a great step in advance. In television between places about a hundred miles apart, 'echo images' are sometimes observed, one image being partly superposed on the other. T. H. Bridgewater showed how this phenomenon can be used to determine the height of the Kennelly-Heaviside layer. The research laboratories of the General Electric Co. showed two gas discharge tubes which operated directly from the 200-volt alternating current mains without using high-tension transformers. The sodium tube gives a yellowish light and the neon-mercury vapour in a uranium glass tube gives a bluish white light. We were impressed by the educational exhibits. Printer's blocks were prepared showing the amount of definition possible by different television scanning systems, and simple diagrams illustrated the underlying principles of television. The G.P.O. exhibited excellent photographs received in Great Britain from Austria, Denmark, Germany, and Sweden by the Siemens-Karolus-Telefunken system. The British Stenode Radiostat Corporation showed various stenode models of radio-receivers of very high selectivity.

As there is little more than one per cent of the world's main line railways electrified, there is plenty of scope for electrical engineers to convince the railway companies of the advantages of electrification. There is general agreement that suburban and tube railways should be electrified. Where the trains are continually starting and stopping, electrification enables the lines to carry far more passengers and to accelerate the service. In underground tunnels and in tube railways, the noxious vapours generated by steam trains makes electrification compulsory. After the War the Austrian Government obtained an international loan, a part of which it set aside for main line electrification. In 1927, however, the work was stopped and the money used for other purposes. Large portions of the scheme were therefore left unfinished. One of the reasons was the lowering of the price of imported coal, and another was possibly that too favourable a view had been taken of the costs of electrification. In *World Power* for March, Dr. M. G. Say discusses these aspects of railway electrification. Main line electrification is not favoured in Great Britain because coal is cheap, the gradients are seldom severe, and there are scarcely any main lines where the tunnels render steam haulage hazardous. The London-Brighton line, 51 miles in length, will be the longest electrified route in Great Britain. It will be worked by multiple-unit trains of six coaches. The present steam train service of two million train-miles per annum will be replaced by an electric service of nearly five million train-miles. The conversion cost is estimated at about £50,000 per mile, and energy outside the London area will be obtained directly from the national grid network. The maximum speed of 65 m.p.h. will enable the quickest trains to have an average speed of 54 m.p.h. If this line is successful, it will probably be the forerunner of further electrified zones eastwards and westwards from Brighton and Worthing.

THE first and the most useful of the commercial applications of radio communication was to marine navigation. In his chairman's address to the wireless section of the Institution of Electrical Engineers,

published in the March number of the *Journal* of the I.E.E., C. E. Rickard gives interesting data of the progress that has been made. The international legislators who frame the rules and regulations for wireless communication insist that marine radio telegraphy shall progressively improve and, so far as economically possible, keep in step with modern progress. About fourteen thousand of the world's ships are now fitted with wireless apparatus. Of these, about ten per cent are fitted with valve transmitters and the rest with spark only. Spark transmitters of 100 watts input power are generally considered to provide the best form of emergency apparatus, probably because it is thought that a strident and hoarse cry for help will attract the most attention. By the new international regulations, no spark transmitters of greater power than 300 watts input power are to be installed. From now onwards, therefore, the percentage of high-power spark stations on board ship will steadily decrease. There are about twelve thousand ships fitted with automatic alarm devices which enable a ship's operator to be called to his post when he is not on watch. At the end of last year, about five hundred ship's lifeboats were fitted with wireless. Vessels of less than 1600 tons gross tonnage which do not carry passengers are under no legal obligation to have radio apparatus. Many of them, however, are fitted with radio, as it is found of great value not only in navigating the ship but also in carrying on their business. In particular, trawlers, whalers, and other vessels connected with the fishing industry are generally equipped with radio. There are now more than 200 automatic radio beacons around the coasts of the leading maritime countries of the world.

THE new Welland Ship Canal between Lakes Erie and Ontario, which was opened on July 1, 1930 (NATURE, July 5, 1930, p. 30), allows vessels of ocean liner size to pass round Niagara Falls and removes one of the two great barriers that have kept deep-sea shipping out of the Great Lakes. Between the lakes and the ocean only the barrier of the Lachine Rapids, round which smaller vessels alone can pass, remains. But the largest lake vessels, about 600 feet in length, are now able to get into Lake Ontario. There are 21 electric drawbridges over the new canal, some of them spanning the canal's full width of 320 feet. Unlike the Panama Canal, where only the locks are illuminated, the entire length of the canal is lighted like a city street. The Welland locks are tremendously deep. Three of them give a total lift of 140 feet in less than three-quarters of a mile. The electrical equipment is built by the Canadian Westinghouse Co., Ltd. The locks have corridors, steps, and electrically lighted mooring platforms, halfway down the sides. The attendants check the way of the ship as it sails in at the lower level. As the water comes in, the men retreat and the lock is flooded. The electric lamps in their water-tight globes are left burning far underneath the water. One end of the canal is 326 feet higher than the other. If it were not for the lock-gates, Lake Erie would run into Lake Ontario, forming a new Niagara Falls. In the unlikely event of a lock-gate failing, there is a boat with powerful hoisting gear always ready to plug the canal by an emergency gate.

A CONFERENCE of teachers and other professional experts in prehistoric archæology will be held in Bern in May, at the personal invitation of Prof. Bosch-Gimpera, of Barcelona, to discuss the future organisation of prehistoric studies. This conference arises out of suggestions which were discussed at the Congress of Archæology held at Barcelona in 1929, when the question was raised whether, in view of the situation which had arisen in regard to international congresses in archæology, it was desirable that the prehistoric section of the Congress of Archæology should be enlarged. It then appeared that there was a desire for a quite new organisation. Since 1929, however, there has been a fundamental change in the situation. The attempt made by the Institut international d'Anthropologie of Paris to revive, and at the same time absorb into its own machinery, the old pre-War Congrès d'Anthropologie et Archéologie préhistorique, by issuing a joint invitation to the congress at Lisbon in 1930, would appear to have strengthened the dissatisfaction of archæologists with the present position rather than have reconciled them to a congress which, while international in name, is attached to a permanent organisation, bound under French law to be predominantly French in composition. As a result of inquiry, it would appear from a report published by Prof. J. Myres in the April issue of *Man*, there is a widespread agreement among archæologists of all nationalities, including even some French, that future congresses should be entirely separated from the Paris Institut and, in fact, that the old Congrès should be revived in accordance with its former statutes.

PROF. MYRES goes on to forecast the probable lines of discussion at Bern in the light of consultations and correspondence with Continental archæologists. The questions to be settled will be whether international organisation in the future should provide for a single congress to cover all human sciences, anthropology, ethnology, technology, as well as prehistoric archæology, or should (at any rate at present) a congress be organised to deal with prehistoric archæology only; and, secondly, whether an entirely new congress on fresh principles should be organised, or should the pre-War Congrès d'Anthropologie et Archéologie préhistorique be revived by friendly agreement with the surviving representatives of the old Congrès and the Paris Institut as an entirely independent institution. On these points the attitude of British archæologists is set out in a series of resolutions passed at a recent meeting of the Joint Committee on Teaching and Research of the Royal Anthropological Institute, a fully representative body. In these, the desire is expressed that the Congrès should remain in being as an independent body, and the Committee conveys to the meeting at Bern the hope that any future congress for prehistoric archæology will admit the more general studies of anthropology and ethnology, which illustrate all the various aspects of prehistoric archæology.

UNDER the auspices of the Museums Association and the Carnegie United Kingdom Trust, an exhibition of

museum specimens specially prepared for circulation to rural areas was held in the County Hall, Westminster, on Jan. 28–30. The exhibition aimed at showing, for the information of museum curators, educationists, and the public generally, what can be done and what is being done to extend the influence of museums to country schools and to the people. Nine provincial museums, the Canadian Commission, and three United States museums sent exhibits, which represented very fairly the possibilities of this branch of service, as well as the limitations imposed upon it by difficulties of size and transportability. It is very gratifying to know how greatly this museum work is appreciated in the districts where it prevails. The *Museums Journal* for March associates with an account of the exhibition, photographs of some of the series shown. One of the great difficulties of curators is to obtain, at reasonable cost, cases at once suitable for exhibiting specimens (often of considerable depth) and for bearing the strains of travel by rail or carrier. May we suggest that the Museums Association would play a most useful part were it to arrange for the mass production of a standard transportable case, probably after the type used by the American Museum of Natural History, which, to us, seems best to meet requirements.

A LIST of the industrial research laboratories of the United States of America has recently been published as *Bulletin* No. 81 of the National Research Council (Publication Office, National Research Council, Washington, D.C. No price). It is the fourth edition of this bulletin and shows a great increase, in the number of industrial research centres listed, on the third edition of 1927. The increase in number is about 60 per cent and may be indicative of either the great progress of industrial research in the United States or a greater interest of such research laboratories in this compilation by returning data for publication, or both. The list is of industrial laboratories only and does not include, therefore, laboratories connected with the Federal, State, or municipal governments, or with educational institutions. Since, as the compilers of this bulletin admit, such laboratories often do attack problems of industrial importance, it seems a pity that they were not included. These laboratories usually are listed in other publications; yet their inclusion probably would have added to the value of this bulletin, by making it even more comprehensive. The data given under each laboratory were furnished by the director of the laboratory, in reply to a questionnaire, of which the chief parts apparently were: name and address of the company (under which the laboratory is listed), director and research staff, account of research work, and, in a few cases, development work. Following this list of industrial companies' laboratories, is an alphabetical list of directors and their addresses. Then comes the geographical distribution of the laboratories, grouped into towns and States. Finally, there is an alphabetical grouping of the subject matter of research. The last two lists form indexes to the whole volume, thus making reference comparatively easy. So far as we know, there is no similar list of industrial research laboratories in Great Britain; such a list should prove of great value as a reference guide to all types of research workers.

IT is announced that the Whipsnade Zoological Park will be opened to the public on Saturday, May 23. The park will be open every day afterwards, including Sundays, from 10 A.M. until lighting-up time.

A SMALL earthquake was recorded at Kew Observatory at 17 hr. 3 min. 9 sec. G.M.T. on April 15. It is estimated that the disturbance originated 1300 miles away, the epicentre being under the Atlantic to the north of the Azores.

THE Faraday Medal (tenth award) will be presented to Mr. Charles H. Merz at the ordinary meeting of the Institution of Electrical Engineers to be held on Thursday, April 30. The presentation will precede the twenty-second Kelvin Lecture, which will be delivered by Prof. W. L. Bragg on "The Architecture of Solids".

THE annual visit to the Research Station, Long Ashton, Bristol, will take place on May 7, when the ciders made during the season 1930–31 will be displayed and the fruit plantations of the Station will be open to visitors from 11 A.M. to 4 P.M. Demonstrations of small horticultural machines and implements, including cultivators, spraying and dusting machines, etc., will be in progress throughout the day.

THE Pontifical Academy of Sciences (Nuovi Lincei) is offering a prize of 10,000 lire for a critical dissertation on the law of Mendel and the chromosome theory. Essays must be unpublished and may be written in English, French, German, Spanish, Italian, or Latin. They may be signed or written under a pseudonym, and must reach the Pontifical Academy of Sciences, The Vatican City, before Oct. 30. The award will be announced at the first meeting of the Academy in December.

THE work of the National Physical Laboratory is illustrated by a series of transparencies now on view in the entrance hall of the Science Museum, South Kensington. They include illustrations of a radium safe, one million volt spark, internal view of the high voltage laboratory, and the primary standard barometer. There is also an exhibition illustrating the occurrence of earthquakes and instruments used in their measurement, with the records obtained at Kew from a number of recent earthquakes. Both series of exhibits will be on view until the end of June.

THE Linnean Medal for 1931 of the Linnean Society of London has been awarded to Prof. Karl E. von Goebel, professor of botany in the University and Director of the Botanical Gardens, Munich. The following have been proposed as foreign members of the Society: Prof. Carl Christiansen, of Copenhagen; Dr. K. E. Correns, Director of the Kaiser Wilhelm Institute of Biology, Berlin; Dr. L. Diels, Director of the Botanical Gardens, Berlin; and Prof. F. A. F. C. Went, professor of general botany in the University of Utrecht.

SIR JAMES JEANS left England on April 18 for the United States, primarily to receive the Franklin Medal

from the Franklin Institute, Philadelphia. On May 18 Sir James will deliver a lecture in Washington under the auspices of the Carnegie Institution. He will visit the Bartol laboratories in Philadelphia on May 19, and on May 20 will receive the Medal from the Franklin Institute and there deliver his lecture. This will be followed by three lectures, at Princeton (May 23), Harvard (May 25 or 26), and Yale (May 26 or 27), which are being given under the auspices of the Franklin Institute. Sir James will sail for England towards the end of May.

THE preliminary programme of the forty-second congress of the Royal Sanitary Institute, which will take place at Glasgow on July 4-11, has recently been issued. Sir Henry Mechan will preside over the congress, which will be divided into the following sections: preventive medicine; architecture and engineering; maternity, child welfare, and school hygiene; hygiene of food; hygiene in industry; veterinary hygiene, and national health insurance. Five conferences have also been arranged, of sanitary authorities, medical officers of health, engineers and surveyors, sanitary inspectors, and health visitors. The inaugural address will be given by Sir Henry Mechan, and the congress will terminate with a lecture by Major Walter Elliot on "A Continuous Health Policy". A health exhibition in connexion with the congress is projected, and there will be opportunities for visits to hospitals and other institutions and places of local interest.

THE preliminary programme of the Second International Congress of the History of Science and Technology is now being sent out, and we note that it is intended, as the subject-matter of the Congress is so extensive, that members should speak to three general themes, namely: (1) The sciences as an integral part of general historical study; (2) Historical and contemporary inter-relationship of the physical and biological sciences; (3) Inter-dependence of pure and applied science. For the afternoons and evenings, visits have been arranged, among other places, to the Royal Society, Royal Institution, Royal Observatory (Greenwich), National Museums, Institute of Historical Research, and Down House, Kent. There will also be excursions to Oxford and Cambridge. Most satisfactory responses have already been made and the Congress bids fair to be a very great success. Further particulars will be furnished upon request by the honorary secretary of the Congress, The Science Museum, South Kensington, S.W.7.

WITH reference to the article on medals awarded for scientific achievement, published as a supplement to NATURE of Nov. 15, 1930, and the additional list in NATURE of Mar. 7, our attention has been directed to a further medal award. In 1928 the Bombay Branch of the Royal Asiatic Society established a silver medal, to be given triennially to a member considered to have made the most signal contribution in Oriental scholarship during the previous three years. The first medal will be presented this year to Mr. S. V. Karandikar, for his book "Hindu Exogamy: A Systematic Study of Hindu Marriage Outside the Gotra". This book was noticed in NATURE of Mar. 15, 1930.

WITH the December number, 1930, the *Tropical Veterinary Bulletin* ceased publication, and in its place the Imperial Bureau of Animal Health is publishing a new journal under the title of the *Veterinary Bulletin*. This includes the matter of the *Tropical Veterinary Bulletin* and, in addition, the diseases of temperate climates. The first volume of about 384 pages is being issued in four quarterly parts, commencing April 1, but from January 1932 the journal will be published monthly, and the volume will run to about 600 pages. The subscription price is £1, post free, which should be sent to the Imperial Bureau of Animal Health, Veterinary Laboratory, Ministry of Agriculture and Fisheries, Weybridge, Surrey, England.

A USEFUL classified catalogue of new and second-hand books on medical subjects has just been issued by Messrs. W. and G. Foyle, Ltd., 119 Charing Cross Road, W.C.2. It can be had free of charge upon application.

WE have received a volume of collected reprints of "Researches published from the Wards and Laboratories of the London Hospital during 1930". It is edited by Mr. Hugh Cairns, and contains 39 papers dealing with a variety of subjects—clinical medicine and surgery, radiology, pathology, bacteriology, and physiology. Five papers deal with psittacosis or parrot fever. The paper by Bedson and Western shows that the virus is a filterable one, though probably of relatively large size, and that the guinea-pig is susceptible to the virus and may be employed for maintaining strains.

A CATALOGUE (No. 456) of nearly 1300 second-hand books of science has just been received from Messrs. Bowes and Bowes, 1 Trinity Street, Cambridge. The subjects are arranged under the headings of journals (general), agriculture, anthropology and ethnology, biography and travel, biology (with microscopy, evolution, and heredity), botany (with a small collection of herbals), chemistry and physics, entomology (with arachnida, and crustacea), forestry and gardening, mineralogy and geology, mollusca, ornithology, zoology (general, with parasitology), and addenda (all subjects). The prices asked appear very reasonable.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A head of the senior engineering department of the Hull Municipal Technical College—The Director of Education, Education Offices, Guildhall, Hull (May 2). A senior lecturer in electrical engineering and an assistant lecturer in marine engineering at the Liverpool Central Municipal Technical School—The Director of Education, Education Office, 14 Sir Thomas Street, Liverpool (May 2). A lecturer in mathematics with subsidiary physics and a lecturer in building technology and science at the Rugby College of Technology and Arts—The Principal

and Organiser of Further Education in Rugby, 61 Clifton Road, Rugby (May 8). An assistant in the chemistry department of the Coventry Municipal Technical College—The Director of Education, Council House, Coventry (May 22). A professor of anatomy in the University of Birmingham—The Secretary, The University, Birmingham (May 30). A university student in physiology in the University of London—The Academic Registrar, University of London, South Kensington, S.W.7 (May 31). A temporary lecturer in chemistry at the Huguenot University College, Wellington, Cape of Good Hope—Miss M. S. H. Kilroe, St. Paul's Girls' School, Brook Green, W.6.

Our Astronomical Column.

Comets.—*Pop. Astr.* for April contains photographs of comet Schwassmann-Wachmann before and after the recent outburst, reported in NATURE for April 11. They were taken by Prof. G. van Biesbroeck with the 24-inch reflector at Yerkes Observatory. The first was taken on Dec. 16, 1930, when the comet's magnitude was about 16 : in spite of its faintness, Dr. F. E. Ross has managed to bring out an appreciable amount of coma by making successive photographic copies. The second photograph, taken on Feb. 11, 1931, shows the comet as a small, bright disc of magnitude 12·5. Examination of the original negative showed a little diffused light at the edge of the disc, but the extended coma had vanished. By Mar. 10 the comet had again sunk to magnitude 16, and the outer coma was again visible. On Feb. 11 the comet was 7·05 units from the sun, 6·33 from the earth. Prof. van Biesbroeck is confident that it will remain visible round the whole of its orbit, which will be a new cometary record. It is now within two years of aphelion passage.

Dr. K. Reinmuth, of Königstuhl Observatory, announces, in *Astr. Nach.* 5779, that he has detected images of a comet on plates taken in March 1902. It was 1·5′ in diameter with a faint nucleus and a short tail in P.A. 220° ; magnitude 12·0. He suspects that it may be a periodic comet, but it has not been identified with any known one. The positions are given in the hope that other images may be found on old plates.

G.M.T. 1902.	R.A. 1902·0.	N.Decl. 1902·0.
Mar. 4^d 10^h 19·9^m	11^h 4^m 37·03^s	1° 13′ 34·3″
,, 5 9 38·3	11 4 13·62	1 15 23·5
,, 5 10 22·2	11 4 13·12	1 15 27·7
,, 5 11 5·8	11 4 12·32	1 15 32·5

Another Interesting Schwassmann-Wachmann Object.—These two astronomers of Bergedorf Observatory are the joint discoverers of several interesting comets. The latest of their discoveries is probably a minor planet ; it attracted considerable attention from its rapid retrograde motion of −1^m 42^s daily and its highly inclined orbit. *Circ.* 413 of Astron. Rech. Instit. contains the following preliminary orbit, computed by Dr. A. Kahrstedt :

Epoch 1931 March 24·0 U.T.

M	19·6013°	
ω	134·2787	1931·0
Ω	0·0056	
i	33·1919	
ϕ	21·4017	
Period	5·524 years	
log q	0·2977	

The aphelion is about a unit inside the orbit of Jupiter, so the perturbations will be considerable. The magnitude is 13.

Parallaxes of Stars at different Galactic Latitudes.—*Publication* No. 45 of the Groningen Laboratory has a paper on this subject by Dr. P. J. van Rhijn and B. J. Bok. Its object is a re-determination of the mean secular parallaxes of stars of various magnitudes grouped with reference to their galactic latitudes. It is concluded that the distances of the faint stars in high galactic latitudes were over-estimated in the similar research in *Publication* No. 29. The proper motions have been re-investigated, using all the recently published star-catalogues and some special investigations for faint stars by Alden, P. van de Kamp, and A. van Maanen. The effects of galactic rotation have been taken into account, using Oort's formulæ of correction.

The following is a summary of the resulting mean secular parallaxes :

Mag.	Lat. 0° to 40°.	Lat. 40° to 90°.
7·0	0·033″	0·047″
9·0	0·017″	0·027″
11·0	0·0086″	0·015″
13·0	0·0045″	0·009″

Tables are given to facilitate the deduction of absolute proper motions of faint stars from their relative values as derived from photographs. They include the effect of differential galactic rotation.

The Distant Faint Companion of Castor.—*Bull. Astr. Inst. Netherlands*, **6**, No. 216, contains a full study of this faint star which belongs to the system of Castor, and is, like the two bright components, a close binary ; it is also an eclipsing variable. The two stars composing it appear to be practically identical in size and brightness ; each of them is 432,000 km. in radius, and of mass 0·593 sun, density 2·468 sun, surface brightness 3·45 magnitudes darker than the sun, total brightness 4·48 magnitudes fainter than the sun. Adopting 5741° as the sun's effective temperature, that of Castor *C* is found to be 3400°, in good agreement with its type of spectrum, which is *M*. Its colour index is 1·52 magnitude. The orbit appears to be circular ; the full period of revolution (that is, double the period of light-variation) is 0·8142822 day, and the radius of the relative orbit 2,701,000 km. The absolute visual magnitude of each component is 9·15 magnitudes. It is noted that the masses and magnitudes accord well with Eddington's mass-luminosity relation.

The Distances of the Cepheid Variables.—A recent note in this column described B. P. Gerasimovic's researches on this subject, leading to the conclusion that Prof. Shapley's absolute magnitudes needed to be corrected by +1·0 mag., and his distances reduced in the ratio 0·631 to 1. *Astr. Nach.* 5775 contains a research on the same subject by A. Kipper. It makes use, in addition to proper motions and radial velocities, of the fact that the angular radius of a star of known colour index can be deduced from its apparent magnitude. By applying this to different stages of the Cepheid variation, the change of angular radius can be correlated with the radial velocity. From a combination of all the methods he finds +1·1 as the correction to Shapley's absolute magnitudes. This is so close to the 1·0 of Gerasimovic that it gives ground for receiving both results with some confidence.

Research Items.

A Neolithic Statuette from Malta.—Sir T. Zammit figures and describes in the *Bulletin* of the Malta Museum, vol. 1, No. 2, a fragment of a stone statuette found in 1929 in clearing the exterior of the apses of the Tarxien neolithic temples. What is left of the statuette shows details lacking in other statuettes from the megalithic ruins. It is 30 cm. high and has a width of 21 cm. with a flat base 10 cm. by 7·5 cm. The upper part, corresponding to the waist, has a hollow, carefully worked, which served as a mortice for the insertion of a dowel to bear the upper portion. The figure is draped with a flounced short skirt, and is sitting or leaning on a bench. A pear-shaped leg protrudes beyond the skirt. Each pair of pleats of the skirt is surmounted by a semicircular embroidered line forming a continuous decoration. The hips are prominent. The bench on which the figure sits, ends in a horizontal frame supported by standing human figures in high relief, the heads appearing as decorative knobs under the frame. They stand in typical hieratic attitude with the left forearm bent across the breast, the right arm hanging loosely by the side. The figures wear a plain tunic falling in folds to the ankles to conceal the feet. Another figure in bolder relief is seated at right angles to the three figures, its arms folded and its hands resting on the obese thighs. These carved figures are peculiar to Malta.

A New Species of *Ornithobilharzia*.—R. Wetzel (*Proc. U.S. Nat. Mus.*, vol. 78, art. 3; 1930) describes a new species of the trematode genus *Ornithobilharzia* from a Canadian goose from Virginia. The description is based on three males and three females found in branches of the portal and mesenteric veins. The testes in the male are 28 in number, that is, fewer than in other species, and the females are longer than the males (about 9 mm. and 6 mm. respectively). Eggs collected from the intestinal contents of the goose are oval, provided with a small terminal spine, and contain active miracidia. The author gives a detailed description of the anatomical characters of the male and female, and a key to the known species of the genus *Ornithobilharzia*.

Researches on Earthworms.—In vol. 5, No. 3, of the *Science Reports* of Tohoku Imperial University, 1930, there are several papers dealing with researches on various oligochætes of Japan. Some of these worms are very large and lend themselves readily to experiment. *Pheretima* is a favourite genus for the purpose. In the first paper, "On the Body Temperaof the Earthworm", by Hojik Kim, *Pheretima megascolidioides* is used, the purpose of the work being to determine the ability of the adjustment of body temperature within a wide temperature range. These worms quickly adjust themselves to the surrounding medium within the temperature range of from 6° to 23° C., beyond which the ability to regulate steadily decreases as the temperature rises. Three species of *Pheretima* and one of *Allolobophora* were used by Du-Hyen Zyeng for his work on the "Distribution of the Intermuscular Nerve Cells in the Earthworm". It is suggested that these cells are vestiges of the primitive nerve net of lower invertebrates. Ekitaro Nomura and Shinryo Ohfuchi continue their work on "The Effect of Inorganic Salts on Photic Orientation in *Allolobophora fœtida*: 5, Sodium Salts—Na_2SO_4, $NaNO_3$ and NaCl", and Shinkishi Hatai describes a large new semi-aquatic oligochæte which he names *Drawida hattamimizu*. This is said to have been known for years to the people living in the villages near Kahoku Lake, opening into the Japanese Sea, and is used extensively by the local fishermen as a live bait for eel fishing, the specific name being their local name for it. The largest seen measured more than three feet in length, when crawling, although the posterior part was not fully extended. It is an interesting fact that this huge worm made its appearance suddenly in the locality mentioned, and Dr. Hatai thinks it was probably imported—perhaps by the celebrated merchant and explorer Gohei Zeniya, who was born in Hatta village, where the worm is specially abundant. So far it has not been found in other localities, although it is suggested that its original home is very likely to be in the Philippine Islands or in Java, which Gohei Zeniya is supposed to have visited in his travels. Minoru Oishi, "On the Reproductive Process of the Earthworm *Pheretima communissima* (Goto et Hatai), Part 1", records some very interesting observations on the mating of these worms.

Lipin of *Hevea* Latex.—E. Rhodes and R. C. Bishop (*Quarterly Journal of the Rubber Research Institute of Malaya*, vol. 2, No. 3, 125-135) have isolated from fresh latex a complex lipin-like substance which exists in the latex in quantities of the order of 0·2 per cent. It was obtained as a solid waxy body by laborious treatment of fresh samples of the latex with rectified spirit, concentration under reduced pressure, and subsequent ether extraction. The substance disperses in water, reduces the water-air surface tension, and the very stable aqueous suspension is coagulated by acids at *p*H 1·9 to 2. The method of preparation, general chemical properties, and the products obtained by hydrolysis clearly indicate that the substance obtained was a lipin but of quite complex and not entirely elucidated structure. Different samples have constant N:P ratio (1:1·31), and 95 per cent of the fatty acids, which constitute 70 per cent of the total weight of the substance, are liquid and have iodine number 123. Like some other similar bodies from plants, it contains a large amount of carbohydrate (10 per cent), which was only removed by somewhat drastic hydrolysis. Apparently the sugar is not present as reducing sugar, though reducing properties are quite evident after acid hydrolysis, when an osazone may be prepared. Though the presence of glycerol has not been definitely established nor the particular nitrogen base or bases identified, it is interesting to note that calculations of the phosphorus as glycerophosphoric acid, the nitrogen as choline, the sugar as hexose, together with the fatty acids, unsaponifiable material, and ash, enable a complete account to be made of the original material. This lipin complex has also a technological claim to examination since Messrs. B. J. Eaton, E. Rhodes, and R. C. Bishop (*ibid.*, pp. 136-138) have shown that it has an accelerating effect on the rate of vulcanisation.

Embryology of *Sargassum*.—Until recently, comparatively little has been known of the details of embryology of the Fucales, apart from a few of the northern hemisphere genera, such as *Fucus* and *Pelvetia*. The studies on a number of sub-tropical genera and species by the Japanese school of botanists should help towards a more definite classification within the group and especially in the sub-group of the Cystosiro-Sargasseæ, which is well represented on that coast. Inoh's paper on "Embryological Studies in Sargassum" (*Science Reports* of the Tôhoku Imperial University, vol. 5, No. 3) shows that the species examined—12 out of the 41 in Yendo's monograph—fall into three groups, each of which is characterised by the method of segmentation of the primary rhizoid cell and the number of rhizoids produced on the embryo. At first sight, this appears a somewhat detailed point on which to base a comparison

of species, but so far as it has been investigated, the embryology, which is also associated with the size of the egg, appears to be very constant and also to be associated with definite features of the subsequent habit of the plant. If further investigation confirms the constancy of certain types of embryo development, this should prove to be a useful method in deciding affinities of doubtful species. A case in point is that of *Turbinaria* (?) *fusiformis*, which some algologists have suggested should be placed under *Sargassum*. This suggestion receives support from embryology, as the details described by Tahara for the segmentation of the rhizoidal cell and number of rhizoids agree with the details given by Inoh for a group of *Sargassum* species which are characterised by the irregular division of the primary rhizoidal cell into eight cells, each of which grows out into a rhizoid.

Sugar Beet Varieties.—Among the reports published in vol. 2, No. 4, of the *Journal* of the National Institute of Agricultural Botany, that which deals with the sugar beet variety trials during 1927–29 is of particular topical interest. The tests have been carried out with replicated plots at several centres simultaneously and have been repeated successively, all results receiving statistical treatment. The types of sugar beet fall into three main groups: (1) class *E*, which is high yielding, but with average or less than average sugar content; (2) class *Z*, with a high sugar content, but with yield below the average; (3) class *N*, which consists of varieties intermediate between *E* and *Z*. The report deals with strains of the *E* type, Dippe *E* being selected as a standard for comparison. From the point of view of yield, Kleinwanzleben *E* proved the best variety, Dippe *E* and Hoerning *H.S.* taking the second and third places respectively. As regards sugar content, however, these three strains were poorer than any other; yet on a basis of yield of sugar per acre, they again headed the list. Further, Kleinwanzleben *E* and Dippe *E* proved the most profitable when their cash value per acre was determined, a figure calculated from yield, sugar content, and factory price. In estimating the value of sugar beet crops, the yield of tops must not be overlooked, but on this point also these varieties proved satisfactory. As regards non-bolting tendencies, however, Kleinwanzleben *E* was slightly the superior. For general purposes, therefore, Kleinwanzleben *E* and Dippe *E* are recommended as the most suitable for growing under English conditions; but on rich black soils, Marsters or Kuhn *P*, both small-topped and non-bolting strains, are considered preferable, for the danger of excessive leaf development is avoided, and they may be sown very early with safety.

The Proposed Madden Reservoir (Panama Canal).—The necessity of a large supply of water for lockages in the Panama Canal has engaged the attention of the engineers in charge for many years. In recent years it has become increasingly evident that more water than is now available in Gatun Lake during the dry season must be provided to meet future requirements. Consequently studies have been made of the feasibility of a storage reservoir on the upper Rio Chagres which would conserve the flood waters for use in the dry season, allow the development of additional hydro-electric power, and aid in the prevention of dangerous currents such as occur in the Canal near Gamboa during floods. The geological investigation has been made by F. Reeves and C. P. Ross, and their conclusions and recommendations are published in *Bull.* 821-B of the U.S. Geol. Surv., 1931 (pp. 49 and maps). The rocks are calcareous and tuffaceous sedimentary rocks of Tertiary age, resting on a volcanic complex of probable Eocene age. They are bent into a structural basin that corresponds approximately with the topographic depression in which the reservoir would be formed. The structure is such as to assure that any leakage would find its way into Gatun Lake, as desired. Some of the rocks are thus permeable to water and others are mechanically weak; but despite these disadvantages the project is found to be feasible.

Glacial Geology of Connecticut.—Prof. R. F. Flint, of Yale, has recently completed the first systematic study of the glacial features of Connecticut as a whole, and the results have been published in *Conn. Geol. and Nat. Hist. Survey, Bull.* 47 (Hartford, 1930, pp. 294). It is concluded that after the last invasion of the ice had reached its greatest extent, with its front lying along or south of Long Island, it passed into a 'dead' or stagnant state. Once its power to move had gone, the blanket of ice must have melted away from the surface downwards. As more and more of the previously buried highland surface emerged, the ice was gradually left only in the valleys. The melt-water made its way seawards through narrow channels left between the ice and the valley sides. Terraces are left representing the marginal lakes of successively lower levels, the lakes having been filled up delta-wise by deposits that were banked up against the ice margin. The faces of the terraces are faithful casts of the irregular margins of the stagnant ice, and their surfaces are pitted with kettle-holes representing isolated slabs of ice that were buried and afterwards melted out. It is noteworthy that the terraces do not slope southwards with the stream gradients, but are quite horizontal. This indicates that the differential tilting that uplifted the regions to the north did not affect Connecticut.

Compensation of Ship's Direction Finders.—In the early days of building iron ships, one of the greatest difficulties in the way of navigating them was to eliminate the effects of the ship's magnetism on the mariner's compass. The most important effect is the 'semicircular' error, due mainly to the permanent magnetism of the iron girders, beams, and steel masts of the ship. Another effect is the quadrantal error due to induced magnetism. The first effect is corrected by placing two steel magnets in a certain position, and the second by two soft iron spheres placed one on each side of the compass. In a paper on radio direction finders read by C. E. Horton to the Institution of Electrical Engineers on Mar. 4, the methods of correcting their errors are discussed. It is pointed out that these direction finders, like the mariner's compass, are affected by both semicircular and quadrantal errors. The effects produced by the currents which flow in conducting paths in the ship have to be corrected by a loop suitably oriented and placed near the direction finder. It has also to be shielded from the effects of the displacement currents in the dielectric by a subsidiary aerial coupled inductively to the direction finder. This latter effect is corrected either by a fixed aerial system (Bellini-Tosi) or a rotating coil system. The semicircular error is due to the fact that although a ship is symmetrical about a central longitudinal line, it is not symmetrical about a transverse line. The best position for the finder is as high above the hull as possible. In some ships it is possible to put the coil on the top of the mast and above the level of other aerials. In this position excellent results are obtained. Whenever a blurred zero is obtained, it indicates the presence of a downcoming or atmospheric ray, and in this case the error of the apparent bearing may be large.

Discharge through Sluices.—Physical Department Paper No. 25, issued by the Ministry of Public Works, Egypt, describes the experiments made under the direction of Dr. H. E. Hurst, on three models of the sluices fitted in the Aswan Dam and Sennar Dam of the Nile. Two of the models were to a scale of 1/50, and the other to a scale of 1/25. The experiments were made either at the School of Engineering, Giza, or at the Delta Barrage, while the total number of discharges measured during the work described in the paper was about 3700. Experiments were made under three conditions of flow: free conditions, submerged conditions, and intermediate conditions; and the conclusion given is that the results show that the usual theory given in the textbooks on hydraulics is inapplicable, and that the flow through a sluice and culvert is complicated. It can be described simply only when the flow is free or submerged, but not when the regime is intermediate between these.

New Raman Effect Apparatus.—The December issue of the *Indian Journal of Physics* contains a paper by Prof. B. Venkateschar and L. Sibaiya, of the Central College, Bangalore, in which they describe a new apparatus for the study of the Raman effect in solids, liquids, and gases and mention some of the results they have obtained with it. The material to be tested is enclosed in a short length of silica tube and placed at the centre of a long silica tube of 2 cm. diameter, which is surrounded by a glass tube of 3 cm. diameter. The glass tube has a short tube projecting downwards filled with mercury, which serves as the cathode. A bulb of about 5 cm. diameter projects upwards from the long glass tube and has, at its centre, the tungsten anode. When the mercury arc is formed, the part of the silica tube containing the specimen is entirely surrounded by it and the effect of the mercury line 2536 in the ultra-violet may be observed. By passing air at temperatures between 120° C. and 400° C., through the silica tube, the effect of temperature on the Raman lines has been investigated for calcite, aragonite, and acetylene. As would be expected, the lines become more diffuse with rise of temperature.

Optical Properties of Mercury Solutions.—A neat demonstration of the fact that mercury is soluble in water, methyl alcohol, and hexane is afforded by an investigation of the absorption of ultra-violet light by such solutions, of which an account is given by K. F. Bonhoeffer and H. Reichardt in the *Zeitschrift für Physik* for Feb. 25. The absorption spectrum consists, in each case, of a pair of diffuse bands near the mercury resonance wave-length (λ2537). The centres of the bands, if regarded as associated with λ2537, are displaced towards the red, but when the density of the liquid is reduced by superheating, the bands close in on each other and approach the resonance line. The explanation offered of these observations is that the bands represent Stark components of the resonance line, the active electric fields being those of neighbouring molecules of the solvent, but it is difficult to account quantitatively for the magnitude of the effect. In the aqueous solution there is further absorption at about 2200 A., which has been tentatively ascribed to ionisation of the mercury.

Conductivity Cells.—In 1923 H. C. Parker published two papers which challenged a fundamental postulate of the Kohlrausch method for the measurement of the conductivity of electrolytes by the observation that the cell constant of a particular cell appears to vary with the resistance being measured. The observation was confirmed by Randall and Scott in 1927, and some difficulty was experienced in accounting for it. In the February number of the *Journal of the American Chemical Society*, Jones and Bollinger have examined the problem, and they show that the effect is caused by the use of the pipette form of conductivity cell, which has recently been much used by American workers and considered to have advantages over the older types of cell. They show, both by calculations and experiments, that with cells of this type there is a capacitative shunt between parts of the cell of opposite polarity, which has the effect of making the measured resistance lower than the true resistance of the electrolyte between the electrodes. They also show that, whereas earlier experimenters have reported a variation in conductivity of electrolytes with change in frequency, no such change can be detected between the limits of 1090 and 4000 cycles per second, when the errors due to polarisation and capacitative shunt are avoided. The design of the conductivity cell has been modified, and the resulting cells, which are very similar to the older types previously used, are said to be capable of giving very accurate results. The ratio of the resistances of a pair of cells when filled with a common solution was found to be independent of the electrolyte used for three different electrolytes. The peculiar effects which have been published in recent years would thus appear to have been due to experimental errors.

Transition Temperature of Glauber Salt.—The temperature at which the transition

$$Na_2SO_4,\ 10H_2O \longrightarrow Na_2SO_4 + \text{satd. solution}$$

occurs has been measured by several methods by Oguri and co-workers, the results being given in the *Memoirs* of the Faculty of Science and Engineering, Waseda University, Tokyo, No. 7, 1930. The values are 32·46° (viscosity), 32·367° (dilatometer), 32·302° (solubility), 32·57° (static vapour pressure), and 32·57° (dynamic vapour pressure). The account of the dilatometric experiments includes a mathematical theory of the determination, in which it is shown how a more accurate value may be obtained from the results than by the usual simple graphical method.

Silicic Acid Hydrosol.—The preparation and properties of hydrosols of silicic acid are described in two papers by K. Inaba in *Scientific Papers* of the Institute of Physical and Chemical Research, Tokyo, Nos. 278-279, for December. The sols, prepared by the hydrolysis of ethyl silicate in presence of small quantities of inorganic acids and of alkalis respectively, showed differences in their properties. The 'acidic sol' prepared in presence of acids could not be completely purified by electrodialysis, as it began to coagulate when the acid concentration was reduced to about 0·0002 *N*; whilst that prepared in presence of alkali could be perfectly freed from alkali by electrodialysis without causing coagulation, and is called the 'neutral sol'. The acidic sol showed rather less conductivity and greater viscosity than the neutral sol. Velocities of migration in an electric field were determined for these sols and for those prepared from silicose tetrachloride by hydrolysis and from sodium metasilicate and hydrochloric acid. Acidic sols had a small degree of dispersion, small migration velocity and particle charge; whilst neutral sols had a great degree of dispersion and migration velocity. The viscosity minimum produced on addition of electrolyte was situated in the neighbourhood of the isoelectric point. The author is of the opinion that the peptising action of the chloride ion is important for stability, as well as hydration or charge, and is most powerful at the isoelectric point.

The Royal Polytechnic Society, Cornwall.

AMONGST the oldest of provincial societies, the Royal Cornwall Polytechnic Society, which has its headquarters at Falmouth, is one of those which has adapted itself to the changing times and continues to serve the interests of Cornwall in many ways. Instituted nearly a century ago for the sole purpose of holding exhibitions to encourage workmen and students and to give them the opportunity of showing their work, the annual exhibition and the summer meeting, held simultaneously, continue one of the Society's main activities. The scope of the exhibition held in July 1930 at Penzance is especially referred to in the ninety-seventh Annual Report of the Society, which records that the exhibition was visited by more than 6000 persons.

The Report also refers to the work of the Falmouth Meteorological Observatory, the Cornwall Rainfall Association with more than fifty observers in the county, and gives reports of the papers read at the summer meeting and some interesting biographical notes. Among these is a sketch of the career of the president, Dr. J. H. Rowe, of Bradford. Born in Hayle in 1870, Dr. Rowe graduated in medicine at Aberdeen and in 1899 began to practise in Bradford, where he has held the presidencies of the Bradford Literary Club, the Bradford Scientific Association, and the Bradford Historical and Antiquarian Society. He is, however, as well known in Cornwall as in Yorkshire and possesses a unique collection of books, pamphlets, portraits, and documents relating to Cornwall, and his presidential address of last year to the Polytechnic Society was a review of the work of Cornish inventors.

In this address, Dr. Rowe said that from a study of the records of some 350 inventors of Cornwall who previous to the year 1890 had invented objects of use or had taken out patents, he could not help drawing the reasonable inference that Cornwall in the past had had more than the average share of clever men. Among those to whom he referred more particularly, were Robert Were Fox, inventor of the dipping-needle; Davy, whose safety-lamp had been the means of preventing countless accidents; Trengrouse, inventor of the unsinkable lifeboat, the cork jacket, and the rocket life-saving apparatus, who spent his fortune of £3500 on his inventions, and died a poor man; Loam, inventor of the man-engine for raising miners from great depths; Trevithick, whose work was "brilliant, meteoric, sensational, but nevertheless effective"; Woolf, improver of the steam engine; Husband, whose pneumatic stamper for crushing minerals was first tried at Hayle Foundry in 1870; the Hornblowers, whose work is dealt with in a separate paper by Mr. R. Jenkins; Gurney, who invented the Bude Light and built steam carriages; the Tangye brothers; Rosevear, who in 1889 made the first wrist watch; and William Christophers, pattern-maker of Hayle, who is said to have invented the spliced cricket bat and to have shown it to Lillywhite, through whom the invention became universally adopted.

Two of the papers included in the Report deal with Cornish copper and tin mining. The first, on "Tributers—their Uses and Abuses", is by Mr. A. K. H. Jenkin, and the second, on "Abandoned Cornish Mines", is by Mr. E. W. Newton, the secretary of the Society. A tributer is a miner who, in lieu of an ordinary weekly or monthly wage, agrees to work for a percentage of the total value of the ores he sends to the surface, after paying the cost of all the tools and materials necessary for winning the same. The tributary system is of great antiquity and if tributers were properly encouraged they might continue even yet to stimulate Cornish mining. If recognition of their work is not made now, however, another decade or so and the race of men capable of rendering such services will have gone.

Mr. Newton's paper deals with the history of the Gwennap mines, which once employed many thousands of miners and from which many fortunes were made. The ores consisted of minerals rich in copper, such as native copper, oxides, arseniates, and grey sulphides. Connected with the Gwennap mines was the great County adit, begun nearly 170 years ago, "the finest and most extensive mining engineering feat carried out in Cornwall". Of the value of the mines Mr. Newton gives many particulars: South Wheal Jewel distributed £400,000 in profits in ten years; Wheal Virgin in 1757 produced copper ores in five weeks which sold for £15,000, at a working expense of £200; in 1806 Wheal Damsel was making a profit of £36,000 a year. The most fascinating mining adventure was the Wherry Mine, the shaft of which was off the coast near Penzance, 700 feet beyond high-water mark. The tin ore was very rich, and it is said, "1 cwt. of white tin was obtained from a sack of ore". An American vessel breaking loose from her moorings demolished the works and the mine came to an end.

Crabs and Lobsters on the Coasts of Britain.

AN Interdepartmental Committee appointed by the Minister of Agriculture and Fisheries and the Secretary of State for Scotland to inquire into the Crab and Lobster Fisheries was set up in 1925 to examine the present position of crab and lobster protection in Great Britain. Its report, which has recently been published (London: H.M. Stationery Office, 1930; 1*s*. 6*d*. net), is based on statistics of landings and information as to the catching power employed in these fisheries. The scope of the inquiry was restricted to the eastern and southern coasts of England and the western coast south of the Bristol Channel and the Isle of Man. The Committee had also under consideration information as to the state of the fishing in various localities in England, and from the fishery districts in Scotland, with local reports on the crab fisheries in 1923. These constitute a valuable basis for comparison with further data, taken together with landing statistics. It is recommended that similar inquiries into the catching power employed be held in 1932.

Investigations were undertaken by the Fisheries Department of the Ministry of Agriculture and Fisheries, with the co-operation of the local fisheries committees of England and Wales, to collect data with regard to size, sex, and condition of crabs. The object was to obtain definite information as to the immediate proportional loss which would result in various districts as a consequence of the introduction of measures intended to give further protection, such as increasing the minimum size at which crabs may be legally taken, prohibiting the use of undersized and soft crabs for bait, or the imposition of a close season where there is not one at the present time. After careful consideration, it was decided not to recommend the introduction of further statutory protective measures in respect of the crab fishery, as there is no falling off in the yields compared with

those of the pre-War years 1911–1913, but rather an upward tendency in the catches during more recent years. It was felt that an increase in the general size limit would entail an immediate loss of a serious nature to a section of the fishermen. As to the destruction of soft crabs, conditions are so different that if more legislation were necessary, close seasons would be different for different areas. It is, moreover, in the power of local fisheries committees to make bye-laws imposing further restrictions on the taking of crabs.

It is recommended that further inquiry into the migratory movements of the crab be pursued, and special attention is directed to the experiments on the growth of the lobster at present being carried on at the Scottish Marine Biological Station at Millport. It is anticipated that much light on the life-history of the lobster will result from this work.

Appendices containing the various statistics, with bibliographies of literature relating to crabs and lobsters, are included in the report.

The Law and Practice of Treasure-Trove.

THE law of treasure-trove has been so ill-defined in the minds of most working archæologists that we welcome the announcement made in the *Museum Journal* for April, to the effect that negotiations on the subject, which have been in progress for several years between H.M. Treasury and the British Museum, have been brought to a satisfactory conclusion. The decisions of the negotiators have been embodied in a circular, which, as defining the rights of the finder as well as his obligations, deserves the widest publicity. The circular, of which copies may be obtained on application to the Director, British Museum, W.C.1, is as follows: "Objects of *gold or silver* which have been *hidden* in the soil or in buildings, and of which the original owner *cannot be traced*, are Treasure-Trove, and by law the property of the Crown. (Unless—as in some rare cases—the 'franchise of Treasure-Trove' has been expressly granted to a subject, in so far as finds in the particular locality are concerned.) If, however, the finder of such objects reports the find promptly, and it is decided that it is Treasure-Trove and therefore the property of the Crown, he will receive its *full market value* if it is retained for the Crown or a museum. If it is not retained, he will receive back the objects themselves, with full liberty to do what he likes with them; or, if he wishes it, the British Museum will sell them for him at the best price obtainable. The only way in which a finder can comply with the law and also obtain these advantages is by reporting the find promptly to the proper authority.

"The proper authority is the Coroner for the district in which the find is made, for he is the authority who inquires 'of treasure that is found' and 'who were the finders'. (Coroners Act, 1887, section 36.)

"Anyone, therefore, who finds such objects should report the find to the Coroner, either direct or through the local police, or by writing to the Director, British Museum, London, W.C.1, who will communicate with the Coroner.

"Coins and other ancient objects of copper, bronze, or any metal other than gold or silver are *not* Treasure-Trove and finds need not be reported to Coroners. But the British Museum is glad to hear of such finds and, if finds are reported to the Director, will in suitable cases arrange for purchase or sale.

"Any further information may be obtained by applying to the Director, British Museum, London, W.C.1."

Symbiosis and Specificity in Lichens.

IN an address at the meeting last year of the Swiss Society of Naturalists (Verhandlungen der Schweizerischen Naturforschenden Gesellschaft, 1930), Chodat gives an interesting survey of the history and recent advances in lichenology. As lichens are the only plants which, as a class, are characterised by a dual nature, they are the outstanding examples of symbiosis—a term first used by De Bary, by which he did not intend to convey any idea of mutual effect of one symbiont upon the other, either for mutual benefit or the reverse.

It has usually been considered that in lichens there is a mutual effect and that this is more marked in the case of the fungus than in that of the alga, for the fungus can seldom, if ever, be ascribed to the same species as any free living form, whilst in many cases the alga has been identified as belonging to some common species. According to some of the earlier workers such as Schwendener, the specificity of the lichen was regarded as due to the fungus constituent, the algal gonidia in such different lichens as *Cladonia* spp., *Xanthoria parietina*, and *Parmelia* spp. all belonging to the one species, *Cystococcus humicola*.

The recent work of Chodat and his co-workers and of Waren has shown that the algal gonidia cannot be ascribed so readily to free living species as was previously thought. The conception has been shown clearly by pure culture work, from which it emerges that although the gonidia of various lichens may be of the same general type, for example, *Cystococcus*, those isolated from different species of a lichen genus, for example, *Cladonia*, are not identical with one another or with the free living forms, and often behave so differently in culture as to be recognisable by the macroscopic form of the colony. It has further been shown by Jaag that similar differences can be recognised between the gonidia isolated from different species of *Parmelia*, and it is especially interesting to find that the different types of *Cystococcus* isolated from *Parmelia* are more like one another than they are to the types of *Cystococcus* isolated from *Cladonia* species.

These facts are a little difficult to interpret and Chodat probably deals with the problem in the simplest way by regarding such different types of gonidial algæ as elementary species. Their identification suggests that the building up of a lichen is by no means haphazard, but that it involves the coming together of a definite species of a fungus with a particular type or elementary species of alga, and only with this one combination will a lichen of a particular species be synthesised.

Fatigue of Spring Steels.

CONSIDERABLE trouble has been experienced by the failure in service of aero-engine valve springs. A paper by Swan, Sutton, and Douglas, read before the Institution of Mechanical Engineers on Feb. 20, records an excellent piece of work on the factors which are involved.

The fractures, which were typical of fatigue failure, are ascribed to the stresses set up by 'surging' superposed on the already highly stressed wire, and were in many cases initiated as a result of some slight surface defect. Most of the wires showed surface decarburisation, and the removal of this layer resulted in an appreciable increase in the safe range of stress. Further, the temperature of quenching exerted a marked influence, and where this was high, longitudinal cracks were formed which resulted in premature failure.

Even in those cases where the surface layer had already been removed before heat-treatment, the safe limits of stress in fluctuating torsion were still further increased by a further removal of the surface layer after that treatment. The probable causes of this phenomenon appear to be the detrimental effects due to further decarburisation, or the production of minute cracks, or both. In steels containing elongated slag inclusions, heat treatment probably results in the formation of cracks at discontinuities and inclusions at the surface.

Another paper was read at the same time by Bateson and Bradley on the fatigue of laminated springs. Tests carried out on complete springs of this type have already shown safe ranges of stress of only 22-40 per cent of those which the materials would withstand in the form of turned and polished specimens. This weakness is clearly due to the surface layers of the plates of which the springs were built up. The thickness of this deleterious layer has now been shown to be quite small. It is practically completely removed by machining 1/16 in. from the surface, and in most cases it is probable that a much thinner layer of 0·01-0·015 in. would be sufficient. This surface effect has been found to be due to the hardening and tempering operations. Only a slight improvement, if any, results from heat-treating the springs after the thin layer of steel has been removed from the surface of the rolled plate.

University and Educational Intelligence.

LONDON.—A course of five weekly lectures, which began on April 21, is being given by Sir John A. R. Marriott, on "The English in India, being the Essentials of the Indian Problem". The lectures are taking place in the University of London, Imperial Institute Road, South Kensington, S.W., and have been arranged by the University Extension Committee of the University. The first lecture was entitled "The Indian Background"; this will be followed in succeeding weeks by lectures on "The English in India", "Constitutional Evolution under the Company", "Constitutional Evolution under the Crown", and "The Problem of India".

THE Quinquennial Congress of Universities of the Empire will be held next July. The main proceedings will take place in Edinburgh; but, before this, several days will be spent in London by the delegates, where they will be received by the Prince of Wales at Guildhall on July 3. The London programme will include receptions by the League of Nations Union, the Victoria League, the English-Speaking Union, and the University of London. Visits will also be made outside London, including the Universities of Oxford and Reading. The Congress will begin in Edinburgh on July 7. Addresses will be given by the Lord Provost of Edinburgh; Sir Donald Macalister, chancellor of the University of Glasgow; Lord Meston, chancellor of the University of Aberdeen; and Lord Beauchamp, chancellor of the University of London. Several subjects of general academic interest will be discussed, including "The University Graduate in Commerce and Industry", the standard and the conditions of candidature for Ph.D. in relation to other post-graduate qualifications, conditions of admission to Universities and their effects, the provision of schemes of study leading to general honours degrees, post-graduate study in medicine and surgery in Great Britain, and facilities for overseas students in British universities.

Birthdays and Research Centres.

April 26, 1879.—Prof. O. W. RICHARDSON, F.R.S., director of research in physics at King's College and honorary professor of physics in the University of London, Yarrow research professor of the Royal Society.

The researches to which I am now devoting most energy concern:

(1) The spectrum of hydrogen (H_2). This is of fundamental importance and interest owing to the simplicity of the structure of H_2 (2 protons and 2 electrons) and the richness of the spectrum. These researches have already provided the most accurate confirmation of the application of wave mechanics to a problem involving the interaction of more than two bodies. Mr. Williams and I have recently found that various band lines have different fine structures. In addition to its intrinsic interest, this should help to clear up the unclassified part of the spectrum.

(2) Soft X-rays. My chief immediate object here is to try to account for the puzzling discrepancy between the results got by optical and photoelectric methods.

(3) Electric emission resulting from chemical action. We have made great progress lately with this phenomenon, which, I think, is destined to shed much light on the nature of chemical action generally.

April 27, 1845.—Dr. D. W. FRESHFIELD, sometime president of the Alpine Club, the Royal Geographical Society, and of Section E (Geography) of the British Association.

I am chiefly interested in geographical education at the universities, and especially at Oxford.

May 1, 1882.—Prof. R. RUGGLES GATES, professor of botany in the University of London (King's College).

The lines of work now being carried on in my laboratory are mainly concerned with cytology and genetics, although work on plant physiology and biochemistry is also being done. Two investigators are working on the structure of chromosomes, and how and when the split takes place in mitosis. Another is investigating the floral development and cytology of the Australian acacias; another, the phenomena accompanying zygospore formation in Mucors, where it has been shown that, in certain cases at any rate, the medium plays a part in determining the conjugation or non-conjugation of two strains.

We are continuing on an extended scale the cytogenetic work with *Œnothera*, especially as regards chromosome linkage and the production of haploids. Several of my staff and students are partly engaged in this work, which promises to give further insight into the relations between chromatin and heredity.

As time and opportunity permit, I am continuing my work on heredity in man, racial crossing, and blood groups, from anthropological, genetical, and eugenical points of view. An immediate need is the determination of the blood groups in the Siwash and other tribes of Indians in British Columbia.

May 2, 1868.—Prof. R. W. WOOD, For.Mem.R.S., professor of experimental physics, Johns Hopkins University, Baltimore.

Investigations of the absorption spectra of salts in anhydrous liquid ammonia are in progress, and certain new filters or colour screens for spectroscopic work have been found. Rather remarkable effects have been found with neodymium ammonium nitrate, the band in the yellow shown by a water

solution breaking up into five narrow components in the case of ammonia solutions. A solid solution of neodymium oxide in fused quartz gives a most remarkable temperature emission spectrum; a fibre held in a Bunsen flame and viewed with a direct vision prism shows four bright bands (two red, an orange, and a green), separated by almost perfectly black intervals. Eight bands have been photographed between wave-lengths 4000 A. and 11,000 A.

Work is going on also with the Raman effect. The best filter for removing the line Hg 4046 is a solution of quinine in very dilute sulphuric acid. It can be prevented from turning yellow (its chief objection) by a thin sheet of Corning noviol glass specified to absorb λ3650 and transmit λ4358. For removing the 4358 line a solution of iodine in carbon tetrachloride of proper concentration is used. I now work with a horizontal quartz arc in a metal box, with the filter solution in a glass tube 6 cm. in diameter and 25 cm. long mounted horizontally between the arc and the tube containing the solution under investigation. An electric fan blows the hot-air column from the burner to one side.

Societies and Academies.

LONDON.

Physical Society, Mar. 6.—**G. M. B. Dobson**: A photoelectric spectrophotometer for measuring the amount of atmospheric ozone. The instrument follows the usual practice of measuring the absorption by the ozone of solar ultra-violet energy; from this measurement the amount of ozone can be deduced. A double quartz monochromator isolates certain pairs of wave-lengths, and the relative energy in the two wave-lengths of a pair is measured by allowing them to fall alternately on to a photoelectric cell, the current from which is amplified by thermionic valves. This allows great sensitivity to be obtained, so that very small amounts of light can be accurately measured. For measuring the amount of ozone, a pair of wave-lengths, one of which is strongly absorbed by ozone while the other is not, is selected. It is shown how the amount of ozone can still be measured when the sky is cloudy if a second pair of wave-lengths, both unabsorbed by ozone, be also measured.

EDINBURGH.

Royal Society, Mar. 2.—**B. Prashad**: Some noteworthy examples of parallel evolution in the molluscan faunas of south-eastern Asia and South America. The three families specially studied in this connexion are the Pilidæ (Ampullariidæ), Unionidæ, and Ætheriidæ. In all three families there are species, externally almost identical, found in the two areas mentioned living under similar ecological conditions. These almost identical types are believed to be the result of the action of the environment alone, and are regarded as examples of parallel evolution.—**Henry Briggs**: The classification and development of the Carbonaceous minerals of organic origin. A classification, based on the ultimate analysis, is applied to coals, cannels, paraffin shales, and torbanites. All analyses are reduced to the basis C + H + O = 100 per cent. A graphical method of presenting the analyses is adopted; it shows the above minerals to be distinct species, each following a 'development line' which expresses the evolution of the mineral from a rank equivalent to lignite to a rank equivalent to semi-bituminous coal. With the exception of that of ordinary coals, the 'development lines' are straight, and each is oriented to a deoxygenated end-product of simple composition.—**H. V. Lowry**: Properties of the function $Ei_n(x)$: the function $\int_1^\infty \exp(-xt)t^{-n}dt$ which Milne called $Ei_n(x)$ in his book "Thermodynamics of the Stars", has also been used by Gold and Roberts in the discussion of some radiation problems. In this paper some of the main properties of the function are discussed, including: recurrence properties, expansions of the function in series, an approximation for large values of n, and a method of using least squares to find a function of the form $a\exp(-bx)$ which shall be close to $Ei_n(x)$ for all positive values of x.—**A. C. Aitken** and **A. Oppenheim**: On Charlier's new form of the frequency function. The probability, or relative statistical frequency, of a wide class of variables has been represented by the 'series of type A'. The series is known, however, to have the practical defect that its terms do not decrease in regular succession, and C. V. L. Charlier has recently advanced a modified form, type C, which he proves to be free from the defect in question, for the first several terms at least. The authors demonstrate the truth of Charlier's conjecture that all the terms decrease in order. Indirectly some abstruse theorems in combinatory algebra are brought to light.

PARIS.

Academy of Sciences, Mar. 9.—**Mesnager**: The bending of a beam does not depend on the shearing stress.—**V. Grignard** and **J. Savard**: The magnesium derivatives of dichlorotriphenylphosphine and on the pentaphosphines. The chloride $C_6H_5 . PCl_2$ treated with the magnesium compound RMgX gives $C_6H_5PR_2$. The preparation and properties of $(C_6H_5)_3PCl_2$ are described, and also a new class of phosphorus compounds, the pentaphosphines, of the type $(C_6H_5)_3PR_2$, where R is an alkyl group.—**Elie Cartan** was elected a member of the Section of Geometry in succession to the late P. Appell.—**Francesco Severi**: A fundamental property of analytical functions of several variables.—**Radu Badesco**: Solution of a functional equation and generalised iterative functions.—**Soula**: Functions which possess an infinity of derivatives.—**Basile Demtchenko**: The inverse mixed problem and surfaces of sliding in doubly connected space.—**O. Yadoff**: A new method of establishing the normal working diagram of turbines.—**V. G. Siadbey**: The apparent radiants of large meteors.—**T. Boggio**: A physical interpretation of Riemann's tensor and of the principal curvatures of a variety V_3.—**P. Vernotte** and **A. Jeufroy**: A simple method of measuring the specific heat of a solid at the ordinary temperature. Application to beryllium. The substance, at room temperature, is dropped into water at 1°–2° C. contained in a Dewar vessel. The calorimeter is standardised with a mixture of water and mercury of the same volume and heat capacity as the body under examination.—**V. Lalan**: The hypothesis of the curve of pursuit and the laws of reflection in optical systems in motion.—**R. Jouaust**: The problem of heterochrome photometry.—**R. Ricard**: The various spark spectra of mercury.—**G. A. Boutry**: Modifications of the characteristic surface of a photoelectric cell with a gaseous atmosphere when the resistance in series is changed.—**Guichard, Clausmann, Billon, and Lanthony**: The independence of the hardness and proportion of hydrogen in electrolytic metals. From the experiments described, the authors conclude that electrolytic metals do not owe their hardness, even partially, to the presence of a hypothetical hydride; their hardness is due to their very fine structure.—**Néda Marinesco**: Specific inductive power and molecular weight. It is possible to deduce the molecular weight of a

dissolved colloid by a study of the dielectric dispersion of the system as a function of the wave-length. Applied to a dilute solution of gelatine, the value for the molecular weight found was 11,300.—**L. Joleaud**: The recent progress of our knowledge on the history of the Pacific in the Tertiary period and Wegener's theory.—**D. Schnéegans**: Observations on the western limit of the Briançonnais sheet to the south of the Maurienne.—**Mihaïlovitch Jélenko**: Two earthquake catastrophes, in November 1930 and January 1931, in Albania.—**Emile F. Terroine** and **Mlles. Germaine Boy, Marguerite Champagne**, and **Gilberte Mourot**: The distribution of urinary nitrogen in the endogenous nitrogen metabolism specific during growth.—**Louis Baudin**: The respiratory quotient of fish as a function of temperature.—**Marcel Abeloos** and **Maurice Lecamp**: The production of abnormal and multiple formations in the limbs of Triton by the transplantation of regenerates.—**F. Vlès** and **A. de Coulon**: The final end of grafts of arrested epithelial tumours.

SYDNEY.

Royal Society of New South Wales, Dec. 3.—**A. R. Penfold**: The essential oils of three species of *Geijera* and the occurrence of a new hydrocarbon. The essential oils from *Geijera parviflora*, *G. Muelleri*, and *G. salicifolia* were examined. Apparently two physiological forms exist in the species *parviflora*. A new hydrocarbon of tentative formula $C_{11}H_{18}$ was isolated and several of its characteristics were examined.—**J. G. Churchward**: Studies in the inheritance of resistance to bunt in a cross between Florence and Hard Federation wheats. Resistance to bunt is inherited as a simple Mendelian recessive. A study of the occurrence of grass tufts in the progeny of the cross indicates the presence of an inhibiting factor. A single dominant factor determines the inheritance of tip-beardedness. In the cross, Florence × Hard Federation, the inheritance of resistance to bunt, grass tufts, and tip-beardedness is controlled by single, independent, Mendelian factors.—**M. B. Welch**: (1) Experiments on moisture in timber. Experiments on the moisture content at different times of the year of certain flooring timbers at Sydney, show that a variation of approximately 2·0 per cent occurs between the maximum and minimum results. The mean moisture content of twenty-six samples was 12·7 per cent, although individual samples varied from 14·8 to 10·1 per cent at different periods. The mean moisture content of the softwoods is in general lower than that of hardwoods, which seldom give a mean figure below 12·5 per cent.—(2) The occurrence of intercellular canals in the wood of some species of *Flindersia*. Longitudinal intercellular canals of a gummosis type occur in the secondary wood of some species of *Flindersia*, notably *F. Brayleyana*. They are found in metatracheal parenchymatous bands, and form a more or less anastomising network extending in a tangential direction but not radially. The contents appear to be similar to wound gum, the canals being formed by the breaking down of the cell walls. Their origin is usually schizo-lysigenous.

VIENNA.

Academy of Sciences, Jan. 15.—**G. Aigner**: A graptolite fauna from the graywacke zone of Fieberbrunn in Tyrol, with remarks on the graywacke zone of Dienten. Of 1200 specimens, some three per cent could be determined, thus ranking the shales with zones 18-22 of the English Silurian according to Elles and Wood.—**B. Kubart**: Investigations on the flora of the coal-basin of Ostrau-Karwin. A *Lyginodendron* with marked medullary structure and zones of increase.—**O. Schindler**: A new *Hemirhamphus* from the Pacific Ocean.—**O. Koller**: The mammalian fauna of the Pithyusæ Islands.—**A. Steuer**: Variation of size and form in the plankton copepods.—**A. Tamerl**: The osculating cylinder of rotation to a given three-dimensional curve.—**J. Hoffmann**: The causes of different radiation-colourings in glasses and of silica and amethyst colourings.—**W. Abel**: Investigations on the separate inheritance of the size of jaw and size of teeth in half-breeds from Bushmen, Hottentots, and Negroes. The canines are sometimes crowded. This is supposed to be due to the crossing of a large-toothed race with a small-jawed race. The jaw is meso-dermal, the teeth are ecto-dermal in plan.—**K. Menger**: The concept of constructivity (2). The construction of series of arithmetical numbers.

Jan. 22.—**K. Spitzer**: Specific dopa-oxydases extracted from fruit. In apple, pear, and banana there is a di-oxy-phenyl derivative which is most probably identical with 'dopa' (=di-oxy-phenyl-alanin).—**E. Schmid**: The radium emanation content of open air and its vertical distribution near the ground (from observations in St. Peter, near Graz, in 1930). The average content was less at a height of 50 metres than at 13 metres or 2 metres. Also, the radium emanation concentration varied with meteorological conditions.—**J. Pia**: Preliminary report on fossil Algæ, the results of a journey to England with the support of the Academy of Sciences. The carboniferous limestone was studied in the field, in Gloucestershire, Yorkshire, and Westmorland, also in the museums of Bristol, Leeds, and London.—**W. Laves**: Physico-chemical studies of colour after experimental injury to the liver (1). The alteration of the electrostatic characters of nucleus chromatin and plasma of liver cells from injuries of the circulation and from direct action of high and low temperatures on the liver.—**V. Lebzelter**: The anthropology of the Kung-Bushmen. Two main types and an intermediate were found.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 16, No. 12, Dec. 15).—Biotic cementation in coral reefs. A distinction should be drawn between calcareous reefs and reefs actually built up by the co-operative growth of coral colonies, the skeletons of which become their chief component. The Darwinian theory of coral reef growth refers to the second type of reef. The solidarity of these reefs depends on organic cementation and the organisms concerned are nullipores.—**W. E. Castle**: The quantitative theory of sex and the genetic character of haploid males. Certain hymenoptera, scale insects, and rotifers produce males which arise from unfertilised reduced eggs and transmit in their sperm only the female sex tendency. It is concluded that they are genetically females though functionally they are sperm producers and are called males on the basis of their somatic character.—**Barbara McClintock**: A cytological demonstration of the location of an interchange between two non-homologous chromosomes of *Zea mays*.—**Sterling Emerson**: The inheritance of *rubricalyx* bud colour in crosses with *Œnothera Lamarckiana*.—**Harold H. Plough**: Complete elimination of self-sterility in the ascidian *Styela* by fertilising in alkaline solutions. The block to self-fertilisation appeared to reside in the egg cortex itself.—**G. I. Lavin** and **J. R. Bates**: The ammonia discharge tube. An active gas is produced which is reducing in character, heats small solid particles in its path to incandescence, and causes an intense green glow in the ammonia collected in the liquid air trap. Different metal and oxide surfaces show different effects in extinguishing the glow. The active gas seems to be a mixture of atomic hydrogen and a hydride of nitrogen (NH or NH_2).—**R. M.**

Badger and J. W. Urmston: The separation of the two types of iodine molecule and the photochemical reaction of gaseous iodine with hexene. Iodine and hexene were exposed to intense radiation from a mercury arc. Compared with another tube containing fresh iodine and hexene, the experimental tube showed much weaker fluorescence with a mercury arc, suggesting that the type of iodine molecule responsible for this fluorescence had largely combined with the hexene.—George Scatchard: Note on the equation of state explicit in the volume.—Y. H. Woo: On the intensity of total scattering of X-rays by monatomic gases (see NATURE, Oct. 4, 1930, p. 501).—H. Bateman: Irrotational motion of a compressible inviscid fluid. The discussion is applied to the case when the velocity is greater than the local velocity of sound and to the circulation round an aerofoil.—W. J. Trjitzinsky: A study of indefinitely differentiable and quasi-analytic functions.—Tracy Yerkes Thomas: On the unified field theory (2). Another set of field equations is derived which indicates that Maxwell's equations hold approximately in the local co-ordinate system in the presence of weak electromagnetic fields.

Official Publications Received.

BRITISH.

The Veterinary Bulletin. Vol. 1, No. 1, April. Pp. 96. (Weybridge: Imperial Bureau of Animal Health.) 7*s.* 6*d.* net.

The Imperial College of Tropical Agriculture. The Principal's Report for the Year 1929–30. Pp. 24. Prospectus for 1931–32 and Register. Pp. 27. (St. Augustine, Trinidad; London: 14 Trinity Square, E.C.3.)

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 18: The Influence of Frequency of Cutting on the Productivity, Botanical and Chemical Composition, and the Nutritive Value of "Natural" Pastures in Southern Australia. Progress Report on Co-operative Investigations at the Waite Agricultural Research Institute. Pp. 28. (Melbourne: H. J. Green.)

Seale-Hayne Agricultural College, Newton Abbot, Devon: Department of Plant Pathology. Seventh Annual Report for the Year ending September 30th, 1930. (Pamphlet No. 36.) Pp. 36. (Newton Abbot.)

Transactions of the Royal Society of Edinburgh. Vol. 56, Part 3, No. 29: On the Morphology, Feeding Mechanisms and Digestion of *Ensis siliqua* (Schumacher). By Alastair Graham. Pp. 725-751+1 plate. 3*s.* 6*d.* Vol. 56, Part 3, No. 30: The Dolerite Isles of the North Minch. By Dr. Frederick Walker. Pp. 753-766+1 plate. 2*s.* (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 6, No. 2, April. Pp. 133-220. (Cambridge: At the University Press.) 12*s.* 6*d.* net.

The Photographic Journal. Vol. 71, New Series, Vol. 55, April: Photography in Science, Art and Industry. Pp. 133-166+56+xlvi+9 plates. (London: The Fountain Press, Ltd.) 2*s.* 6*d.*

British Guiana: Second Legislative Council, First Session, 1930, Geological Survey. Report on the Buck Canister-Oranapai Section of the Marazuni Diamond Field. Pp. 18. (Georgetown, Demerara: Department of Lands and Mines.)

Reports of the Council and Auditors of the Zoological Society of London, for the Year 1930, prepared for the Annual General Meeting to be held on Wednesday, April 29th, 1931, at 4 P.M. Pp. 91. (London.)

Goitre in the Light of Recent Research. By Prof. C. E. Hercus. (Cawthron Lecture, Sept. 5th, 1929.) Pp. 22+10 plates. (Nelson: Cawthron Institute.)

Researches in British Guiana, 1926–1928, on the Bacterial Complications of Filariasis and the Endemic Nephritis; with a Chapter on Epidemic Abscess and Cellulitis in St. Kitts, British West Indies. By A. W. Grace and Feiga Berman Grace. (Memoir Series, No. 3.) Pp. viii+75. (London: London School of Hygiene and Tropical Medicine.) 8*s.*

Anopheline Mosquitos in Southern Rhodesia, 1926–1928: a Report on Investigations made during Researches on Blackwater Fever conducted by Dr. G. R. Ross. By H. S. Leeson. (Memoir Series, No. 4.) Pp. ix+55+15 plates. (London: London School of Hygiene and Tropical Medicine.) 8*s.*

FOREIGN.

U.S. Department of Commerce: Coast and Geodetic Survey. Serial No. 499: Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory near Tucson, Arizona, in 1923 and 1924. By W. N. McFarland. Pp. ii+103. (Washington, D.C.: Government Printing Office.) 50 cents.

Publikationer og mindre Meddelelser fra Københavns Observatorium. Nr. 72: Über die kritische Masse im problème restreint und über das problème restreint im allgemeinen. Von Elis Strömgren. Pp. 6. Nr. 74: Bestimmung der Bahn des periodischen Kometen Comas Solá (1926 f). Von Julie M. Vinter Hansen. Pp. 25. (Københavns.)

Bulletin of the American Museum of Natural History. Vol. 59, Art. 5: A new Classification of Mammals. By George Gaylord Simpson. Pp. 259-293. (New York City.)

Report of the Danish Biological Station to the Ministry of Shipping and Fisheries. No. 36, 1930. By Dr. A. C. Johansen. Pp. 96. (Copenhagen: C. A. Reitzel.)

Proceedings of the United States National Museum. Vol. 78, Art. 17: Mollusks from the Aspen Shale (Cretaceous) of Southwestern Wyoming. By John B. Reeside, Jr., and A. Allen Weymouth. (No. 2860.) Pp. 24+4 plates. (Washington, D.C.: Government Printing Office.)

U.S. Department of Commerce: Bureau of Standards. Miscellaneous Publication, No. 114: Filters for the Reproduction of Sunlight and Daylight and the Determination of Color Temperature. By Raymond Davis and K. S. Gibson. Pp. 165. (Washington, D.C.: Government Printing Office.) 45 cents.

Collection des travaux chimiques de Tchécoslovaquie. Rédigée et publiée par E. Votoček et J. Heyrovský. Année 3, No. 3, Mars. Pp. 135-186. (Prague: Regia Societas Scientiarum Bohemica.)

Publikationer fra det Danske Meteorologiske Institut. Communications magnétiques, etc., No. 13: A Theoretical Determination of the Heights of the Stratosphere, the Ozone Layer and the Height of Maximum Luminosity of the Aurora. By Helge Petersen. Pp. 19. (København: G. E. C. Gad.)

Proceedings of the American Academy of Arts and Sciences. Vol. 66, No. 5: The Volume of Eighteen Liquids as a Function of Pressure and Temperature. By P. W. Bridgman. Pp. 185-233. 1 dollar. Vol. 66, No. 6: The Problems of Lagrange and Mayer with Variable End Points. By Marston Morse and Sumner Byron Myers. Pp. 235-253. 45 cents. Vol. 66, No. 7: Compressibilty and Pressure Coefficient of Resistance, including Single Crystal Magnesium. By P. W. Bridgman. Pp. 255-271. 45 cents. (Boston, Mass.)

Mémoires publiés par la Direction Générale des Télégraphes de Suède. Étude des courants telluriques. Par Dr. David Stenquist. Deuxième fascicule. Pp. 17. (Stockholm: R. W. Statlanders Boktryckeri.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1644: Local Bird Refuges. By W. L. McAtee. Pp. ii+14. (Washington, D.C.: Government Printing Office.) 5 cents.

U.S. Department of Commerce: Bureau of Standards. Research Paper No. 262: Prism Size and Orientation in Minimum-Deviation Refractometry. By L. W. Tilton. Pp. 59-76. (Washington, D.C.: Government Printing Office.) 10 cents.

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 637-B: Preliminary Report on the Ground-Water Supply of Mimbres Valley, New Mexico. By Walter N. White. (Contributions to the Hydrology of the United States, 1930.) Pp. ii+69-90+1 plate. Bulletin 821-C: Iron Ore on Canyon Creek, Fort Apache Indian Reservation, Arizona. By Ernest F. Burchard. (Contributions to Economic Geology, 1930, Part 1.) Pp. ii+51-78+plates 14-18. 15 cents. (Washington, D.C.: Government Printing Office.)

Division of Fish and Game of California. Fish Bulletin No. 27: The Ring Net, Half Ring Net, or Purse Lampara in the Fisheries of California. By Donald H. Fry, Jr. (Contribution No. 101 from the California State Fisheries Laboratory). Pp. 67. (Sacramento: California State Printing Office.)

Proceedings of the United States National Museum. Vol. 78, Art. 7: A Revision of the Species of Coccophagus, a Genus of Hymenopterous, Coccid-inhabiting Parasites. By Harold Compere. (No. 2850.) Pp. 132+14 plates. Vol. 78, Art. 18: A new Species of Amphipod Crustacean (Acanthonotozomatidae) from California, and Notes on *Eurystheus tenuicornis*. By Clarence R. Shoemaker. (No. 2861.) Pp. 8. Vol. 78, Art. 22: Redescription of Two Species of Trematode Worms from the MacCallum Collection, with a Note on the Family Pronocephalidae. By Emmett W. Price. (No. 2865.) Pp. 10. Vol. 78, Art. 23: New Genera and Species of Nematode Worms. By Asa C. Chandler. (No. 2866.) Pp. 11. (Washington, D.C.: Government Printing Office.)

Science Reports of the Tokyo Bunrika Daigaku, Section A. No. 6: On the Vapour Pressure of Liquid. Part 2: On the Vapour Pressure, Henry's Constant and Osmotic Pressure of Concentrated Solutions. By Keiichi Watanabe. Pp. 67-84. (Tokyo: Maruzen Co., Ltd.) 30 sen.

Field Museum of Natural History. Botanical Series, Vol. 10: Flora of the Lancetilla Valley, Honduras. By Paul C. Standley. (Publication 283.) Pp. 418+68 plates. Botanical Series, Vol. 8, No. 4: The Cyperaceae of Central America. By Paul C. Standley. (Publication 284.) Pp. 239-292. Botanical Series, Vol. 7, No. 2: The Rubiaceae of Ecuador. By Paul C. Standley. (Publication 285.) Pp. 179-251. Zoological Series, Vol. 18, No. 2: Bats from Polynesia, Melanesia and Malaysia. By Colin Campbell Sanborn. (Publication 286.) Pp. 7-29. (Chicago.)

Proceedings of the Imperial Academy. Vol. 7, No. 2, February. Pp. iii-v+29-83. (Tokyo.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 288: Note on the Photoelectric Effect by Relativistic Wave Equation of Dirac. By Toshinosuke Muto. Pp. 111-126. 25 sen. No. 292: Der Einfluss metallischer Überzüge auf die mechanischen Eigenschaften von Stahl beim Nitrieren. Von Tadamasa Yosiki. Pp. 143-154+plate 5. 25 sen. No. 293: On the Constitution of Tea Tannin. By Michiyo Tsujimura. Pp. 155-159+plate 6. 15 sen. Supplement No. 13: Eine einfache graphische Method für die Berechnung des partiellen spezifischen Volumens von Eiweisskörpern. Von Tominosuke Katsurai. Pp. 7-8. 10 sen. (Tōkyō: Iwanami Shoten.)

Bulletin of the National Research Council. No. 77: Physics of the Earth. 1: Volcanology. By the Subsidiary Committee on Volcanology. Pp. viii+77. 75 cents. No. 78: Physics of the Earth. 2: The Figure of the Earth. A Collection of Short Papers, written by Leading Scientific Men in several branches of Geophysics, and treating of the Size and Shape of the Earth. Pp. v+286. 3.50 dollars. No. 79: Physics of the Earth. 3: Meteorology. Prepared under the Auspices of the Subsidiary Committee on Meteorology. Pp. xi+289. 3.50 dollars. (Washington, D.C.: National Academy of Sciences.)

U.S. Department of Commerce: Bureau of Standards. Bureau of Standards Journal of Research. Vol. 6, No. 3, Research Papers Nos. 279-291. Pp. 355-522. (Washington, D.C.: Government Printing Office.) 40 cents.

Smithsonian Institution. Explorations and Field-Work of the Smithsonian Institution in 1930. (Publication 3111.) Pp. iv+224. (Washington, D.C.: Smithsonian Institution.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 83. East African Birds collected during the Gray African Expedition, 1929. By W. Wedgwood Bowen. Pp. 11-79+plates 2-12. The Cirriped Genus Pyrgoma in American Waters. By Henry A. Pilsbry. Pp. 81-83. Nearctic Vitreine Land Snails. By H. Burrington Baker. Pp. 85-117. (Philadelphia.)

U.S. Department of Commerce: Coast and Geodetic Survey. Special Publication No. 171: World Longitude Determinations by the United States Coast and Geodetic Survey in 1926. By Clarence H. Swick. Pp. ii+29. (Washington, D.C.: Government Printing Office.) 15 cents.

U.S. Treasury Department: Coast Guard. Bulletin No. 20: International Ice Observation and Ice Patrol Service in the North Atlantic Ocean, Season of 1930. Pp. iv+50+11 plates. (Washington, D.C.: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. 82, No. 16: The Ductless Glands of Alligator Mississippiensis. By A. M. Reese. (Publication 3110.) Pp. 14+3 plates. (Washington, D.C.: Smithsonian Institution.)

Transactions of the Astronomical Observatory of Yale University. Vol. 6, Part 4: Theory of the Eighth Satellite of Jupiter. By Ernest W. Brown. Pp. 47-65. (New Haven, Conn.)

Diary of Societies.

FRIDAY, APRIL 24.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—Sir William Foster: John Zoffany in India.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (at Westminster Hospital), at 4.30.

INSTITUTE OF MARINE ENGINEERS, at 6.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—E. J. Mathieson: The Generation and Uses of Electrical Power in a Modern Colliery.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (Annual General Meeting) (at Waldorf Hotel, Aldwych), at 6.45.—At 7.30.—Sir Richard Gregory, Bart.: Science in Industry.

BRITISH ASSOCIATION OF CHEMISTS (Scottish Section) (at Central Halls, Glasgow), at 7.30.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Col. L. W. Harrison: Epidemiology of Venereal Diseases.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Philip Hartog: Joseph Priestley and his Place in the History of Science.

SATURDAY, APRIL 25.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Newcastle-upon-Tyne), at 2.30.—T. C. Futers: Notes on a Recent Visit to South Africa with the Empire Mining and Metallurgical Congress: Witwatersrand Gold Mines; Coal, Asbestos, and other Mines; Diamond Mines (Lecture).—Paper open for further discussion:—Old Mining Records and Plans, T. V. Simpson.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch) (at College of Technology, Manchester), at 4.—E. Ronceray: Sand, and Sand Preparation.

MONDAY, APRIL 27.

INSTITUTE OF ACTUARIES, at 5.—K. J. Britt: Amalgamations of Life Assurance Companies.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—M. Ayrton: Modern Bridges.

ROYAL SOCIETY OF ARTS, at 8.—Dr. N. A. V. Piercy: The Present Position in Aeronautics (Howard Lectures) (3).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—W. Charles: Full Denture Prosthesis.

TUESDAY, APRIL 28.

EUGENICS SOCIETY (at Linnean Society), at 5.30.—Dr. A. J. Lewis: Genetic Problems in Psychiatry.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. W. E. Le Gros Clark: The Brain of *Microcebus murinus*.—C. Elton, E. B. Ford, J. R. Baker, and A. D. Gardner: The Health and Parasites of a Wild Mouse Population.—Dr. C. J. van der Klaauw: On the Tympanic Region of the Skull in the Mylodontinæ.—R. Anthony: Vestiges de deux remplacements successifs de la 3ème molaire de lait chez l'Éléphant d'Asie (*Elephas indicus* Cuv.).—D. Aubertin: Revision of the Genus *Hemypyrellia* Tns. (Diptera: Calliphoridæ).

INSTITUTION OF CIVIL ENGINEERS, at 6.

INSTITUTE OF INDUSTRIAL ADMINISTRATION (at 28 Portland Place, W.1), at 6.30.—H. Lesser and others: Discussion on Personnel Policy and Administration.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Symposium on Sensitometry.—Dr. W. Clark: General Considerations of Sensitometry as Applied to Sound Recording.—C. R. Keith: Sensitometry in the Modern Film Laboratory.—G. S. Moore: Precautions in Practical Sensitometry.—Miss G. Geoghegan: Demonstration of the Tallent Reflection Density Comparator.

QUEKETT MICROSCOPICAL CLUB (at 11 Chandos Street, W.1), at 7.30.—Gossip Meeting.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—A. L. Armstrong: Recent Excavations in the Pin-hole Cave, Cresswell Crags.

ROYAL AERONAUTICAL SOCIETY (Students' Section).—E. Wieser: Airships (Lecture).

WEDNESDAY, APRIL 29.

BRITISH ASTRONOMICAL ASSOCIATION (at Sion College), at 5.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 6.—Miss Evelyn Cheesman: In the Savage South Seas (Lecture).

ROYAL SOCIETY OF ARTS, at 8.—Sir Harold Carpenter: Stainless Metals.

THURSDAY, APRIL 30.

ROYAL SOCIETY, at 4.30.—Dr. A. E. H. Tutton: Determination of the Yard in Wave-Lengths of Light.—U. R. Evans, L. C. Bannister, and S. C. Britton: The Velocity of Corrosion from the Electrochemical Standpoint.—T. L. Eckersley: On the Connexion between the Ray Theory of Electric Waves and Dynamics.

LINNEAN SOCIETY OF LONDON, at 5.—Dr. G. S. Carter: Aerial and Aquatic Respiration.—Dr. E. S. Semmens: Hydrolysis in Living Plants by Polarised Light: Effect of Blue Skylight on Plant Metabolism.—Dr. J. M. Dalziel: Hairs Lining the Loculi of Fruits of Species of *Parinarium*.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Presentation of the Faraday Medal to C. H. Merz.—Prof. W. L. Bragg: The Architecture of Solids (Kelvin Lecture).

INSTITUTION OF LOCOMOTIVE ENGINEERS (at Institution of Mechanical Engineers), at 6.—Miss V. W. Holmes: A New and Infinitely Variable Poppet Valve Gear.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Dr. M. Curry: Aerodynamics of Sails (Lecture).

FRIDAY, MAY 1.

CERAMIC SOCIETY (Building Materials Section) (at Imperial College of Science and Technology), at 10.30 A.M.—M. Barrett: Night Architecture.—W. A. McIntyre: Durability of Terra Cotta with Particular Reference to the Filling of Blocks.—M. Barrett: Stock Terra Cotta.—M. Barrett: Metallised Terra Cotta.—At 2.30.—E. R. F. Cole: Kiln Products in Architecture.—G. Haworth: Informal Talk on Modern Machinery Used in Three Processes of Brick-making, *i.e.* Semi-plastic, Stiff-plastic, and Plastic Wire-Cut.—W. Emery: Notes on the Firing of a Blue Brick Oven.

ROYAL SOCIETY OF MEDICINE (Otology Section) (Annual General Meeting), at 10.30 A.M.—Dr. Schmaltz: The Physical Phenomena Occurring in the Semi-circular Canals during Rotatory and Thermic Stimulation.—Dr. H. W. Barber: Eruptions Involving the External Auditory Meatus.—Discussion: Non-malignant Diseases of the External Ear and Auditory Meatus.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—Dr. G. M. B. Dobson: Variations and Distribution of Atmospheric Ozone.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Prof. J. E. Lennard-Jones: Cohesion (Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—Annual Meeting.

ROYAL SOCIETY OF MEDICINE (Laryngology Section) (Annual General Meeting), at 5.—Prof. G. Portmann: A Big Tumour of the Deep Regions of the Face Removed by Operation, with Cure.—Dr. A. Brown Kelly, Dr. D. R. Paterson, and others: Discussion on Obstruction at the Upper End of the Œsophagus (Excluding Pharyngeal Diverticula).

ROYAL SANITARY INSTITUTE (at Town Hall, Batley), at 5.—Councillor H. Crothers and Councillor H. S. Houldsworth: Housing, with Special Reference to the Housing Act, 1930, from the Aspect of a Town Councillor.—Dr. T. Gibson and H. Hornby: Housing, with Special Reference to the Housing Act, 1930, from the Administrative Standpoint.

NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY (at Royal Society of Arts), at 6.—Miss S. Bevington: The Causes of Juvenile Drifting.—A. H. Seymour: Personnel Work in Modern Industry.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section) at 7.—Prof. W. M. Thornton: High-Voltage Precision Measurements (Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—H. Crowe and others: Discussion on Hydraulic Valves.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Prof. P. G. H. Boswell: The Glacial Deposit of East Anglia, with Especial Reference to the Industries of Early Man.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. D'Arcy W. Thompson: Charlotte Brontë in Brussels.

SATURDAY, MAY 2.

ROYAL SANITARY INSTITUTE (at Town Hall, Batley), at 10 A.M.—Major D. S. Rabagliati and others: Discussion on The Practical Value of Meat Inspection.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section) (at Cambridge).

PUBLIC LECTURES.

TUESDAY, APRIL 28.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. L. Hogben: Some Aspects of Human Inheritance (1): The Biology of Twinning.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Prof. F. A. E. Crew: Laws of Inheritance. (Succeeding Lectures on April 29, 30, and May 1.)

WEDNESDAY, APRIL 29.

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL, at 5.30.—Prof. O. Förster: Neurology. (Succeeding Lectures on April 30 and May 1.)

THURSDAY, APRIL 30.

UNIVERSITY COLLEGE, LONDON, at 5.30.—M. Aubert: Les origines de la Voûte sur Croisée d'Ogives. (Succeeding Lecture on May 1.)

FRIDAY, MAY 1.

UNIVERSITY COLLEGE, LONDON, at 5.—Prof. B. Ashmole: History of Ancient Sculpture.