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The Ceremonial of Coronation

IN the ceremonial and pageantry of coronation, such as that now at hand, there draws to a close a period of transition in which the royal power passes from dead to living. The solemn investiture of the new monarch with the symbols of kingly dignity and the acclamation and rejoicings of his people mark the final stage in a ritual of change, which, from the earliest days of primitive kingship, has been held of gravest moment for the community. Although we may no longer believe with our primitive forefathers, as still do some of the less-advanced peoples of to-day, that the vigour and fertility of crops and herds, and even the prosperity of the nation, may depend directly upon the virility of the ruler, this much of the mystical lingers in our mode of thought, that only with the ceremonial of coronation do we feel that we have passed in full sense from waters, which might prove turbulent, to the haven of a new reign.

To the coronation of His Majesty King George VI, must be attached an added significance over that of his predecessors. The change in the interrelation of the constituent parts of the Empire under the provisions of the Statute of Westminster has thrown into high relief the personal responsibility which now rests upon the King-Emperor as the sole constitutional link of Empire. For the first time the Coronation Oath, in its amended form, assumes a position of outstanding import in the ceremonial observances. It has become something more than the solemn undertaking to make just use of the royal prerogative than it has been in the past. In the imperial sense, it is now the head and front of the rite.

This process of evolutionary development, which we see taking place before our eyes, is in full accord with the history of the ceremonial of coronation in Great Britain. Like the British constitution, of which it is an appanage, its ability to endure rests on its capacity to change without break in continuity. So far from being a collection of survivals, the coronation ceremonial, even though close parallels may be cited from ancient pagan custom and the practices of 'savages', in each of its rites expresses some one aspect or another of the emotional force which inspires workaday citizenship. Each change in form, and more especially each variation in emphasis as between the elements in the ceremonial, to be marked in the course of its history, has expressed the general sense of the community at that period in its reactions of loyalty towards the monarch, successively as head of the English State, as ruler of the United Kingdom, and as King-Emperor of the Empire.

The British ceremonial of coronation, like the monarchy, is the oldest in the European States which still adhere to the monarchical form of government. It is also the most elaborate. Its history begins in the eighth century with an Anglo-Saxon rite, in which the ceremony of sacring the king was introduced in the middle of a Mass. Oil was poured from a horn on the king's head, the anthem "Zadok the Priest" was sung, the bishops and nobles placed a sceptre in the king's hand, the staff was delivered to him, and finally a helmet was placed upon his head. The assembly then cried "May King . . . live for ever". The enthronement followed, and the nobles swore fealty. The Mass then concluded with special prayers.

In part, and especially in so far as it was an enthronement with acclamation, this ceremony

was of much earlier origin. The Germanic tribes, after the election of their ruling chief, used to enthrone or elevate him on their shields. He was then carried on the shields around the assembled people on the shoulders of certain of the nobles. This custom was adopted by the Franks, and was the method by which Clovis and his immediate successors were elevated to the throne. It continued in use for some time after the introduction of Christianity with the addition of a religious service. It survived in part in the procession from the Tower to Westminster and the elevation to the marble throne in the English ceremony, and in France in the showing of the king to the people.

The tribal ceremonial, in which the elected chief was elevated on the shields of his subjects, in accordance with the needs of the times, symbolized his function as leader of his people, more especially in war. With the coming of Christianity and the participation of the Church in affairs of State, another aspect of kingship, no less primitive, was brought into prominence in the inaugural ceremony. This was the spiritual and magico-religious element, which in early and primitive forms of the kingship identifies the ruler with divinity or accredits him with magical powers to be used for the benefit of his people. In the coronation ceremonial of Western Europe, its immediate source must be sought in the Bible, and as time went on in the Eastern conceptions of monarchy which came with Byzantine influence, rather than directly in survivals of pagan ideas. For although pagan chiefs and rulers claimed descent from heathen deities and demi-gods, such as Odin or Wotan, neither English monarchs nor His Most Christian Majesty of France appear to have laid claim to divinity, but rather to rule through divine influence—by the grace of God. At the same time, a detailed comparison with non-Christian rites indicates so many similarities in form and idea as to suggest at least a strong colouring of a mode of thought, which belongs to a more primitive phase of religious belief. As is well known, the early Church was not averse from adapting the concepts and ideas of paganism to further the advancement of Christianity.

It is a reasonable assumption that the magico-religious conceptions, which Sir James Frazer has shown to play a predominant part in the evolution of early forms of kingship, should be much in evidence at the inauguration of a new ruler. The problem before the primitive mind must always have been how best to ensure that the qualities and powers, which secured in the ruler who has now passed away the prosperity of his people, should be continued in the person of his successor. When the succession was determined by mortal combat, in which the victor either remained, or became, the ruler, as in the priesthood of Nemi, the result determined the issue. Where the cult of the ancestors prevailed, especially when the spirit of an ancestor was believed to reappear on earth in his descendants, as among certain of the Bantu-speaking peoples, the principle of inheritance was adequate to their need. Failing the direct assurance of such determinants, however, it was deemed necessary, as we can see from the character of the inaugural rites themselves, to ensure the continuance of the qualities and powers of the old ruler in the new by a ceremonial which in its origin and essence was magical, or at best magico-religious, however it may have come to be regarded later, when incorporated in a more advanced system of religious belief.

In royal and chiefly inaugural ceremonies which are of a traditional character and not modern innovations, there are certain recurring features, some appearing sporadically, others again and again with regularity. Mr. A. M. Hocart in his acute and ably argued study of the kingship (Oxford, 1927), analysing this ceremonial, notes some twenty-six characteristic features. His analysis is too long to quote here ; but the most important point he makes is that the ceremonial is one in which the ruler dies, and is born again as a god. Among other characters may be mentioned a ritual combat in which the ruler must prove victorious, baptism with water and anointing with oil, investiture with special garments and regalia, the enthronement, the acclamation of the people, the sacrifice of a victim—often human—and usually the bestowing of a new name on the king.

Lest it seem that the interpretation of the coronation ceremonial as a re-birth is somewhat remote from the form of rite with which most are familiar, it may not be out of place to refer briefly to one or two examples which support this contention. Only the more significant points are mentioned.

In the ceremony of inauguration of a ruling chief in Fiji, which Mr. Hocart quotes as his 'type specimen', a specially prepared sheet of bark-cloth is wrapped round the chief's arm, and a bowl of kava is presented to him, after a period of fasting and abstinence. When he drank this, he was not permitted to take the bowl with the

arm which had been swathed in the bark-cloth sash. For four nights kava was made ; and at the end of that period the chief bathed, while a raid on a village secured a human victim who was killed, baked and eaten at a feast. At one point in the proceedings a man offered to fight as a champion for the chief. Muskets were fired so that the whole land might know that the ceremony was completed.

The points of interest in connexion with this ceremonial are that in part it is similar to the ritual which is observed on the death of a chief, while the ceremonial drinking of kava, and the bark-cloth scarf, apparently are intended to suggest that the god is brought to the chief in the bark-cloth and enters his body after he has died in the form of the kava. He is then born again and bathes to cleanse himself from the impurities of the womb.

The theory that the inauguration of a chief or king is a new birth is more clearly brought out in the ancient Indian ritual, in which the priest in investing the king with three garments speaks of two of them as cauls out of which he is born, while the mantle which is thrown over him last of all, is called "the womb of sovereignty". In this ceremony there is a magical victory in a mock fight, while the climax of the rite is a lustration of the enthroned king with a double stream of water. This purification by water is followed by an anointing with clarified butter.

Although little is known of the actual coronation rites of Ancient Egypt, the Sed festival, which took place at a late date in a reign, renewed the vigour of the monarch by a rebirth and rejuvenation in which the rites were in all probability a repetition of the rites of coronation.

The idea of continuity through rebirth is most clearly expressed, perhaps, in the ceremonies which accompany the accession of the Adah of Idah, northern Nigeria—a vigil of eight days at the royal necropolis ; a period spent at the "birth-place", where the future ruler is joined by the chief wife of his predecessor ; and the action of two officials who sport as man and wife, the latter then mimicking childbirth and delivering the Adah to the chief eunuch as 'her' son. The Adah is then divested of his birth garments and adorned with the royal robes.

While it is undoubtedly true that neither in France nor in England, as already mentioned, was it claimed that the king was divine, yet there are many similarities in detail with the ceremonies mentioned which are suggestive of at least a cognate mode of thought, and it may be even a more intimate connexion : the vigil—no longer observed—the anointing, the robing and investiture, the acclamation of the people, the perambulation, and the challenge of the king's champion, which takes the place of the ritual combat, though the office and not the rite alone remains.

Most significant, perhaps, in the older ritual is the ceremony of the anointing, which until the Reformation was the most important element in the ceremonial. By it, the person of the king was made sacred. Indeed it was held by some that the king henceforth was both priest and layman ; and although this doctrine does not seem to have prevailed in England, in France the king appears to have held priestly office and on occasion is said to have officiated in priestly vestments. It is evident that in both the English and the French ceremonial the Divine Spirit and the kingly office were brought into peculiarly intimate relation. These two closely related forms of the rite, with the Empire, made use of the chrism, the most sacred of the blessed oils, in France mixed with a drop of oil from *La Saincte Ampoule*, in which the Holy Dove had once placed holy oil for the coronation of Clovis, in England from the time of Edward II, when the coronation ritual reached its most elaborate development, for anointing the parts of the king's body, while for his head was used oil from the flask which, as the Pope wrote to Edward, the Virgin Mary had delivered to Thomas à Becket for that use at some later day. From this anointing the two monarchs derived their power of healing by 'touching' for the King's Evil.

With the Reformation and the personal rule of the Tudors, the idea of the sanctification of the king's person gave place to other concepts of monarchy. The importance of the unction waned to give place to the ceremonial of placing on the monarch's head the crown, the symbol of territorial dominion, as had been shown by the triple crown of Charlemagne, silver for Germany, gold for Rome, and the sacred crown of iron, made from a nail of the Cross, for Lombardy. The crown, it is true, is not without a 'magic' of its own—otherwise why should our kings still be crowned with the crown of St. Edward, though that venerable relic was broken up under the Commonwealth—but its real significance lies not in its interpretation as a survival, but in its living meaning as an emblem of a constitutional and personal relation between king and people.

Audubon the Magnificent

(1) Audubon
By Constance Rourke. Pp. vii + 342 + 12 plates. (London, Bombay and Sydney: George G. Harrap and Co. Ltd., 1936.) 12*s.* 6*d.* net.

(2) Singing in the Wilderness: a Salute to John James Audubon. By Donald Culross Peattie. (Country Books, 2.) Pp. xvi + 245 + 8 plates. (London: George Allen and Unwin, Ltd., 1936.) 7*s.* 6*d.* net.

(1) THIS is the biography of a genius in ornithological art, in the early days of American science and culture. But more than this, it is the story of a personality so gallant and vivid, so unworldly and unbusinesslike, so unconquerably gay in adversity and prosperity alike, as to make extraordinary the present-day ignorance of him and his work. He was the pioneer of a new ornithology, describing birds as living and sentient beings rather than as specimens—more naturalist than man of science, and perhaps more artist than either.

Mystery surrounds his birth. He was adopted at the age of nine years by Captain and Mrs. Audubon. Captain Audubon, son of a poor fisherman, owned a merchant ship which traded in San Domingo, where he bought a sugar plantation and prospered greatly. During his stay on the island, a boy was born to a Mdlle. Rabin, for whom Captain Audubon evidently felt some responsibility. He therefore took a boy with him when he left San Domingo for his home in Nantes and he and his lawful wife formally adopted a boy four years later, of an age to correspond with the birth of Mdlle. Rabin's son. The Audubons later used the name of Jean Rabin to indicate this boy. In the face of these facts, it must be due to the general glamour of the man, that Miss Rourke indulges in special pleading for identifying the future naturalist with the little son of Louis XVI, the lost Dauphin.

The boy had very strong tastes from the first, seeking the woods and streams at all times, for ever trying to observe, draw, and stuff birds. He was a handsome healthy boy and was intended for the Navy, but Captain Audubon had to remove him from the naval school as he was always playing truant. For a time he studied in Paris under David, the great art teacher, but classical drawing had no charms for him, and he returned home. Eventually Captain Audubon sent him to America, to manage an estate of his, Mill Grove, at that time in the care of Quakers. Here he had great freedom, hunting, drawing, shooting, and making friends with the neighbouring settlers.

An English family named Bakewell lived near Mill Grove, and the young Audubon and Lucy Bakewell fell in love at first sight, and irrevocably. Never was man more fortunate in his love, for Lucy understood his wayward nature, was convinced of his greatness, and bore with cheerfulness the poverty and hardship of his early years.

Young Audubon's business misfortunes began early, and he returned to Nantes for a year. His adopted father arranged a partnership between him and an earnest youth, Ferdinand Rozier, and they were smuggled out to America to avoid conscription in Napoleon's forces. Audubon was henceforward known as John James Audubon. After some time, the young partners began storekeeping, and in this book we have the account of the long journey of the newly wed Audubon and Lucy, by coach and "flat boat" to Louisville on the Ohio, at that time a "frontier village". The account of this journey is a delightful piece of description. Louisville was the centre of a small settlement of French refugees of good birth, and one of these, Nicholas Berthoud, married Lucy's sister later and was a great help to the Audubons. Throughout all this time, Audubon was making drawings of birds, perfecting his technique, rushing off to the woods and streams in season and out of season. His personality made friends for him, but his lack of any business instinct, and his inveterate habit of playing truant from business, must have been a sore trial to poor Rozier.

Kentucky was a birds' paradise at that time, and Audubon became less and less of a storekeeper and more of an artist-naturalist. At Louisville he had the first of his two meetings with Alexander Wilson, his predecessor in American ornithology. Wilson had started life as a poor Scottish weaver, was self-taught, anxious, reserved and dour. He was travelling in order to get commissions for his work "American Ornithology". Audubon showed his own drawings, which Wilson praised, and the two went "hunting" together, but without any resultant friendship. Audubon's poverty and possibly a certain jealousy prevented him from subscribing to Wilson's book, and Wilson records surprisingly that he left Louisville without receiving one act of courtesy, one subscription or seeing one new bird. Audubon gives a different account of the meeting, but the result of it was a rancour and jealousy on Wilson's part which extended to his supporters, publishers and others, and pursued

Audubon throughout his career. Audubon never denied Wilson's priority, but it is certain that the clash of two such different temperaments produced in each a jealous antipathy.

Miss Rourke takes us through the various phases of Audubon's business ventures, interspersed with lively interludes of voyage and hunting, ending with the breaking of the partnership, and Audubon's ultimate bankruptcy. He was now thirty-five years old, penniless ; Lucy had helped him by teaching and by her own private fortune. By this time they had two sons, and had buried two little girls. Audubon's record effectually closed the door to other employment in commerce. It was now, when most men would have been in despair, that Audubon, and with him the faithful Lucy, became convinced anew of his genius, and decided that he should publish a great book "The Birds of America". Lucy and the boys remained behind, and the father set off for New Orleans, later to Philadelphia, to seek the wherewithal for publication. Many were his failures and vicissitudes; he taught dancing, he painted portraits, he stuffed specimens for museums. His drawings did not find favour with publishers in America, and moreover he suffered from the active animosity of Wilson's publishers, who wanted no rival "Ornithology". Eventually in 1826 he was able to go to England. He was well received in Liverpool, and in Edinburgh he was elected fellow of its Royal Society. He met Sir Walter Scott, Bewick and other men of note. Lizars, the engraver of Selby's "Book of British Birds", undertook to prepare plates from Audubon's pictures, but later gave up, and Havell, the London engraver, took the work in hand. Audubon's faith in himself was such that he decided to publish in four great volumes, double elephant, although ten years would be needed for completion. He toured England for subscriptions, and also France, meanwhile painting portraits and selling drawings. When he had a little money, he sent gloriously extravagant presents to his Lucy.

Two years passed, and Audubon returned to America to make still more drawings. Subscriptions were coming in slowly, but enough to secure continuance of publication. He returned to England, Lucy with him now, and faced a storm of attacks this time on the truth of his observation. But now at last Audubon's star was in the ascendant ; he had many good friends, Sir Thomas Lawrence, Christopher North and others. A new project was started, and the "Ornithological Biography" was begun, as companion text to the great work. For this he had the inestimable help of William McGillivray, who gave scientific value to the publication. Audubon's individual treatment of the book was shown in the interposition of "Episodes" of hunting adventures between the scientific descriptions. Despite warnings, and the growing volume of animosity from Wilson's partisans, he published the first volume himself, and, elated by its enthusiastic reception, returned to America for another joyous hunting excursion. His sons were now able to work with him.

The magnificent "Birds of America" was published in 1839, and, the "Biography" being also finished, Audubon and his family returned to America and settled in Harlem. America, having failed to recognize his worth earlier, now rushed to acclaim him, and the rest of his life was spent in happy pursuit of art, music and natural history. Another work "The Quadrupeds of North America" was carried through, largely with the help of Audubon's sons, and Mr. Bachman. Audubon's sight failed some years before he died in 1851, and at last his mind had dimmed.

Audubon was an artist rather than a scientific ornithologist and as such was a surprise to his generation. His very technique was new—water-colour combined with pastel. New also was the presentation of birds in active movement, and in natural surroundings of flower and leaf. Most surprising of all is the decorative balance of each plate ; some of them are instinct with a feeling beyond art or bare naturalistic presentment. Like Audubon's character, his work is something unique and apart, joyous and spontaneous, yet entirely individual and determined.

(2) Mr. Peattie's book is in a measure complementary to the other. It is written almost in 'novel' form, and centres round the love idyll rather than the grim struggles for fame. The earlier part of Audubon's life is more fully treated than are his efforts in England. The illustrations are particularly well chosen. The coloured frontispiece shows Audubon's decorative art at its best, and we note the tender beauty of the pictures "Passenger Pigeons" and "Barn Swallows". The interesting self-portrait of the artist shows the limitations of the amateur in this *métier*, in contrast with his mastery in bird illustration. Those who lack leisure for the longer biography, will find here an unforgettable presentation of a unique and great personality.

Both books before us contain illustrations representative of Audubon's art. Both contain a wealth of anecdote culled from his journals, which he wrote almost all his life. The accounts of his long struggle for means to accomplish his destiny fill the reader with alternate hope and despair, sympathy for his business partners and unbounded respect for his Lucy. The records of his journeys on the rivers are valuable as history of a bygone day, and the beauty conjured up by them is a sad reminder of the glories that commerce and ever-increasing population have destroyed. E. G. G.

Primitive Behaviour

Primitive Behavior
an Introduction to the Social Sciences. By William I. Thomas. (McGraw-Hill Publications in Sociology.) Pp. ix + 847. (New York and London: McGraw-Hill Book Co., Inc., 1937.) 30*s*.

THE impulse to collect is almost universal. Some people collect cigarette cards, others stamps or coins. Ethnological museums collect the skulls, weapons, utensils and works of art of primitive societies. Mr. Thomas has collected records of their customs and beliefs. Like most collectors, he has carefully arranged and catalogued his booty. Therefore his eight hundred closely printed pages of facts will be invaluable, as a work of reference, to the student. But those who seek explanations, or the stimulus of theory, will have to go elsewhere. Mr. Thomas has not, indeed, refrained from comment altogether. He has adopted certain general conclusions. He believes that different peoples have reacted in different ways to similar situations, and so rejects the over-simplified view that development has been unilinear. He believes that a society is more influenced by its neighbours than by its physical surroundings—that the cultural area is more important than the geographical area; and he believes that any innate differences there may be between different races has had little or no effect on their respective cultures. Here Mr. Thomas, in repudiating an over-emphasis on innate factors, seems to have gone to the opposite extreme.

Apart from these general conclusions, there are few theories to be welcomed or attacked. Mr. Thomas, therefore, has had no temptation to select his material, and has collected it entirely without bias. But the striking feature of the book is not that explanations are avoided—this might be the result of caution—but that Mr. Thomas finds so little to explain. The astonishing persistence of a primitive custom, even when it serves no obvious function, is, for him, only a particular example of the perseveration of habit. Thus the real problems of psychology do not exist for him at all. Had he paid more regard to the fact that the perseveration of habits varies within wide limits, that while some are unbreakable others can be broken without effort, his curiosity would have been less easily satisfied, and he would have suspected the presence of hidden motives behind those primitive customs which are unalterably fixed. Had he suspected the presence of hidden motives for the persistence of a custom, he would have suspected that the same motives might have been, in part, responsible also for its origin.

To take an example: Mr. Thomas sees in the Jewish abhorrence for the flesh of pigs a habit, which through long duration has acquired the force of law. He does not feel the need for any further explanation. As, for him, no special motive is required to account for the perpetuation of this taboo, he is prepared to believe it originated without a motive—at any rate, he quotes, with evident approval, an author who derives this 'habit' from the supposed difficulties of pig-keeping in an arid land. Or, take another taboo, that of incest and the marriage of near kinsmen. Here Mr. Thomas finds a real motive: the desire to establish an alliance between two groups, or to have relations-in-law on whom to call in case of need. This is sound enough, so far as it goes. But such a practical consideration can scarcely account for the extreme horror of incest, for the common belief that it blights the crops and brings nameless calamities not only on the guilty couple, but also upon their clan. This extreme horror is, for Mr. Thomas, merely another example of the rigidity with which any long-standing habit comes to be observed. But the curiosity of anyone who is not hypnotized by that magic word 'conditioned reflex' will not be lulled so easily to sleep.

The obsessional neurotic has certain taboos and rituals of his own. For example, he cannot touch a knife, or must dress in a particular order. If he touches a knife accidentally, he is overwhelmed with nameless dread. If he makes an error in the order of his dressing, for example, cleans his teeth before he brushes his hair, he must go back to bed and begin all over again. If he is prevented from doing so, he suffers an outbreak of acute anxiety—as acute as if his wife or children were dangerously ill; indeed, he often feels dimly that they are in some mysterious way threatened by his lapse. Are such obsessional taboos and rituals trains of conditioned reflexes, mere habit systems? Certainly, but so is a great part of normal behaviour, which, nevertheless, can be broken without anxiety. There is clearly some important factor that distinguishes the obsessional from the non-obsessional habit, which is ignored when the same word is used, without qualification, for both.

Now many of the taboos and rituals of primitive people are obviously obsessional—as Freud pointed out in 1912. Primitive man, indeed, is an obsessional neurotic, who is provided by tradition with

taboos and rituals, and thus saved the trouble of developing private symptoms of his own. Freud's explanation of these taboos and rituals may be neither wholly accurate nor complete. In particular, the secondary social advantage, where it exists, is important and should not be neglected. But to ignore the deeper motives, to dismiss primitive behaviour as habit fixed by repetition, originating in a judgment—wrong perhaps, but reasonable within the limits of primitive man's intelligence and knowledge—this is to make a retrogressive step, which can only lead to the complete sterility of socio-psychological research.

Although Mr. Thomas is blind to the deeper motives behind primitive behaviour, he has a good eye for secondary and social motives; and as a collector and classifier he can have few rivals. His book is a mine of information, and may retain its value far longer than would a more stimulating and imaginative work, which would almost inevitably have soon been obsolete.

ROGER MONEY-KYRLE.

A Yearbook of British Universities

The Yearbook of the Universities of the Empire, 1937
(Published for the Universities Bureau of the British Empire.) Pp. xxix+1125. (London: G. Bell and Sons, Ltd., 1937.) 15*s*. net.

THE present issue of this handy guide to the learned world follows closely the lines of its recent predecessors. The main body of the work consists of a series of summary accounts, one for each university, grouped by countries and each comprising: (1) a directory of the officers and members of the staff of the university, (2) general information regarding organization, etc., and (3) reports of events of outstanding interest which occurred during the past year. Preceding the compendia relating to the institutions in (1) Great Britain and Ireland, (2) Canada, (3) Australia, (4) South Africa and (5) India, respectively, are five chapters reviewing their history, regulations, practice and distinguishing characteristics. Appendixes deal with: professions and careers, admission to universities, open post-graduate scholarships, etc. (several hundred paragraphs covering 47 pages), centres of scientific research and information (70 pages), and other matters of interest to the learned world and the public generally.

Of the Universities Bureau of the British Empire, the body responsible for the production of the Yearbook, full particulars (memorandum and articles of association and membership) are given on pages x–xxix. Among the objects are "to facilitate . . . the interchange of information . . . and . . . of students and teachers between the said universities and between them and the universities of foreign countries". It is therefore natural that in the reports of events of the past year, a considerable amount of space should be devoted to particulars of "visits of teachers from other universities, etc.". It is noteworthy, at a time when channels of international intercourse are deliberately obstructed in pursuit of nationalistic policies, that many visitors from foreign countries lecture in the universities of Great Britain. The list of visitors to Cambridge, for example, includes professors from Harvard, Paris, Breslau, Copenhagen, Amsterdam, Utrecht, Lund, Lwow, Madrid. The significance of such international visits would perhaps be more strikingly disclosed if the particulars of them were exhibited in one place instead of being scattered among the several university sections.

As regards students from other countries in the universities and university colleges of Great Britain and Ireland, a numerical statement compiled from returns received from all those institutions (except Trinity College, Oxford), appears on pp. 994–995. It gives the total number of such students as 5,882, which is one tenth of the total number of *full-time* students in those institutions. It reveals the remarkable fact that German students (416) outnumbered those from any other European country by more than five to one. Switzerland came next with 77, then France (76), Poland (72), Holland (69), Norway (50), Austria (44), Hungary (38). Other notable contributions were from India (1313), China (295), Palestine (157), Egypt (348), South Africa (568), United States (592), Canada and Newfoundland (280), Australia (248), New Zealand (148).

In fulfilment of one of its principal objects, the Universities Bureau organized last year the fifth quinquennial Congress of Universities of the Empire, which was held at Cambridge last July. It seems odd that the Yearbook should contain no reference to this event except by the inclusion of the Congress report in a list of books on p. 1015. In a "Yearbook of the Universities", should not some record of such outstanding events of the year, directly affecting them though not peculiar to any one of them, find a place in a general or regional chapter?

Lecture Experiments in Chemistry

By G. Fowles. Pp. xvi+564. (London: G. Bell and Sons, Ltd., 1937.) 16*s*. net.

ONE of the difficulties facing the young teacher of chemistry is the devising and executing of experiments suitable for class and laboratory use. For some years before taking up the first post, the teacher will have been performing experiments in what are regarded as more advanced parts of the subject, and when the time comes to deal with the supposedly simple experiments involved in a course of School Certificate standard, trouble begins for those who are unaware of the great difficulty of many such experiments and have not the necessary skill and experience.

To such teachers the work of Mr. Fowles will be both welcome and beneficial. His book is confined mostly to School Certificate standard, and the material is arranged in lessons, which will also be useful until the teacher has enough confidence to evolve an independent scheme of teaching. Many alternative experiments are given, and the references to books will be useful to older teachers who wish to keep up to date. Several sections deal with subjects not adequately dealt with in the usual text-books, such as colloids, indicators, etc., although in some cases the treatment here seems rather too difficult for the standard at which Mr. Fowles aims.

There is some repetition in the book, as for example, when the preparation of a gas such as ammonia is described several times in different experiments, and the size of the book could have been materially reduced by more careful arrangement of material, cross references, etc. The appendixes on aims and methods of teaching chemistry will be read with interest by teachers. The range of the book is too restricted to make it of much use in more advanced courses, and the disconnected order is also a drawback to its use in courses in universities, for which it is obviously not intended.

The Extra Pharmacopoeia

By W. Martindale. Twenty-first edition. In 2 vols. Vol. 1. Pp. xxxv+1182. (London: The Pharmaceutical Press, 1936.) 27*s*. 6*d*.

THE Pharmaceutical Press has now taken over the publication of this standard work from Messrs. H. K. Lewis and Co., Ltd. A new edition of the first volume has now appeared with an enlarged page and a blue cover. This volume is complete in itself and gives an account of the pharmaceutical and therapeutic properties of practically all the drugs prescribed by medical men. The revision must have involved a great deal of work, even when divided among seventeen pharmacists. Thousands of references to recent medical literature have been included, in the place of older and less important information.

The general arrangement has been to some extent rationalized, so that drugs with similar actions appear together, but the process has not been carried far enough. For example, the section on acidum aceticum in the twentieth edition included the acetates, acetylcholine, choline, glycine and betaine hydrochloride. The latter has been properly transferred to the section on hydrochloric acid, but choline has been left where it was, with new company in the form of thallium acetate and cysteine. The extensive index largely compensates for defects of arrangement, but it would be difficult, for example, to find the substance commonly known as benzedrine under the alias of desoxynorephedrine.

The book contains an amazing quantity of information and is remarkably up to date. The inclusion of the names of manufacturers of proprietary remedies is a very welcome addition. The information about these substances will do much to encourage rational prescribing. Every medical man and every pharmacist should possess this book.

A Monograph of the British Neuroptera

By F. J. Killington. Vol. 1. (Ray Society Vol. 122 for the Year 1935.) Pp. xix+269+15 plates. (London: Bernard Quaritch, Ltd., 1936.) 25*s*.

IT is now nearly seventy years since the appearance of McLachlan's monograph on British Neuroptera. In the meantime, the most notable contributions to a knowledge of this subject have been the studies by the late C. L. Withycombe, which were mainly in the fields of morphology and biology. The book before us provides, as nearly as possible, a complete account of the British members of the Planipennia. Its author has also incorporated the results of his own observations, and has succeeded in producing a remarkably well-balanced treatise. It is gratifying to see morphology, biology and taxonomy all come in for adequate treatment.

The first 180 pages provide the reader with a general introduction to the order, including also some accounts of its fossil representatives and of the phylogeny. There follows a detailed treatment of the British species up to the beginning of the family Hemerobiidæ. The rest of this family, together with the whole of the Chrysopidæ, are to form the subject of a second volume which has yet to appear. The book is well arranged and excellently illustrated, the greater number of the figures being new. The author is to be congratulated on having produced a work of real merit and of a character which might well be emulated by monographers of other groups.

A. D. I.

Aeroplane Structures

By Dr. A. J. Sutton Pippard and Capt. J. Laurence Pritchard. Second edition. Pp. xvi+368+13 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1935.) 21*s*. net.

THIS book forms an excellent introduction to the problems connected with the structural design of aircraft. The presentation starts from first principles, which are fully explained, and proceeds in easy steps to numerous practical applications, many of which are carried through to the numerical solution. A number of diagrams and tables should prove also of value for those engaged in actual design work. The authors, whose great practical and teaching experience makes itself felt throughout the book, have succeeded in bringing home the fundamentals, and the book can be unreservedly recommended. A. B.

Optical Contact*

By the Right Hon. Lord Rayleigh, F.R.S.

WHEN two glass surfaces are put together without special precautions, they do not come into close contact, and their separate individuality is completely preserved. Yet this is not what might be expected. If the two glasses were really close, they would be equivalent to one piece, and no reflexion would be observable from the interface. Ordinarily this does not happen, because various agencies prevent the glasses coming close enough together. Thus particles of dust and traces of grease tend to do this, and moreover, ordinary surfaces, such as those of spectacle prisms, are not flat enough to come into close contact, except over a very limited area.

However, by using really flat surfaces, scrupulously clean, and by sliding them together so as to exclude dust, two surfaces may be made to *contact*, that is to say, they will come into contact so close that the reflexion at the interface practically vanishes, and when once this has been achieved –and it is easier said than done—the glasses adhere with very considerable force. Such glasses are said to be in optical contact.

Although, as we shall see, the germs of this subject are to be discovered in much earlier work, optical contact has mainly come into notice in connection with the manufactures of Messrs. Adam Hilger, Ltd., under the management of Mr. F. Twyman; Mr. Green, the foreman of their optical shop, has been prominent in this. To mention one example, the echelon transmission gratings made by the firm have the glass plates put into optical contact, which improves the transparency and makes the instrument much more efficient. I have heard the late Prof. A. A. Michelson, who was perhaps not very lavish of praise, speak with enthusiasm of this great improvement in his invention. Nevertheless, the interface, even of contacted glass, does give a faint reflexion. I shall have more to say about this presently.

There is a strong force of adhesion between two contacted glasses. Glasses having an area of less than 2 square inches can be shown to withstand a pull of 56 lb. weight. On occasion, contacted glasses have been made to stand even considerably stronger pulls than this, up to 56 kilograms per square centimetre. However, there does not seem to be anything very definite about it, and there is little doubt that the separation starts at points of local weakness.

* From the Friday evening discourse at the Royal Institution delivered on December 18, 1936.

The germ of this subject can be discovered in the writings of long ago. Let me recall the well-known experiment of Newton's rings. Two glass wedges, one of which has a convex face of 50 ft. radius, are clamped together without any special precautions, except ordinary cleaning, and give by reflection a circular patch of optical contact—the familiar black centre, surrounded by a system of coloured rings. It is interesting to recall that the blackness of the centre was felt to be a difficulty by the early exponents of the wave theory of light. Yet a simple consideration shows that it ought to be black, the consideration namely that an infinitely thin crack is equivalent to no crack at all, and therefore cannot reflect light.

We obtain local optical contact at the centre of Newton's rings without the technical difficulties which are encountered in contacting flat plates. This is natural, because all the pressure that we use is taken locally, and if there is any dirt or obstruction in the way it is crushed.

It may seem a discrepancy in what I have been saying, that the optical contact which we get in this case is not accompanied by strong mechanical adhesion. This fact will conveniently serve as a starting point in considering the character of the adhesion between flat plates. Although the adhesion is very strong in resisting a fair pull, it is not at all strong in resisting what I may call an *unfair* pull, that is to say, a force tending to strip the plates apart. Such a force can be applied by wedging or pulling the plates apart at one edge or one corner, and we then overcome the adhesion in detail, for the force applied is all concentrated at the edge of the contacted area. It is like tearing a strip of calico when a start has been made by making a short cut with the scissors. All the force is concentrated locally, the breadth of the strip of calico contributing nothing to increase its strength. In the case of Newton's rings, when the convex surface is squeezed flat locally, as soon as the force is relaxed the elasticity of the material brings a stripping force of the kind to bear, and the two glasses separate themselves easily.

If, however, the convexity is very slight, and the amount of flattening involved in contact is consequently small, we may obtain Newton's rings with adhesive contact, no clamping being necessary to keep the glasses together (Fig. 1). This case may be regarded as intermediate between the case of Newton's rings and the case of accurately contacted flat plates.

Newton's rings result when we have contact in the middle, and separation outside; but the converse case may also occur. If a piece of glass gets scratched, experience shows that it becomes difficult to contact it. The reason of this is that the hard particle that causes the scratch, ploughs up a sort of ridge, which of course prevents contact near it. If the scratch is short, we may nevertheless obtain contact at a distance from it by the flexure of the glass. A specimen of this kind shows the scratch in the middle, the interferential tints all around, with contact and blackness at the circumference. If it is allowable to be a little Irish, we might describe it as "Newton's rings with the black centre at the outside." The interferential tints enable us to determine the height of the ridge.

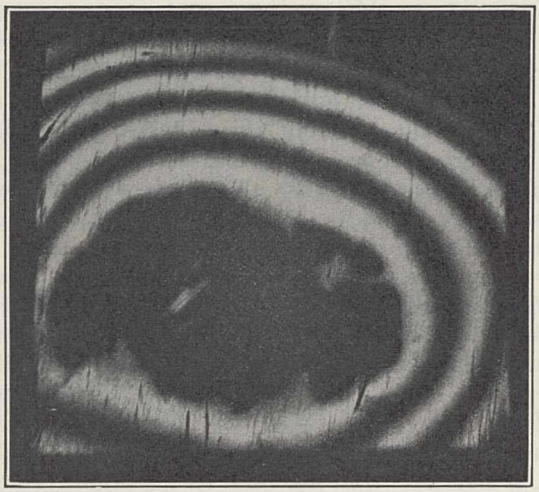

Fig. 1.

Although to a first approximation the reflexion from the interface of contacted plates is black, or in other words non-existent, yet there is a slight reflexion. In the ideal case when the surfaces are in contact the reflexion should be evanescent, but the intensity should increase as they are separated, all this occurring within the range when the interface reflexion is still black to the casual observer. The wave theory allows us to connect the intensity of reflexion with the distance, and it was hoped in this way to obtain a direct measure of the distance between the surfaces, which might be brought into relation with the energy required to separate them.

I found, however, that there was a very curious uncertainty in the amount of reflexion, particularly when surfaces of silica glass were used. I mean that one pair of contacted surfaces would give quite a different reflecting power from another, sometimes ten times as much. What could be the explanation? It was natural to seek it in the character of the surfaces themselves. Since it is not so easy to modify the surfaces experimentally while preserving the flatness necessary for contacting, I thought of trying a single surface immersed in liquid of the same refractive index, which automatically adjusts itself to the shape of the immersed surface. This at once gave a clue to the mystery. Carbon tetrachloride has nearly the same index as fused silica, and by adding a little ether an exact adjustment can be made for green, the brightest part of the spectrum, so that green light passing through a prism of silica immersed in the liquid suffers no deviation.

In this way we get a liquid which matches optically the inside of the silica prism, irrespective of what the optical quality of the skin may be. The skin, on the other hand, determines the reflecting power of the immersed silica. If the skin is the same as the inside, then there should be no reflexion. When I tested a surface commercially polished, there was usually very little reflexion, and if a fired surface, or a surface slightly washed with dilute hydrofluoric acid was used, the reflexion became practically evanescent. On the other hand, any attempt to polish it further with the somewhat amateurish technique of my laboratory increased the reflexion largely; and rubbing it on a dry felt wheel with a very fine abrasive powder did so still more, until a practical maximum had been reached. An abrasive powder used in this way does not destroy the polish. The increase of reflexion produced is so great that it can readily be seen even without immersion.

The felt wheel with the fine abrasive produces a modified skin; and it is interesting to inquire what is the optical character of the skin and, also, what is its thickness? By putting the surface in a series of refracting liquids, we can find which liquid reduces the reflexion to a minimum. I find that a mixture of 75 volumes of carbon disulphide and 25 volumes of benzene, index 1·596, does this. It is to be concluded that the skin is quite as refractive as light flint glass, whereas the body of the silica (index 1·46) is much less refractive than crown glass.

This is a surprising result, and shows that the skin produced by the treatment is something quite different from any of the known modifications of silica. Yet it is difficult to see what else than silica can enter into its composition. By dipping part of the plate in dilute hydrofluoric acid we may dissolve off the modified layer from that part, leaving a kind of step. To estimate the height of this step, we apply a flat test plate and observe the dislocation of interference fringes when they cross the step. In this way the height of the step, and hence the thickness of the layer, has been estimated at $\frac{1}{20}$th of the wave-length

of light in air. Fig. 2 shows a strip of this kind; it has, however, been etched more deeply than is necessary to remove the layer. Similar effects to those with silica can be obtained with glass surfaces, but the layer produced by the felt wheel with abrasive is definitely less refractive than in the case of silica, and since the material is more refractive to begin with, the change is a good deal less conspicuous.

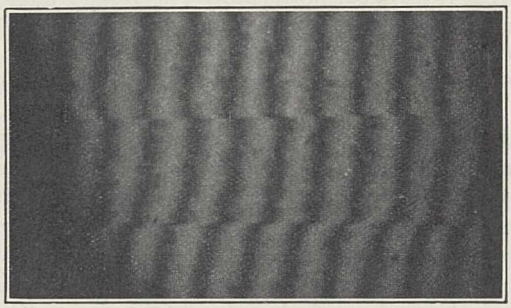

Fig. 2.

Returning to the contacted surfaces, it will now not be difficult to understand why some have a stronger reflexion from the interface than others. It is because the ordinary process of polishing is somewhat haphazard. It may produce a modified layer, as the felt wheel with fine abrasive does, or it may remove the layer already produced. This depends on the exact conditions of the polisher. I have verified this, using a cloth polishing wheel with rouge, which was quite wet to begin with and was allowed to dry. The reflexion of the silica surface was tested at intervals, and was found to pass through a minimum at a certain degree of moisture of the polisher. Concurrent weighings showed that this was the stage at which material was being most rapidly removed.

It is evident that if the contacted surfaces are not exactly alike, residual reflexion is to be expected, even if there is no separation of the surfaces. Further, even if they are alike, there will be reflexion at the separating surface between the skin and the body of the material in each of the glasses. If therefore we wish to reduce the interface reflexion to a minimum, we must get rid of the skin. I have tried contacting two glasses which have been deprived of their skin by means of hydrofluoric acid or caustic potash, but this is not as satisfactory as might have been hoped, because the chemical treatment develops all kinds of defects which were latent in the polished surface, and the light scattered by these makes it very difficult to investigate the faint residual reflexion. I have not been able to determine with certainty that the reflexion is in any case less than would correspond to about 10 A. distance between the planes. This is three or four times as much as the distance apart of the atoms in crystals.

In conclusion, I wish to explain how we may determine the amount of work done in separating two contacted surfaces, or even the amount of work which can be gained by the action of the attractive forces when they are contacted. These amounts of work are not the same, for the process of decontacting and contacting again is not, in the thermodynamic sense, reversible. We must start with a contacted surface and slowly tear the contact away. A square of glass is contacted diagonally on to a larger piece, but one corner of the square overlaps the edge (Fig. 3). For security, the two pieces are clamped together as shown by the dotted outline, and the non-contacted surface of the smaller glass is blackened to diminish false light. Projecting the reflexion through the larger basal glass, initially, all is dark. On pulling the corner of the smaller glass away from the larger one with the forefinger, the contact is stripped away, and interference fringes spring into view (Fig. 3*b*). These extend as the pull is increased, five or six orders of colours being brilliantly developed. On releasing the corner, the glass becomes flat again, the contact is restored, the fringe system recedes, and a moment later it vanishes entirely, leaving all dark as at first.

The quantitative experiment is on the same principle; but the pulling apart is done by weights gradually added, instead of by the finger. The glasses are horizontal, and to find how far the weights attached to the corner have descended, we count the number of interference fringes. This shows how much the corner, initially in the plane of the larger glass, has been depressed from it. Hence the work of decontacting may readily be

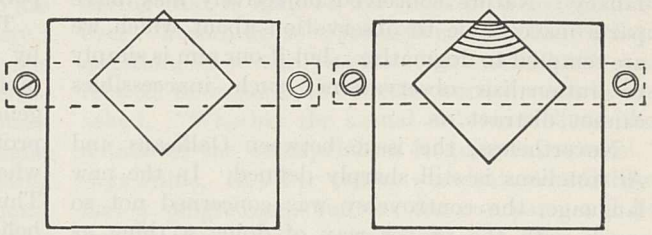

Fig. 3.

calculated. On removing the weights, the plate recontacts, and the work recovered may be determined. The work spent in bending the glass is readily allowed for. Experiments made in this way gave 71·2 ergs per square centimetre for the work of stripping, and for that recovered by recontacting about half this amount.

It is interesting to note that the work done in creating a liquid surface (surface tension × length) is of the same order as this.

Modern Aristotelianism

By Dr. Herbert Dingle

And we do hereby make and constitute the said Society by the Name, President, Council, and Fellows of the Royal Society of London, to be a Body corporate, to be continued under the same Name in a perpetual Succession; and that they and their Successors (whose Studies are to be imployed for the promoting of the Knowledge of natural Things and useful Arts by Experiments . . .) shall . . . (First Charter of the Royal Society, 1662.)

It is, in fact, possible to *derive* the laws of dynamics rationally . . . without recourse to experience. (Prof. E. A. Milne, *Proceedings of the Royal Society*, A, 158, 329; 1937.)

IT is not easy to express in a phrase the idea which early in the seventeenth century became the 'experimental philosophy' now called science, but we shall not err seriously if we adopt the statement that the first step in the study of Nature should be sense observation, no general principles being admitted which are not derived by induction therefrom. The 'Aristotelianism' with which this idea waged what is usually regarded as a successful and final battle was, by contrast, the doctrine that Nature is the visible working-out of general principles known to the human mind apart from sense perception.

Both sides thought of Nature as existing externally and objectively. It would conform better with modern physics to speak of science in more subjective terms as the formulation of rational relations between sense observations. This definition has the advantage of providing an automatic safeguard against the Aristotelian fallacy: Nature conceived objectively may have parts inaccessible to observation about which we are tempted to dogmatize; but if our aim is simply to rationalize observations, such inaccessibles cannot distract us.

Nevertheless, the issue between Galileans and Aristotelians is still sharply defined. In the new language, the controversy was concerned not so much with the proper way of doing a thing as with the thing which it was proper to do: Should we deduce particular conclusions from *a priori* general principles or derive general principles from observations? Intellectual activity involves two elements—call them either Nature and the human mind, or experience and reason. To the Aristotelian the human mind had super-sensory knowledge of the principles which Nature obeyed, or alternatively reason could, apart from sense, dictate the course of experience; to Galileo, Nature was independent, and the mind could watch and try to describe in general terms her processes, or alternatively reason could seek to correlate sense observations into a logical system. To the Aristotelian, man was, in a sense, the measure of all things. To Galileo, "Nature nothing careth whether her abstruse reasons and methods of operating be, or be not, exposed to the Capacity of Men".

History shows few examples of loyalty to a trust comparable with that of the succeeding generations of scientific workers. It is no idle boast that until now the thoughts and practices of men of science have been such as Galileo would have approved. Even merely verbal heresies, such as the statement that science is based on faith in an 'Order of Nature' have been few and harmless; we may have said such things, but we have always acted as though Nature might nothing care for what our minds call order. It is not a light matter, then, when we find in our own day a revival of Aristotelianism in the front ranks of science itself.

The phenomenon may be described in broad terms as an idolatry of which 'The Universe' is the god. Precisely what 'The Universe' means is not always easy to discover; its worship is sometimes mono- and sometimes poly-theistic, and no two votaries appear to bow before the same altar. But its various forms have this in common, that they transcend observation and cannot be derived by induction from observation alone. Furthermore, having been created, they dominate experience instead of representing it.

This cosmolatry, as might be expected, came by metaphysics out of mathematics. What is more surprising is that the world of science generally is accepting it with at best a silent protest, kept inarticulate by a lurking fear that what cannot be understood might haply be true. Thus we find among the general public a vague belief that physics is simply the study of the universe, and in the scientific world itself the wholesale publication of spineless rhetoric the irrationality of which is obscured by a smoke-screen of mathematical symbols. It is worth while to see how this has become possible.

The theory of relativity appears to be the innocent cause. It is no secret that when that theory burst upon the world it was very little understood. The new mathematical knowledge and the uprooting of deep-seated prejudices which understanding demanded were thought exorbitant, and the price was not paid. But the theory could

not be ignored. It solved a long-standing astronomical problem and successfully predicted a new phenomenon, and these were the hall-marks of true science. Hence relativity had to be accepted. Now it happened that early in its career it was speculatively applied to the universe, and the most widely read introductions to the theory included descriptions of this application. Consequently the bewildered physical world came to imagine a necessary association between relativity and cosmology and, believing where it could not prove, extended to the cosmical speculations the scientific sanction which had been earned only by the underlying system of mechanics.

This was a mistake. The relation of relativity to the universe is in principle precisely the same as that of Newtonian mechanics: both concern the behaviour of any mechanical system whatever, and can therefore tell us nothing about the peculiar character of any particular system. Newtonian mechanics could not state the number of planets in the solar system or the distribution of masses in the universe, but if these things were found by observation, it could tell how the bodies would interact. Relativity mechanics has exactly the same limitation and the same power—a fact which, so completely has the situation been misunderstood, will probably be news to many physicists. How, then, is it applied to the universe? Simply by making assumptions, which by now have become dogmas. It is assumed that the universe is homogeneous. Why? Because the possible alternatives, being infinitely numerous, must be ignored if we are to make our speculations definite. It is assumed that the universe is isotropic for the same reason. It is assumed that the characteristics of the possibly infinitesimal region we have observed are not merely local but also are copied by all that we have not observed. Why? Because that assumption brings the universe within the scope of our mathematical attainments. In this way we reach our grand modern conception of 'The Universe', on which we proceed to build laws of Nature far superior to those paltry inductions from phenomena that Newton ranted about. Our new laws are universal, eternal, established on the rock of divine mathematics, and in the tumult of their coronation no one hears a still, small voice which says, "Nature nothing careth whether her abstruse reasons and methods of operating be, or be not, exposed to the Capacity of Men."

The new Aristotelianism has now grown so confident that we have no need to unmask it: it has itself discarded masks, and we have only to recognize it for what it is. Sir Arthur Eddington, for whom the "cosmical constant", which Prof. A. Einstein thinks illusory, is a "fundamental constant of nature", tells us that "there is nothing in the whole system of laws of physics that cannot be deduced unambiguously from epistemological considerations. An intelligence, unacquainted with our universe, but acquainted with the system of thought by which the human mind interprets to itself the content of its sensory experience, should be able to attain all the knowledge of physics that we have attained by experiment". But Eddington's own practice refutes his creed. He is too great to be the slave of chimæras, and his generalizations are but unsuccessful attempts to utter what he finds inexpressible. If he had a philosophy big enough for his intuitions we should know something.

Prof. E. A. Milne's "kinematical relativity" has quite a different character. Here we not only establish mechanics on 'The Universe' instead of on Newton's "manifest phenomena", but also we invent our own universe so as to be seraphically free from the least taint of observability. This creation is defined by the "Cosmological Principle", which selects out of all conceivable bodies those which, if they had observers on them, would restrict the behaviour of such observers to a certain mutual conformability. Verbal respect is paid to old-fashioned prejudices by the admission that there *is* an actual universe of which this is only a selected part, and, etiquette having thus been observed, hundreds of pages and thousands of pounds are being spent on calculation of the properties of this "selection" by a growing army of "research" workers. In this campaign observations can be what they will provided the functions keep their ancient places; a question is "answered" when the equation is formulated. Thus the question how long the system of nebulæ has existed is "resolved" by saying that it may be for years or it may be for ever, "according to circumstances". The further question, how the possible "circumstances" are related to experience, is not worthy even to be asked. "Whether the actual universe follows the details of the extrapolation is quite immaterial," says Milne. In other words, we admit that Galileo had a programme, but we, for our part, will be Aristotelians.

Perhaps this comparison is unfair, for no one can deny to the Aristotelians the gift of logical acumen. To their modern representatives it seems as though a fancy is no sooner in the head than it is on paper and sent for publication regardless of logical consistency. Thus, in the first paragraph of a recent paper, Milne, after asserting that "all the matter in the universe . . . must necessarily be taken into account in describing the motion even of a free particle", immediately announces that he fulfils this requirement by restricting his considerations to matter which obeys the

cosmological principle. Again, he claims to deduce the Doppler effect from the manner in which the cosmological principle leads two or more observers to reconcile their clock readings, and hails this as evidence that the actual universe obeys the principle (indeed, Milne believes that God could not have made the universe otherwise). But obviously the Doppler effect could be detected if only one observer existed, so its derivation from the sociability of many must be fallacious. And so on.

This combination of paralysis of the reason with intoxication of the fancy is shown, if possible, even more strongly in Prof. P. A. M. Dirac's letter in NATURE of February 20 last, in which he, too, appears as a victim of the great 'Universe' mania. In essence the argument is this. Large numbers need an entirely different type of explanation from small ones (since the number of pure numbers is infinite the distinction is meaningless, but meaning seems to be irrelevant to these considerations). If, from an indefinitely wide choice, we select a certain unit of time ("say the unit e^2/mc^3"), the age of the universe according to one cosmological speculation is "about" equal to the square root of the number of protons in the universe according to another, and to the ratio of certain electronic forces. Hence we may take it as a "general principle" that *all* large numbers, etc. "In this way," adds Dirac, "we avoid the need of a theory."

The position must not be misunderstood. We are not dealing here with legitimate imagination transcending the temporary limits of exact demonstration. Nothing is easier and nothing is more deadly than to call for the stifling of all ideas that cannot here and now be proved of permanent value. But the question presented to us now is whether the *foundation* of science shall be observation or invention. Newton did not lack imagination, but he chose to examine pebbles rather than follow the Gadarene swine, even when the ocean before him was truth. Milne and Dirac, on the other hand, plunge headlong into an ocean of "principles" of their own making, and either ignore the pebbles or regard them as encumbrances. Instead of the induction of principles from phenomena we are given a pseudo-science of invertebrate cosmythology, and invited to commit suicide to avoid the need of dying. If anyone is uncertain about the place of imagination in science, let him compare Lord Rayleigh's discovery of argon with Dirac's discovery of the contemporary creation of protons which, according to *The Times*, "alters fundamentally our ideas of the structure of the universe and the nature of time".

Nor are we dealing with a mere skin disease which time itself will heal. Such ailments are familiar enough ; every age has its delusions and every cause its traitors. But the danger here is radical. Our leaders themselves are bemused, so that treachery can pass unnoticed and even think itself fidelity. It is the noblest minds that are o'erthrown, the expectancy and rose of the State which was lately so fair and in which there is now something so rotten that the very council of the elect can violate its charter and think it is doing science service. Five years hence we shall be celebrating the tercentenary of the death of Galileo and the birth of Newton. It rests with us whether we shall present to their memories a living monument of their own foundation or the resurrection hymn of their adversaries.

Rural England at the Royal Academy

MANY of the subjects which enlisted the enthusiasm of British artists fifty years ago, notably the historical and military, have faded out of modern exhibitions, but the scenery of the English countryside and coast retains its attraction, and is fully represented in this year's Academy. Landscape, and especially English landscape, is the principal subject of the water-colour paintings. These, relegated to a side gallery, are generally viewed after the eye has become attuned to the larger and stronger oil paintings.

It may be well, therefore, for those interested in landscape to visit the South Rooms first. Here are studies of the coast of Cornwall, the Cotswolds, the Sussex Downs, the Fens and Yorkshire moors, and examples of historic architecture such as the castles of Richmond, Bamburgh and Holy Island. The country church as the principal feature in East Anglian landscape is well treated in "Morston, Norfolk" (889) by Mr. Harry Morley. The seasonal aspect of the country landscape is beautifully rendered in Mr. E. W. Haslehust's "Winter" (764), where yellow reed beds are reflected in still water and backed by a dark thicket of bare boughs. "March Landscape" (949), by Mr. Victor W. Burnand, is a careful rendering of the tracery of elm boughs seen against the evening sky.

We come now to the oil paintings. The pictures entitled "The Evening Meal" (133) and "Pigs in a Barn" (332) by Mr. Frederick W. Elwell, are excellent studies of the interior of old timbered barns which, when the doors are open, give such opportunities for light and shadow. Mr. Fred Hall has a study of the same subject "In the Old Timbered Byre" (283). Mr. Edwin Byatt's "Mills at Outwood, Surrey" (164) shows the exterior view of roofs and gables of old barns and reminds us of the necessity for keeping in repair a picturesque feature, which when allowed to fall into dilapidation becomes a melancholy object in the countryside. It is perhaps from landscape paintings, rather than from direct observation, that the average person learns how decorative are the roofs and gables of old barns in the landscape of agricultural England. This is not entirely the average man's fault, for in actual fact there are few farmyards in which some part of the old roofs has not been repaired or replaced with unsuitable materials. The painter, however, can ignore these unsightly additions and represent the group of ridges and gables as they ought to be. There are a number of such studies in the present exhibition: "Afternoon on the Farm" (134) by Mr. Douglas P. Bliss, "Swanborough Pond" (266) by Mr. Vignoles Fisher, "A Sussex Lane in Winter" (650) by Miss D. H. de Carteret and "Essex Farmyard" (678) by Mr. Douglas Relf.

These studies lead one to consider the part of the landscape painter in the pressing task of preserving the scenery of rural England. The names of landscape painters figure very little on the councils of the numerous societies concerned in this important task, neither is it necessary that the exercise of their special talent should be interrupted by such activities. Rather should those engaged in the preservation of England's beauty study with care the outlook of the artist as embodied in contemporary exhibitions, and note particularly those artifices of composition by which disfigurements are passed over, and the yet more important devices by which the pictorial characters of a view are so enhanced as to carry the imagination from the actual to the infinite.

In the latter connexion, it is worth while to consider the titles which should be given to landscape pictures. The prevailing practice at the Royal Academy is to give the actual name of the locality or local feature without indication of the type of beauty which the picture embodies. Here and there, however, is a generalized landscape with an ideal title, as Mr. Reginald Hallward's "A Window on Eternity" (849). If the local names be retained in the case of a feature highly idealized, the artist provokes unfavourable comment; if it be not retained, the interest of association is lost. I venture on the suggestion that in such cases the picture should be given the title of the locality and the sub-title of the pictorial quality which it embodies. As a case in point I may cite the very interesting study of "Early Morning: Corfe Castle" (456) by Mr. Stanley Royle. An essential pictorial character of a castle set upon a hill is the verticality of the lines which carry to infinity the gradient of the natural feature. But the walls of Corfe, undermined and blasted by Cromwell, have in parts been left leaning over, and so the ruin has lost considerably in effect. But in this painting the artist has straightened up the walls, and in the houses and church below has emphasized the vertical lines. Here, therefore, it might be well to give a sub-title which would explain to the general public that departure from photographic representation, which is in this case more than justified by the ideal attributes the picture embodies.

One of the most perfect landscapes in this year's Academy is Mr. Oliver Hall's "Greenholme Bridge, Westmorland" (215). The curve of the single arch, the upward sweep of the approaching road, the reflection in running water and background of trees make a delightful grouping of forms, and the subject suits the tonality which characterizes this artist's work. Of the pictures of inland waters the large "River Scene" (510) by Mr. Algernon Newton, shows the sigma curve which is one of the essential beauties of streams which wander across the plain. In the matter of coastal scenery we are once more indebted to Mr. Julius Olsson, among whose studies are "Opal Moon: Irish Coast" (317) and "The Storm Cloud" (169), an impressive picture of sea and sky.

The picturesque occupations of the countryside have received comparatively little attention, but two works at least deserve special attention, among pictures that by Miss L. Kemp-Welch of "The Lumber Team" (551) and among sculptures the very pleasing and unusual study "Lakeland Dalesman", equestrian statuette (1470) by Miss Ophelia Gordon.

. . . .

The following portraits are of interest to the scientific fraternity, Sir Albert Seward (52) by Mr. Harold Knight, the late Brig.-General Sir Capel Holden, by Mr. P. Connard (158), Prof. T. B. Abell (290) by Mr. W. C. Penn, Mr. Sydney Evershed, by Mr. G. Harcourt (324), Sir George Hill, by Mr. J. Gunn (433), Sir Alexander Gibb (656) by Sir William Rothenstein, Sir Arthur Evans, charcoal drawing (1137) by Mr. Francis Dodd, and a marble bust of Sir Arthur (1451) by Mr. David Evans, a bust of Dame Helen Gwynne-Vaughan (1430) by Mr. Julian Allan and a stone bust of Prof. R. W. Reid (1435) by Sir W. Reid Dick.

VAUGHAN CORNISH.

Obituary Notices

Dr. J. K. Fotheringham, F.B.A.

JOHN KNIGHT FOTHERINGHAM, who died on December 12 of last year, was the greatest authority of his time on ancient chronology. The name Fotheringham is derived from the Manor and Castle of Fotheringay, held in the twelfth century by the royal family of Scotland as part of the Honour of Huntingdon in Northamptonshire. Mr. Walter de Fodringaye was one of the executors of Devorgilla, Lady of the Manor and wife of John de Baliol in 1289, and was appointed by her as the first principal of Baliol (Balliol) College, Oxford. By their close connexion with the House of Baliol, some of the Fotheringay family settled in Scotland at the end of the thirteenth century and the name was changed to Fotheringham. One William Fodringhay had a charter from David II of lands in Aberdeen and Banff. In 1296 Hugh de Foderingaye of Perthshire and Roger, vicar of Kilmuir in Ross-shire, did homage to Edward I. Duncan, Bishop of Dunkeld, granted Fordell, County Perth, to Walter de Fotheringham in 1340.

The family has, therefore, a long Scottish ancestry. They became Presbyterians at the Reformation. Dr. J. K. Fotheringham's father was born at Dunbarrow Bridge, and was minister of Glanton Presbyterian Church, Northumberland, in 1859–65, and of Tottenham Presbyterian Church, Middlesex, in 1865–1905; he was moderator of the Presbyterian Church of Scotland in 1912. John Knight Fotheringham was born at Tottenham in 1874, one of three brothers. He was a delicate child, and had indifferent health during his whole life. The inheritance of his remarkable genius must be partly attributed to his maternal ancestry; his mother was Jane Ross, also descended from an ancient Scottish family; her father was master of the Lancasterian School at Tottenham, and she taught at that school. He was educated at a school in connexion with the Tottenham Presbyterian Church and then at the City of London School, where he came under the instruction of Dr. Abbott, the headmaster. Under Abbott and Rushbrooke he received a sound classical training and entered Merton College, Oxford, in 1891 with a leaving scholarship. At Merton he obtained a first in Greats in 1896 and then proceeded to obtain a first in Modern History in 1897. Magdalen College gave him a Demyship, 1898–1902; he attended the British School in Athens for one year, settled in Oxford and became a coach. Magdalen College elected him to a research fellowship in 1909. He became reader in ancient history, University of London, 1912, and was a lecturer in classical literature at King's College, 1904–9, lecturer in ancient history at King's College, 1909–12.

About 1898, Fotheringham began the serious study of mathematics and astronomy, and made such astonishing progress that in 1908 he was able to make a valuable correction to the work of Ginzel, Nevill and Newcomb on eclipse calculations. He was made assistant at the Observatory at Oxford in 1918. About 1910 he became interested in Babylonian astronomy, and I then made his acquaintance; from that time until his death we collaborated constantly. In the meantime, he had been applying astronomy to Greek chronology, and had produced fundamental results. He now began to apply Babylonian astronomy to still earlier chronology and attained the undisputed position of the greatest living authority in these matters. The University of Oxford, therefore, created for him a post as reader in ancient astronomy and chronology in 1925 and he was elected to the British Academy in 1932.

It will be seen that the mental range of this scholar probably exceeded that of any one of his contemporaries in any land. An excellent classical scholar, a man of wide reading in modern history, an astronomer of great originality, a brilliant mathematician, and a specialist in ancient history—these are his attributes. Moreover, he was regarded as an authority on Presbyterian Church policy and was a devoted layman and elder.

The first contribution of Fotheringham to learning was an edition of the text of Jerome's version of the "Chronicle of Eusebius" (1905). The Bodleian MS. together with two others (Undine and Paris) is reproduced in collotype prefaced by a history and palæographical examination of all the extant manuscripts. For this work he visited many European libraries. In 1923 appeared his printed Latin text of the "Chronici Canones" of Eusebius with a complete *apparatus criticus*, and Latin introduction. It is obvious that this work of Eusebius on the *fila regnorum* or lists of reigns in Jewish, Persian, Assyrian, Greek and Roman history with historical comments was of fundamental interest to him as a student of ancient history; the tale that he took up this work because his birthday fell on August 14, a day dedicated to a Saint Eusebius, is surely apochryphal. In 1906 appeared vol. 11 (1801–37), second edition 1911, of Longman's "Political History of England", but henceforth his life was to be almost entirely devoted to astronomy and its application to ancient history. Here he was destined to make contributions to science on which his great fame will for ever rest.

Fotheringham edited the fragments of Cleostratus with a critical discussion of his importance as the first astronomer to introduce the signs of the zodiac into Greek science, together with the eight-year cycle of intercalation. In this work he combined a knowledge of philology with astronomy so as to enable him to clear up the meanings of several Greek words and to interpret passages which had baffled the greatest classical scholars. Several articles were devoted to the date of the Crucifixion, or the problem, "In what year between A.D. 27–34 did Nisan 14 or

15 fall on a Friday". His tables for the visibility of the new moon enabled him to place this problem on a more scientific basis, but he never came to a conclusion which he proclaimed infallible. In his last article he prefers A.D. 33, April 3.

In 1915 Fotheringham published a very learned work on Marco Sanudo, the Venetian prince who conquered the whole of the Grecian Archipelago in 1205–6 for his native city in wars with Genoa. To do this piece of work he had to use Italian, Byzantine Greek and French sources. He showed himself master in this department of medieval history, a strictly philological investigation. But astronomy was claiming more and more of his attention, particularly the history of that subject, and he was naturally drawn to Babylonian astronomy. I supplied him with the texts of the observations of the risings and settings of Venus during the reign of Ammizaduga, tenth king of the First Babylonian Dynasty. The book which we published together, "Venus Tablets of Ammizaduga", contains his *opus magnum*. I cannot enter into details here, but suffice it to say that he and his colleague Carl Schoch undertook to construct tables by which the new moons and risings of Mercury, Venus, Mars, Jupiter and Saturn can be fixed back to 3507 B.C. in the case of the moon, 2099 Mercury, 2999 Venus, 2148 Mars, 2153 Jupiter, 2123 Saturn. By elaborate astronomical control of the calendar and by the Venus tables, Fotheringham's calculation for the sixth year of Ammizaduga at 1916–1915 B.C. was agreed to by Schoch after long discussion; Schoch, recognized as the most brilliant constructor of historical planetary tables, at first opposed this calculation, but was finally convinced. (So far as I know, astronomers were convinced by Fotheringham's work, with the exception of Neugebauer.)*

Fotheringham also devoted much time to the work of the Babylonian astronomers Naburianos and Cidenas, whom he regarded as the principal sources on which Greek astronomy was founded. In the last months of his life he made a brilliant interpretation of figures on Babylonian astrolabes which had baffled Assyriologists to the present day. He studied the voluminous publications of Greek astronomical texts, "Catalogus Codicum Astrologorum Græcorum", and was able to prove that much of it was borrowed from Babylonia.

Fotheringham was now recognized as a man of unique knowledge; in fact, no man living combined his immense classical knowledge with astronomy and chronology. His fame spread in intellectual centres all over the world and his correspondence was heavy. He left a minute catalogue of all his books and articles, together with a list of all the inquiries he received on chronology and astronomy. The list of inquiries runs to more than 350, and includes most of the eminent names of archæologists of the last three decades in all lands. This notice is only a very restricted résumé of the work which J. K. Fotheringham accomplished. The printed testimonials which he submitted from various astronomers when he stood for the Savilian professorship at Oxford fill 34 pages. One of them states concerning his work on the secular acceleration of the sun and moon, "Fotheringham's theory is the only one which definitely solves the problem and means the death blow to the gravitation theory (as applied to eclipses) and will be the theory of the future", and this scholar pronounced Fotheringham to be the most brilliant mathematical astronomer of his age. He had a profound influence in Germany and America; in fact, he was far better known abroad than he was in Great Britain. I must for my own part assert that I was always fully aware of his almost unlimited ability. His death has completely deranged my plans. He was a typical Oxford product, modest, accurate and profound. One can readily believe after working with him more than twenty-five years that he was never angry about anything in his life. Many were his disappointments in academic promotion, and worst of all he suffered constantly from poor health. All these things he bore like a Christian gentleman, a title which gave him more satisfaction than any other.

S. LANGDON.

*Neugebauer's objection to Fotheringham's dating of the First Babylonian Dynasty seems to be subjective and unscientific, for he himself adopted Fotheringham's values for the acceleration of Venus and the moon.

An astronomical correspondent writes as follows:

Dr. J. K. Fotheringham's interest in astronomy developed from the study of ancient chronology. In order to be able to study astronomical chronology he took some lessons in spherical trigonometry and elementary mathematical astronomy from the late Prof. H. H. Turner, and afterwards received some further help in the use of lunar tables and the calculation of eclipses from Prof. J. B. Dale, of King's College, London, and Dr. P. Cowell, superintendent of the Nautical Almanac Office. With this modest preparation for astronomical studies, he proceeded to write a series of papers, in which his knowledge of ancient chronology had full scope, which are of great astronomical importance. In these papers he discussed the occultations of stars by the moon preserved in Ptolemy's "Almagest", the equinox determinations of Hipparchus, and ancient observations of solar and lunar eclipses. The result of these investigations was to establish that the sun has a secular acceleration of 3·0″ per century per century, and the moon has a secular acceleration of 21·6″ per century per century. Lunar theory predicts a secular acceleration for the moon of 12·2″. The residual acceleration, 9·4″, for the moon, and the whole of the secular acceleration of the sun cannot be accounted for by gravitational theory. It is now generally accepted that these secular accelerations are attributable largely, if not entirely, to the action of tidal friction, more especially in narrow seas such as the Irish Sea and the Bering Straits.

From these studies, Fotheringham was led on to the study of the discordances between the observed positions of the moon and the positions computed from pure gravitational theory. Newcomb had allowed for the major discordances by the introduction of an empirical periodic term. This so-called "Great Empirical Term" was incorporated by Brown

into his "Tables of the Moon". But there remained minor fluctuations, which showed some correlation with the departures of the sun, Mercury and Venus from their predicted positions. Fotheringham made a careful analysis of the departures of the moon and sun from pure theory, and showed that there was a fairly constant ratio between the departures for the two bodies, the explanation of which is to be found in fluctuations in the earth's rate of rotation. Though other investigators were working on the same problems at the same time, Fotheringham's contribution was an important one.

In a further paper, Fotheringham made a study of precession, galactic rotation and equinox correction, in which he made a determination of the rotation of the galaxy, and revised the values of the precessional constants. This paper lost some of its importance through the discovery by Oort in the following year of the differential rotation of the galaxy. From this paper Fotheringham was led to the investigation of the mass of Venus. He believed that he had established that there was a fluctuation in the mass of Venus. These results have not been accepted by astronomers. Fotheringham was apt to be led astray by his failure to appreciate the value of observations and the systematic errors to which they were liable. This was due to his lack of any observational experience and to the limitations of his astronomical knowledge. That he was able to obtain the results that he did with so inadequate a training is greatly to his credit.

Other astronomical work of Fotheringham's included a study of the earliest visibility of the moon to the naked eye, which is of chronological importance because, in both the Babylonian and the Jewish calendars, the beginning of the month was fixed by observation of the moon; a restoration of the calendars of Meton and Calippus; discussions of the new star of Hipparchus and of the dates of the birth and accession of Mithridates. He also made a contribution to astronomical history in a monograph on Cleostratus, in which a complete text of the fragments of his work was given, and the nature of his contributions to astronomy was discussed.

We regret to announce the following deaths:

Dr. J. J. Davis, curator of the Herbarium, University of Wisconsin, known for his work on parasitic fungi, on February 26, aged eighty-four years.

Dr. S. F. Grace, senior lecturer in applied mathematics in the University of Liverpool, author of works on hydrodynamics and tides, on April 30, aged forty-one years.

Prof. E. Perroncito, formerly professor of parasitology in the University, and professor of general pathology and director of the Royal School of Veterinary Medicine, Turin, aged eighty-nine years.

Prof. Stephen Soudek, professor of applied zoology in the Agricultural College, Brno, known for his work on pests of agriculture and forestry, on February 20, aged forty-six years.

News and Views

Magnetic Disturbances and Auroras

As reported in Nature of May 1, p. 752, considerable magnetic disturbance, presumably related to an active region of the sun containing some big sunspots, began on April 24, and this terrestrial disturbance or series of disturbances was continued until about April $29^d\ 0^h$ U.T. The activity, as recorded at the Greenwich magnetic station at Abinger, includes four distinct disturbances or 'storms', of which the most active periods and extreme ranges in horizontal force have been kindly supplied by the Astronomer Royal, as follows:

April 24^d	21^h to April 25^d	2^h U.T.		280γ
25	16	26	1	300
26	18	27	5	395
27	19	29	0	> 305

The greatest ranges at Abinger over the whole period of disturbance were 50′ in declination, 500γ in horizontal force and 355γ in vertical force.

In a letter addressed to the Editor, Father J. P. Rowland, *S.J.*, director of the Stonyhurst College Observatory, directs attention to these four storms and suggests that the last, which was of longest duration and produced the most rapid oscillations in the traces, might perhaps be attributable to the largest of the groups of sunspots (with central meridian passage on April 24·6) which extended some 14° in longitude on the sun's surface. The ranges of the magnetic elements recorded at Stonyhurst (about 200 miles north-north-west of Abinger) during this period of magnetic activity were 93′ in declination and >620γ in horizontal force, thus exceeding any recorded ranges at Stonyhurst since February 1929. In another letter, Mr. J. McWilliam describes a notable display of the aurora which he saw about midnight when ten miles south of Grantham and which was still visible, though less striking, when seen from Sheffield about two hours later. The display was seen even though there was brilliant moonlight. (As previously mentioned, on p. 752, Mr. Hawke reported this display in *The Times* of April 27, and information of another about midnight on April 26–27 comes from Mr. Housman, of the Seaton Observatory, Workington.)

The Royal Observatory, Greenwich, was informed by the British Broadcasting Corporation that a brilliant aurora was reported from Halifax, Nova Scotia, on the night of April 27–28. During this last

period of magnetic activity, there was for several hours a complete dislocation in short-wave wireless communication between Great Britain and Canada. In point of fact, throughout the period, April 24–29, short wave communication was often impossible on this channel, other channels being variously affected but to a less extent. Cable and Wireless Ltd. also report during the same period frequent interruption due to earth currents in cable circuits operating between Great Britain and Newfoundland and vice versa. On the morning of April 28 between 1^h and 7^h and again from $10\frac{3}{4}^h$ to $12\frac{3}{4}^h$ U.T., the earth currents on this circuit were so severe that trans-atlantic communication by cable was impossible.

University of London's Institute of Archæology

ON April 29, the Earl of Athlone, Chancellor of the University of London, formally declared open the Institute of Archæology, housed for the present in St. John's Lodge, Regent's Park, and unveiled wall-tablets to the memory of Mrs. Tessa Verney Wheeler, who was honorary secretary of the original Appeal Committee to collect funds for the foundation of the Institute, and of Mrs. Mary Woodgate Wharrie, a generous benefactor. The Chancellor was welcomed by Sir Charles Peers, chairman of the Committee of Management, and thanks were conveyed to him after the ceremony by the Right Hon. W. G. A. Ormsby-Gore, who was First Commissioner of Works when St. John's Lodge, as Crown property, was allotted to the use of the Institute, and Dr. R. E. Mortimer Wheeler, director of the Institute. Arrangements have been made for the tenure of the present premises for a period of years; but it is hoped that eventually quarters for the Institute will be found among the University buildings in Bloomsbury near the Historical Institute and the Institute of Art.

IT is usual on an occasion such as this opening ceremony to describe it as "epoch-making". In the present instance this term might be used with nearer approximation to the truth than is common. As was pointed out at the time, the proposal for an Institute of Archæology in the University of London was first made, the expansion of archæological investigation and the increased interest in the application of its results had made the provision of some such organization as a training ground a matter of urgency. As Sir Charles Peers said in welcoming the Chancellor, archæology, if one of the newest sciences, has the vigour of youth; and although in the nine years which have lapsed since the original proposal was formulated, progress towards meeting the requirements of archæological training may have seemed slow, it has been substantial. The Institute is already well on the way to providing in its library, its collections of antiquities and its training in methods of research the requirements which Sir Charles laid down as the minimum. Lord Athlone's reference to the present importance of Palestine in British field archæology not only emphasizes the value of the collection of Palestinian antiquities—the largest in existence outside Palestine—which the Institute owes to Sir Flinders Petrie and the generosity of the British School of Archæology in Egypt, but also, by endorsing his support of the appeal for a chair of Biblical archæology, afforded convincing testimony that in saying he regarded the ceremony he had just performed as the laying of a foundation stone rather than as a formal opening, he was expressing something more than a conventional compliment.

Celtic and Saxon Art in Early England

THE exhibition of photographs of stone crosses and other forms of Celtic and Saxon sculptural art in stone now on view in the Iron Age Gallery of the British Museum (Bloomsbury) is an indication of the remarkable wealth of this material still surviving, which, in its mass, is something of a revelation even to the expert. The indefatigable labours of the late Romilly Allen, Baldwin Brown and W. G. Collingwood, the last-named more particularly in the north of England, have made known to archæologists the extent and value of this class of evidence, especially as afforded by the stone cross, in the interpretation of racial and cultural movement in the early historic period of Britain; but the work of the survey initiated by the Department of British Antiquities of the Museum some eighteen months ago, in which the assistance of the layman and amateur student has been enlisted widely, has brought together a record of examples of the various classes of this art in the form of photographs, which is surprising. As a whole, it is claimed, probably with justice, that this collection of examples of Celtic and Saxon sculptural art is the finest in existence.

SOMETHING of the work which already has been accomplished by the survey is shown in a selection of the photographs, primarily of the stone crosses, but also including fonts, tympana, capitals and the like. Geographically, the area covered is England, with the 'Anglian' crosses of southern Scotland; but selected examples from outside England are shown for purposes of comparison. The Isle of Man and Ireland, important areas which are a study in themselves, naturally are not included. Special features have been made of photographs by John and Mrs. Piper, who have made an extensive collection of photographs of Anglo-Saxon and late Romanesque sculpture, of a group of sculptures from the West Riding of Yorkshire by Mr. J. E. Tetley and of a regional survey of Cheshire and Staffordshire, which is illustrated by distribution maps and a map prepared in collaboration with the School of Geography of the University of Liverpool, showing relation to forest clearance and habitation in the eleventh century.

Armagh Observatory

DR. E. M. LINDSAY, at present an assistant in the Harvard Observatory in Bloemfontein, South Africa, has been appointed astronomer at Armagh Observatory. This Observatory was founded in the year 1791 by Richard Robinson, Baron Rokeby, Archbishop of Armagh and a great benefactor of the city of

Armagh. The Primate gave as an endowment of the Observatory twenty acres of land close to Armagh, on which the Observatory is built, and the estate of Derrynaught, which he had bought out of his private means. He further provided for the salary of an assistant and the current expenses of the Observatory. The power of nominating and appointing the astronomer is reserved for the Archbishop of Armagh and Primate of all Ireland for the time being. The first astronomer of the Observatory was the Rev. Dr. J. A. Hamilton, who was succeeded in 1815 by the Rev. W. Davenport, and then, in 1823, by the Rev. T. R. Robinson, who held the post until his death in 1882—a period of more than fifty-eight years. The anemometer which bears Dr. Robinson's name was first put up on the roof of the Observatory in 1846, but meteorological observations had been commenced thirteen years earlier. Dr. J. L. E. Dreyer succeeded Dr. Robinson in 1882, and the next director appointed was Mr. J. A. Hardcastle, who, however, died in 1917 without having actually taken up the post. The Rev. W. F. A. Ellison became director in 1918 and occupied that position until his death at the end of last year.

Royal Institution: Annual Meeting

THE annual meeting of the members of the Royal Institution was held on Saturday, May 1. In the unavoidable absence of the president, the Right Hon. Lord Eustace Percy, the chair was taken by Major Charles E. S. Phillips, secretary and vice-president. In submitting the annual report of the Visitors to the meeting, the chairman referred to the satisfactory state of the membership, which has increased steadily in recent years, and which stands now, including honorary as well as full members and associate subscribers, at 1,055. The reconstruction of the Library and other rooms, which the Managers were forced to undertake when a large part of the building was found to be in an alarming state of disrepair, was completed in October. This work, which the accounts show had cost nearly £16,000 at the end of the year, and included the construction of a large new laboratory, has added greatly to the beauty and convenience of the house. Owing to the withdrawal of the direct current mains in Albemarle Street and neighbourhood, it has been necessary for the Institution to provide its own equipment for the supply of direct electric current. A large storage battery and two mercury arc rectifiers, supplied from the A.C. mains, have been installed. The output from the rectifiers has been specially smoothed, and is found to be sufficiently free from ripple for most experimental purposes. The battery is used for arc lanterns in the lecture theatre.

THE expenditure on these and other purposes has been largely met from the munificent bequest of the late Mr. Harry Brown, which, it is now reported, has amounted to more than £29,000. No. 19 Albemarle Street, adjoining the Institution's premises, recently purchased, has now been fully occupied. The two top floors are used for library and museum extension, and the lower floors have been let off for the present, producing income which is being devoted to research purposes. The accounts of the Davy Faraday Research Laboratory, in which the Institution's research expenditure is accounted for, show a deficit of nearly £2,000 on the year's working. The chairman was able to announce a generous Coronation year gift by the honorary secretary of the Laboratory, Sir Robert Mond, of a sum of money sufficient to meet the deficit. The following were elected to the various offices: *President:* The Right Hon. Lord Eustace Percy. *Treasurer:* Sir Robert Robertson. *Secretary:* Major Charles E. S. Phillips. *Managers*—Sir John Cadman, Sir James Crichton-Browne, Dr. Cecil H. Desch, Sir James Devonshire, Prof. A. C. G. Egerton, Lord Falmouth, Mr. J. S. Highfield, Mr. Arthur Jaffe, Sir William Larke, Mr. V. Warren Low, Sir Murdoch MacDonald, Mr. C. C. Paterson, Prof. J. C. Philip, Sir Thomas Purves and Admiral C. V. Usborne. *Visitors*—Mr. C. Cuthbertson, Prof. C. L. Fortesque, Dr. J. J. Fox, Captain A. C. Goolden, Prof. H. Hartridge, Mr. Emil Hatschek, Prof. F. L. Hopwood, Dr. R. Lessing, Mr. A. H. Levy, Mr. F. I. G. Rawlins, Mr. Russell J. Reynolds, Prof. H. R. Robinson, Dr. G. Shearer, Major W. S. Tucker and Colonel W. A. Vignoles.

Shakespeare's Universe

FOR his Friday evening discourse before the Royal Institution on April 30, Prof. J. Dover Wilson discussed "Shakespeare's Universe". To understand Shakespeare, he said, one must understand his universe—a very different one from that of Newton, and still more from that of Einstein. In his day the ideas of Copernicus and Galileo were just beginning to penetrate to the consciousness of the ordinary man, and did not become really influential until after the middle of the seventeenth century. Shakespeare lived in a universe which, first described by Ptolemæus of Alexandria in the second century A.D., held sway over men's minds throughout the Middle Ages and had thus served humanity for fifteen hundred years. The best picture of this universe in our literature is to be found in "Paradise Lost", for though Milton understood the new astronomy and actually refers in his poem to Galileo, whom he had met in Italy, he made use of the old scheme of ten concentric spheres with the earth at the centre. As the spheres revolved at different rates and with their own peculiar motions on one another, they made music which was known as "the music of the spheres"; the sound was inaudible to mortal ears. Shakespeare's description of this astral musical box is well-known. Thus the universe was a 'harmony'; and harmony is the master-key of Shakespeare's thinking, whether upon the world at large, upon human society, or upon man himself, man the microcosm which reflected the macrocosm in little.

MUSIC meant a great deal to Shakespeare. It had medicinal properties to which he often refers. Moreover, the man of harmony would be at once fond of music and a good citizen, because human

society was thought of as a harmony also. What kept concord in man, in society and in the universe as a whole was order or degree, the virtues of which are celebrated by Ulysses in the long speech in "Troilus and Cressida" (1.3.84–124), which gives us Shakespeare's most elaborate and explicit statement of Elizabethan political philosophy. This correspondence between humanity and the starry universe was no mere poetical metaphor. In that day, the stars and the human race were thought of as intimately linked. Comets and eclipses were portents. Astrology, the study of the influence of the stars, was a most learned and elaborate science in which everyone believed. We have no right to condemn such notions as mere superstition. Men toiled at them, gave up their lives to them, as modern men of science do to science. The Elizabethans were as intellectual as ourselves, probably more intellectual. Three hundred years hence, will not our roads to truth seem as strange, as ill-directed as theirs seem to us ?

The Flow of Metals

PROF. E. N. DA C. ANDRADE delivered the twenty-seventh annual May Lecture before the Institute of Metals on May 5. Flow is most easily observed in the liquid state, but whereas there is a satisfactory theory of gases, and the structure of crystalline solids has been elucidated by the methods of X-ray analysis, very little is known of the actual behaviour of the molecules in the liquid state. Prof. Andrade has put forward a theory of liquid viscosity on the basis that the momentum is transmitted from layer to layer not, as in a gas, by the passage of molecules from one layer into the other, but by instantaneous association of the molecules when they touch, so that at any nearest approach two molecules share their momentum. On this basis, a formula can be derived which gives the viscosity of a simple liquid at its melting point, and another which gives the temperature variation of the viscosity. Molten metals are particularly suitable for experiments designed to throw light on this problem of viscosity, because they constitute liquids which consist of one kind of atom only, and they are not, in general, associated. The viscosity is conveniently measured by sealing up the molten metal in a sphere, suspended *in vacuo*, and observing the damping of the torsional oscillations of the sphere about a vertical axis due to the enclosed liquid. The method has already been used for the alkali metals, and is being extended to other metals. The flow of solids is, perhaps, at first sight, even more troublesome theoretically than the flow of liquids, for single crystals of metals exhibit plastic flow under very small stresses, whereas a perfect crystal should be strong, and also brittle. It cannot be said that there is any fully satisfactory theory of the flow of single crystals of metals, but a good beginning has been made. It is, of course, a far step from the single metal crystal to the polycrystalline metal of industry, but we know that any crystal boundary is likely to stop the propagation of a dislocation, or glide in general, and so will make the metal less weak and less liable to flow. Industry cannot, of course, wait for theory, but the only really satisfactory way to approach the problem of the strength of metals is by way of the single crystal.

Exhibition of Opals at the Geological Museum

A SPECIAL loan exhibition of Australian opals and other gemstones, from the collections of Mr. Kelsey I. Newman, has been arranged for this Coronation month at the Geological Museum in South Kensington. The exhibition comprises many of the most beautiful opals hitherto obtained from New South Wales, including the famous 'Flame Queen', a magnificent and unique stone reputed to be the finest specimen yet won from Australian opal fields. Most of the stones are 'black' opals from the Lightning Ridge field, New South Wales, where the gem occurs in fissures or joints in sandy sediments of Cretaceous age. Since the 'black' opals from this area first came into the market about 1908, more than a million pounds worth of these stones has been produced from Australian sources. A collection of Australian sapphires, principally golden stones, is also exhibited. These are from the alluvial deposits of Anakie in Queensland, from which locality stones to the value of £113,000 have been produced since 1921. Other temporary exhibitions at the Museum include a display of recent presentations of semi-precious and ornamental stones presented by H.M. Queen Mary ; and a small exhibit on the geology and history of the Coronation Stone, which is compared to Old Red Sandstones of similar petrography from the neighbourhood of Scone in Perthshire.

Coronation Planting Schemes

IN order to encourage planting and the beautifying of the countryside as one aspect of Coronation celebrations, the Coronation Planting Committee has been formed under the presidency of the Marquess of Lothian, with an office at 68 Victoria Street, Westminster. The Committee is fully representative of practically all associations which aim at preserving the beauty and natural scenery of Great Britain. Its objects are explained in a pamphlet entitled "For King and Countryside : Towards a more Beautiful Britain", and it may be recalled that the scheme was launched at a meeting in Guildhall on November 26, 1936. Other booklets have now been published dealing with the village and how to make it beautiful, commemorative tree planting, design of allotment areas, play-parks, window-box gardening, etc. The Committee has also issued a leaflet with suggested forms of competitions for village communities, in order to foster pride in the village, floral displays and a care for trees. It is proposed to prepare a volume recording all the amenity schemes undertaken throughout the country in commemoration of the Coronation. The Committee's aims should make a wide appeal especially to those bodies which feel that transitory decorations need to be supplemented by permanent records of the occasion.

Causes of the United States Floods

THE unprecedented floods of the Ohio River in January of this year are the subject of a paper by Prof. C. F. Brooks and Major A. H. Thiessen in the *Geographical Review* of April. Floods may occur in the eastern United States at any time of the year, for there is always an extensive warm water surface near by to provide great volumes of water vapour, and not far distant are cold surfaces to furnish moving wedges of cold air to elevate the tropical air. Outstanding floods, however, occur only where a persistent high pressure area over the western Atlantic sends air currents inland for days in succession, and a winter high pressure area over the central or northern interior of the United States sends cold air southward or south-eastward. Along the front between the masses of polar air and the tropical air continuous ascent of the warmer air occurs with resultant heavy rains. In an ascent of two miles, three quarters of the water vapour in the warm air is precipitated. The authors calculate that a mass of air, nearly saturated at 77° F. over the Caribbean Sea, chilled over land in middle latitudes to 68° F., would contain about 80,000 tons of water vapour for every square mile of surface. If this were forced upward to a height of two miles the rainfall would be 0·8 inches. This would probably occur in one day with wind at a velocity of four to eight miles an hour. Since the average speed of the tropical air mass is 30 - 40 miles an hour, it is easy to understand the occurrence of torrential rains of some five inches a day.

The Czechoslovak National Research Council

THE Czechoslovak National Research Council, which is affiliated to the International Council of Scientific Unions, was founded in 1924 originally with ten (now twenty) sections and with a membership limited to two hundred. It includes all branches of science as well as mathematics, medicine and philology, and at first its activities were mainly concerned with establishing good international scientific relations. To-day, its aims are specially directed towards the promotion and financial support of scientific research in general. In this it has the co-operation of the Czechoslovak Ministry of Education, and its work assumed considerable importance when the economic depression began to impede both international relations and the prosecution of pure researches. In 1935, a Masaryk Foundation for the endowment of scientific work was established with an initial capital of three million crowns (about £25,000 at the time) to ensure that adequate financial assistance was available for the purchase of apparatus needed for research purposes, for the publication of scientific books and memoirs and for travelling scholarships. These funds of the Czechoslovak Research Council are intended especially for the support of promising young men of science in Czechoslovakia, irrespective of their nationality or creed. In the annual report for 1936 it is mentioned that the Council awarded travel fellowships to ten students and granted 193,000 crowns (about £1,400) towards the publication of some fifty noteworthy scientific works and for acquiring apparatus. During 1937, thirteen students have been sent abroad to continue their studies. The president of the Council is Prof. B. Němec, and the general secretary, Prof. F. Ulrich, whose address is Prague II, Albertov 6.

Solar Heaters in California

THE large amount of sunshine available in California during the summer has led to the extensive use of solar water-heating apparatus for domestic purposes, and a detailed account of their construction and use is given by Prof. F. A. Brooks of the Berkeley Agricultural Experiment Station in *Bulletin* 602 of the College of Agriculture. The solar absorber consists of a zigzag pipe in a glass-covered, thermally insulated box placed on a sloping roof facing south, in front of attic windows so that the glass may be readily cleaned. An insulated pipe leads from the top of it to the top of an insulated hot-water tank in the attic roof and another pipe from the bottom of the absorber to the bottom of the tank. In the winter the solar absorber is supplemented by a coil in the range connected to the tank in the same way. The useful life of such an installation is fifteen years, and the cost per 1,000 British thermal units of solar heat absorbed is about one ninth of a cent.

Prof. M. N. Saha, F.R.S.

WE have received a pamphlet summarizing the scientific work of Prof. M. N. Saha, who, as indicated in NATURE of March 13, has recently been elected president of the National Institute of Sciences of India for the current year. In addition to his theory of stellar spectra, which in fact was begun in India before he came to England, Prof. Saha has made experimental researches with the object of confirming the theory and has produced papers on selective radiation pressure, active nitrogen, spectroscopy and atomic and molecular structure, the colours of inorganic salts, thermodynamics, Dirac's theory of the electron, and upper atmospheric phenomena. He has also written treatises on heat and on modern physics, and has promoted much research on molecular spectra by students working under him.

Association of Teachers in Technical Institutions

THE twenty-eighth annual Conference of the Association of Teachers in Technical Institutions will be held at Coventry on Saturday May 15–18 under the presidency of Mr. W. E. Park. All meetings will be held in the Technical College, Coventry. Resolutions to be discussed by the Conference comprise the following : 'courses of training for technical teachers ; tenure of university scholarships ; leave of absence for technical teachers ; assistance to teachers attending short courses of the Board of Education ; co-operation in technical education ; the Factory Act ; day technical classes. Further information can be obtained from the Secretary, A.T.T.I., 29 Gordon Square, London, W.C.1.

Congress on Spectroscopy

A FIFTH spectroscopy conference will be held at the George Eastman Research Laboratories of the Massachusetts Institute of Technology on July 19–21, repeating to a considerable extent the type of conferences held during the past four summers. A programme of papers and discussions is being prepared on analysis of materials by the emission spectrum, absorption spectro-photometry, photographic photometry, biological and chemical effects of spectral radiation, and industrial applications of spectroscopy. The usual summer courses on practical and applied spectroscopy will be offered at the Institute between June 14 and July 24. Further information can be obtained from Prof. G. R. Harrison, Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts.

The Partial Transit of Mercury on May 11

ON May 11 next, a partial transit of the planet Mercury across a narrow segment of the sun's disk occurs between $8^h\ 31^m$ and $9^h\ 30^m$ U.T., the maximum ingress being only 7·3″. The partial transit will not be visible from Great Britain but can be seen generally from over southern Asia, the Philippine Islands, Western Australia, the Indian Ocean and Central and Southern Africa. The "Nautical Almanac" for 1937 on p. 519 gives the local circumstances for several places from which the partial transit may be observed. Dr. A. C. D. Crommelin has pointed out that it is important for observers in the southern hemisphere to watch for the appearance of any arc of sunlight around the limb of the planet (projected on the sun's limb) due to a Mercurian atmosphere. Such an arc has been observed in the case of Venus but never with certainty in the case of Mercury. Although this partial transit is not visible from Great Britain, Dr. Crommelin suggests further that spectroscopists in Great Britain may see Mercury projected on the chromosphere; the nearest approach to the sun is at $9^h\ 0^m$ (Summer Time $10^h\ 0^m$) at position angle 154° from the north point.

Announcements

SIR FREDERICK GOWLAND HOPKINS has been awarded the Harben Gold Medal of the Royal Institute of Public Health. The Medal is awarded triennially, under a trust created by the late Sir Henry Harben, to the person, irrespective of nationality, who, in the opinion of the Council of the Royal Institute of Public Health, has rendered the most eminent services to public health. Past recipients of the Medal include: Louis Pasteur, John Simon, Max von Pettenkofer, Lister, Koch, Metchnikoff, Behring, Roux, Ronald Ross, Sir Charles Sherrington, and Kitasato.

THE Council of the British Scientific Instrument Research Association has accepted with regret the resignation of Dr. Harry Moore, who, since the retirement of the late Sir Herbert Jackson, in July 1933, has been the director of research of the Association. The period during which Dr. Moore has been in charge of the Association's research work has been one of great activity and usefulness to the British scientific instrument industry. Dr. Moore's particular knowledge and experience of the research needs of industry will not be lost, as he has accepted an appointment in which he will direct the research work of an industrial corporation. Mr. A. J. Philpot has been appointed to succeed Dr. Moore as director of research.

DR. E. B. WORTHINGTON, demonstrator of zoology in the University of Cambridge, has been appointed director of the Laboratory at Wray Castle on Lake Windermere of the Freshwater Biological Association of the British Empire.

DR. N. K. ADAM will open a discussion, under the auspices of the University of London Animal Welfare Society, on "The Destruction of Sea-Birds by Oil Waste" in the Chemistry Theatre at University College, London, on May 10 at 5.30. Admission is free.

SIR JOHN RUSSELL will deliver the thirty-eighth Bedson Club lecture at Armstrong College, Newcastle-upon-Tyne, on May 21, at 6.30. The subject of the lecture will be "Chemistry in Modern Food Production".

THE ninth International Congress for Psychotherapeutics will be held at Copenhagen on October 2–4. The official languages are English, French and German. Further information can be obtained from the president, Prof. C. G. Jung, Küssnacht, Zurich.

AN International Congress is being organized by the International Abolitionist Federation to be held in Paris from May 20–22, when the problem of prostitution will be studied from the legal, medical and moral points of view. Further information can be obtained from the Secretariat of the Federation, 8 rue de l'Hôtel de Ville, Geneva.

THREE fellowships in psychiatry, each of the value of £300, are offered for half-time work at the London Child Guidance Clinic, 1 Canonbury Place, N.1. Further information can be obtained from the Secretary of the Council, Woburn House, Upper Woburn Place, London, W.C.1.

WE regret that in a short notice of "The Hair in Health and Disease", by Mr. Edward Lawrence, in NATURE of May 1, the statement was incorrectly made that the author was a barber. Mr. Lawrence has been a fellow of the Royal Anthropological Institute and member of the Geologists' Association since 1885. He is described on the title page of his book as scientific correspondent of the *Hairdressers' Weekly Journal* and author of "Savage Life and Custom", etc., and his works include, he informs us, "Over 400 contributions on folk lore, antiquarian and other subjects to *Hairdressing Fashions* and *The Hairdressers' Weekly Journal*".

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 805.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

An Attempt to Detect the Disintegration of the Neutron

EXPERIMENTS performed by Kikuchi, Aoki and Husimi[1] were interpreted as evidence for the disintegration of the neutron. When neutrons from a heavy water target bombarded by deuterons were passed through various substances, electrons having energies up to 1 MeV. were observed, and it was suggested that these could be accounted for by the reaction :

$$n \rightarrow p + e + 1 \text{ MeV.}$$

The probability that this should happen during the interaction of a neutron with the field of any given nucleus was expressed in terms of a collision cross-section, varying from about 10^{-24} sq. cm. for heavy nuclei to about 10^{-25} sq. cm. for light nuclei.

We have failed to confirm this in two different types of experiments. The first set of experiments were made to detect the proton and the electron starting from a point in the gas in a Wilson cloud chamber. Experiments to determine the statistics of the neutron-proton collision were in progress, and the same apparatus was used in these experiments. A description of the apparatus and the method of measurement will shortly be published elsewhere[2]. Oxygen at about three atmospheres pressure was used in the chamber, so that any proton recoils obtained would be due to the water vapour. This number could be estimated from the previous experiments with the apparatus. 150 photographs were taken, and the number of recoils observed was 0·6 per expansion, and this is the number to be expected from the hydrogen in the water vapour. In no case was there an electron track starting at the beginning of a proton track. The condition of the chamber was such that electron tracks due to the X-radiation from the accelerating tube were clearly visible. The ranges of the recoil protons were measured, together with the angles they made with the direction of the source. In most cases these were consistent with the assumption that they were due to proton recoils from 2·5 MeV. neutrons. The number of pairs of proton and electron tracks to be expected, if the neutron disintegrates into a proton and an electron with a collision cross-section of 10^{-24} sq. cm., is 30 per expansion. Hence we conclude that the cross-section for the disintegration of the neutron is at least 1,000 times smaller than that suggested by Kikuchi.

The second experiment was an attempt to observe by a coincidence method the simultaneous production of a proton and an electron from a neutron. An intense source of neutrons was obtained by bombarding a target of $Al(OD)_3$ with deuterons accelerated through a potential of 70 kV. The ion source was of the type described by Tuve, Hafstead and Dahl[3]. Later, a still more intense source was obtained by using a heavy water target cooled with liquid air. By comparison with a standard radium-beryllium source, using a boron trifluoride chamber, the strength of the neutron source was found to correspond to about 600 millicuries. A small argon-filled ionization chamber connected to a linear amplifier was used to detect the protons produced in the argon or in the walls of the chamber, and a Geiger counter was used to detect any electrons produced in the chamber. The front of the ionization chamber was covered by an aluminium window of 2 cm. air equivalent stopping power, and was placed about 5 mm. from the front of the Geiger counter. From the geometry of the apparatus, it was estimated that 1/10 of any sufficiently energetic electrons produced in the ionization chamber would enter the Geiger counter. A 'scale of two' thyratron counter was arranged to count coincidences between the kicks in the two counters. The centre of the ionization chamber was placed 4–5 cm. from the neutron source.

The number of coincidences observed with and without the interposition of a brass sheet, capable of stopping the electrons, between the two counters were compared. 72 coincidences were observed without the brass and 70 with it present. The experiment therefore gives no evidence that the neutron disintegrates into a proton and an electron. From the dimensions of the apparatus it is estimated that the cross-section for the disintegration of the neutron, if it takes place, is less than 3×10^{-26} sq. cm.

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C. L. SMITH.
J. H. FREMLIN.

Cavendish Laboratory,
Cambridge.
April 23.

[1] Kikuchi, S., Aoki, H., and Husimi, K., NATURE, **138**, 841 (Nov. 14, 1936). *Proc. Phys.-Math. Soc. Japan*, **18**, 727 (1936).
[2] Dee, P. I., and Gilbert, C. W., in course of publication.
[3] Tuve, Hafstead and Dahl, *Phys. Rev.*, **48**, 240 (1935).

Thermal Precipitation of Radioactive Substances

THE usual method of separating solid radioactive particles from the gas phase is precipitation by an electric field. This is the classical procedure for the collection of the active deposit of radon and thoron, and can also be applied to artificial radio-elements, such as radio-arsenic prepared in arsine by neutron bombardment[1]. The process depends on the presence of an electric charge on the particles ; and unfortunately, at least in the case of artificial radio-elements

produced by slow neutrons, such a charge does not necessarily exist. It is, therefore, of practical as well as theoretical importance to seek other means of concentrating the radioactive particles. One promising means which we have tried is 'thermal precipitation', which is based upon a very simple principle.

A heated body in a cooler gas is surrounded by a dust-free space, a phenomenon already observed by Tyndall. Recently, it has found practical application as a means of collecting dust samples from air; for when a gas stream is forced to pass within the dust-free space of the hot body, whatever dust it may contain is deposited on the unheated surface facing the heated body[2]. So far, the method seems to have been tested only on particles visible under the microscope; but as between the limits of diameter of at least 20 μ and about 0·2 μ the efficiency of the method does not depend on the size of the particles[3], it seemed promising to apply it to the collection of the small aggregates composed of radioactive substances. The following account will show that our experiments were successful.

We sent a slow stream of air, carrying radon in equilibrium with its active deposit, through a small thermal precipitator consisting of a wire (0·25 mm. diameter) between two parallel microscopic coverslips each held 0·1 mm. from the wire. If the wire were at the same temperature as the glass plates, only the usual very slight, and perfectly homogeneous, contamination of the plate by the active deposit could be observed. If, however, the wire were heated to a temperature of 200° C., the active deposit was precipitated on both glass plates, opposite the wire, in the form of a narrow straight line. This we verified by measurement of the activity of the plate in a Geiger-Müller counter, using a lead screen with a slit which was moved over the surface of the glass parallel to the former position of the wire, and by photographing the active deposit on the coverslip by fixing the latter at a very small distance from a photographic plate. The possibility of preparing radioactive sources not on a wire but on a plate, and nevertheless highly concentrated in a narrow line, may conceivably be of great use in radioactive work.

The efficiency of the precipitation was tested by inserting an electric condenser immediately behind the thermal precipitator. It was found in two experiments that when the precipitator wire was heated, 67 per cent of the deposit formerly collected in the condenser remained in the thermal precipitator. It is probable that after establishing the best conditions of temperature and geometrical arrangement, even a higher percentage of the radioactive particles would be caught; but only a closer study will reveal whether there is a lower limit for the size of particles which can be precipitated thermally.

We hope now to apply the method of thermal precipitation to the collection of artificial radio-elements.

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April 5.

[1] Paneth, F. A., and Fay, J. W. J., NATURE, **135**, 820 (1935). *J. Chem. Soc.*, 384 (1936).
[2] For literature and details see Watson, H. H., *Trans. Faraday Soc.*, **32**, 1073 (1936).
[3] See Green, H. L., *Trans. Faraday Soc.*, **32**, 1091 (1936).

A Note on the Theory of β-Radioactivity

THE ratio between the probability of absorption of a K-electron by a nucleus and the total probability of emission of a positron by the same nucleus can be calculated on the hypothesis put forward by Fierz[1] that the interaction term in the neutrino theory contains the five possible invariants. Let J_K be these invariants, obtained by scalar products from combinations of Dirac's matrices. If one puts $H_\beta = \sum_K C_K J_K$, the probability of the process of β-radioactivity is proportional to $|H_\beta|^2$. Let $\vec{p}_\nu$, $\vec{p}_{el}$, W_{el} be the momentum of the neutrino, that of the electron, and the energy of the latter, these quantities being measured in units of mc and mc^2 (m = mass of the electron; c = velocity of light). If the atomic number Z of the reacting nucleus is small, one obtains for the probability $P(W)dW$ of the emission of an electron (a positron), the energy of which lies between W and $W + dW$:

$$(1)\quad P(W)dW = k[C_1^2 + C_2^2 + 3C_3^2 + 3C_4^2 + \frac{\vec{p}_\nu \cdot \vec{p}_{el}}{p_\nu \cdot W_{el}}(C_1^2 - C_2^2 - C_3^2 + C_4^2) \pm \frac{1}{W_{el}}(C_1C_2 + 3C_3C_4)]\, p_\nu^2 p_{el} W_{el} dW_{el},$$

where k is a constant. The energy p_ν of the neutrino is equal to the difference W_0 between the energies of the initial and the final nucleus, minus the energy W_{el} of the emitted particle. The signs $\pm$ in (1) refer to an electron or a positron.

Let us put $C_1^2 + C_2^2 + 3C_3^2 + 3C_4^2 = A$, $C_1C_2 + 3C_3C_4 = B$. The C_i's are real numbers, whence $|B| < A$.

We can calculate the total probability of emission of a positron, the energy of which lies of course between 1 and W_0, and also the probability of absorption of a K-electron, which is obtained from the same relation (1), only with a different energy balance. A similar calculation has already been made for different interactions[2]. After integrating over the angles, one obtains for these probabilities $\int_1^{W_0} P(W_{pos})dW_{pos}$ and P_K respectively; the ratio λ of the latter to the former can be obtained experimentally. This ratio is here equal to

$$\lambda(W_0,Z) = \frac{P_K}{\int_1^{W_0} P(W_{pos})dW_{pos}} = 10^{-4} Z^3 \frac{1 + C}{\zeta_1(W_0) - C\,\zeta_2(W_0)},$$

where the constant C is equal to

$$C = B/A,\quad |C| < 1.$$

The functions $\zeta_1(W_0)$ and $\zeta_2(W_0)$ are the following:

$$\zeta_1(W_0) = \frac{137^3}{240\pi} \times \frac{(4W_0^4 - 18W_0^2 - 16)\sinh\cosh^{-1} W_0 + 30W_0 \cosh^{-1} W_0}{(W_0+1)^2},$$

$$\zeta_2(W_0) = \frac{137^3}{240\zeta} \times \frac{(10W_0^3 + 65W_0)\sinh\cosh^{-1}W_0 - (60W^2 + 15)\cosh^{-1}W_0}{(W_0+1)^2}.$$

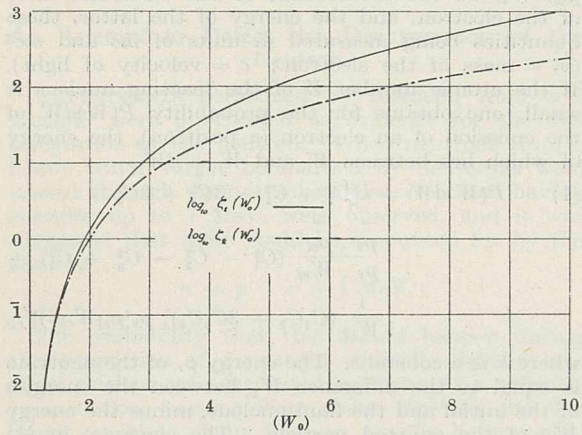
It should be noticed that for all values of W_0 (that is, $1 < W_0 < \infty$), one has $\zeta_2(W_0) < \zeta_1(W_0)$.

W_0 contains the rest energy and the kinetic energy of the emitted (absorbed) particle.

Table I.

W_0	1·5	2	3	4	5	6	7	10
$\zeta_1(W_0)$	0·1409	1·3062	12·185	41·416	97·652	189·05	324·36	1076·3
$\zeta_2(W_0)$	0·1326	1·0575	7·1836	20·104	40·190	67·392	101·95	248·74

Table 1 gives numerical values of ζ_1 and ζ_2 for W_0 lying between 1·5 and 10 mc^2, and Fig. 1 gives the common logarithm of these functions.



It is of some interest to notice that two experiments would be sufficient to test the above theory, since a single one is enough to determine the constant C:

$$C = \frac{\lambda\zeta_1 - 10^{-4}Z^3}{\lambda\zeta_2 + 10^{-4}Z^3},$$

the experiments being carried out for different values of W_0 and Z, and giving directly the corresponding values of the ratio $\lambda(W_0,Z)$. In the calculation of the ratio λ, the particular value $C = 0$ leads to the hypothesis of Fermi in which J_1 alone (put equal to unity) enters into the interaction term.

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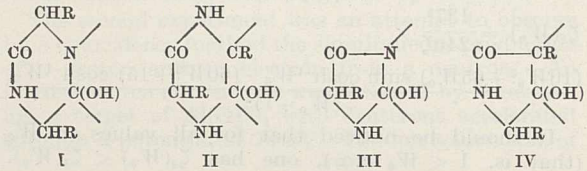
March 31.

[1] Fierz, M., *Z. Phys.*, **104**, 553 (1937).
[2] See Mercier, A., *C.R.*, **204**, **1117**, (1937). See also Møller, C., *Phys. Rev.*, **51**, 84 (1937).

Intramolecular Folding of Proteins by Keto-Enol Interchange

IN recent communications[1] to this and other journals, the hypothesis has been developed of a lactam-lactim interchange (I) to account for the linear folding of polypeptide chains in keratin and myosin and what appears to be a similar, generalized, intramolecular folding in the 'globular' proteins. We wish to point out that in certain respects the argument is unchanged if, instead of a lactam-lactim, a keto-enol interchange (II) is postulated.



There would appear to be little that is new in this alternative possibility, yet it has one property that is particularly attractive in the search for the stereochemical basis of protein specificity. We refer to the fact that in the keto-enol interchange it is the hydrogen atom associated with the side-chain carbon atom that is made use of, and thus we have a possible reason why folds should form only in certain places, as for example in keratin and myosin, the X-ray data and elastic properties of which seem to demand for the α-isomer one hexagonal fold for every *three* amino-acid residues. The responsibility, so to speak, is thrown on to those features of the protein molecule best calculated to bear it, the nature and distribution of the side-chains, and we can imagine certain special sequences acting as a predisposing cause of hydrogen transference at definite intervals and thereby giving rise to specific folds. It may possibly be a drawback of the lactam-lactim interchange that it is perhaps scarcely specific enough.

The general argument is, of course, independent of the exact nature of the hydrogen link involved, whether it be a 'hydrogen bond'[2] or a synchronized oscillation, as recently suggested by Huggins[3]; though actually the latter idea seems to harmonize better with the line of thought traced out here.

There is no need to confine attention to hexagonal folds, either: 5-rings such as III and IV, based also on the lactam-lactim and keto-enol interchange respectively, invite consideration.

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D. M. WRINCH.
Mathematical Institute,
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April 2.

[1] Frank, F. C., and Astbury, W. T., *J. Text. Inst.*, **27**, *P* 282 (1936); *Chem. Weekbl.*, **33**, 778 (1936). Wrinch, D. M., NATURE, **137**, 411 (1936); **138**, 241 (1936); *Proc. Roy. Soc.*, A (in the press). Frank, F. C., NATURE, **138**, 242 (1936).
[2] Jordan Lloyd, D., *Biol. Rev.*, **7**, 254 (1932); Jordan Lloyd, D., and Marriott, R. H., *Trans. Far. Soc.*, **29**, 1228 (1933). Mirsky, A. E., and Pauling, L., *Proc. Nat. Acad. Sci.*, **22**, 439 (1936). Wrinch, D. M., and Jordan Lloyd, D., NATURE, **138**, 758 (1936).
[3] Huggins, M. L., NATURE, **139**, 550 (1937).

Anti-Knocks and Pro-Knocks in the Combustion of Fuels

IT is well known that anti-knocks in concentrations of 0·1–0·2 per cent are capable of eliminating detonation completely, whilst they are without influence on the normal combustion regime. This is explicable on the chemical theory of detonation[1,2,3], according to which detonation can only occur if an intense oxidation reaction has had time to start in the unburnt mixture. The organic peroxides formed in this stage alter considerably the kinetic parameters and facilitate the production of a detonation wave. Anti-knocks break the reaction chains and hence increase the induction period, thus allowing the mixture to burn before a sufficient concentration of peroxides has been accumulated.

Gusev and Neumann[4] have shown that two maxima occur in the relation between the average combustion rate and the fuel concentration. The

corresponding fuel concentrations are 110 per cent and 125 per cent with respect to the stoichiometric mixture.

Our experiments, conducted in a steel cylinder of 500 c.c. capacity, have shown that the initial rate of combustion of pentane air mixtures passes through a maximum when the pentane concentration x is 110 per cent. The accompanying table shows the increase of pressure ΔP_x at different time intervals t (millisec.) after spark ignition, for different pentane concentrations, x per cent. The initial temperature and pressure were 20° C. and 4·6 atm.

x \ t	25	35	45	55	60	70
100%	2·25	5·62	10·25	15·5	17·9	19·75
110%	3·75	9·75	16·3	24·0	27·0	28·0
115%	3·25	8·5	15·0	21·2	24·7	25·10
125%	2·25	5·0	9·5	13·8	29·5	27·25
143%	0·75	1·5	3·0	5·64	7·25	10·75

It is clear from these figures that, with x equal to 125 per cent, the velocity of flame propagation increases rapidly at the end of the combustion process. It is easy to calculate, on the assumption that the 125 per cent mixture is compressed adiabatically in front of the flame, that after 55 millisec. the temperature at 18·4 atm. will be approximately 360° C. It has been shown, however, by Aivazov and Neumann[5], that under these conditions a cold flame will be formed after an induction period of a few milliseconds, and that this gives rise to a high concentration of

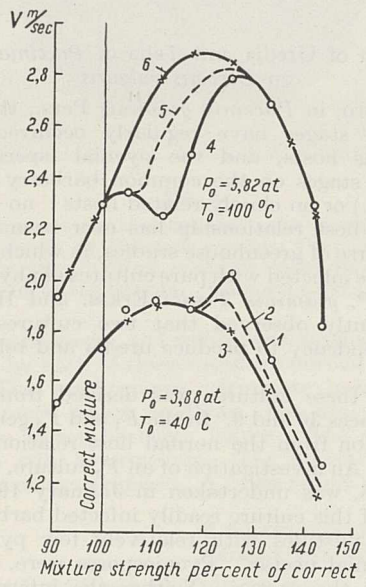

Fig. 1.

peroxides which would easily explain the acceleration of the combustion rate and the onset of detonation. The presence of the latter is shown on the indicator diagram in our experiments by a sharp rise of pressure accompanied by oscillations, and also by the characteristic metallic knock. With weaker mixtures the induction period of the cold flame is longer, and complete combustion of the mixture can take place before the initiation of a cold flame.

In spite of the relatively low initial speed of propagation of the flame front in the 125 per cent mixture, the time τ for complete combustion is less than that for other concentrations on account of detonation. Thus :

x =	100	110	115	125	143
τ =	70	64	65	60	110

The chemical theory of detonation is therefore capable of explaining both maxima on the Curves 1 and 4 of Fig. 1, where the mean velocity is plotted as a function of the pentane concentration. The effect of adding 0·33 per cent and 0·67 per cent lead tetra-ethyl ($Pb(C_2H_5)_4$) is shown in Curves 2 and 3, from which it is clear that whilst this anti-knock is without influence on the velocity of normal burning, it narrows and finally eliminates the region of detonation, so that at a concentration of 0·67 per cent the normal curve $\bar{v} = f(x)$ is obtained with a maximum for x at 110 per cent. The addition of 4·46 per cent isoamylnitrite (Curve 5), on the other hand, increases the detonating tendency of weak mixtures without affecting the shape of the curve for richer mixtures. The detonation region widens still more when 8·3 per cent $C_5H_{11}ONO$ is added (Curve 6) and the curve then contains only one maximum for x at 115 per cent. According to the thermal theory of flame propagation, the maximum should lie at about 110–115 per cent when dissociation of the products is taken into account.

Since lead tetra-ethyl increases and nitrites decrease the induction period of hydrocarbon cold flames, these experiments lend further confirmation to the chemical theory of detonation in motors.

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[1] Callender, *Engin.*, **123**, 147, 182, 210 (1927).
[2] Egerton, *Phil. Trans. Roy. Soc.*, **234**, 433 (1935).
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[5] Aivazov, B. V., and Neumann, M. B., *Acta physicochim. U.S.S.R.*, **4**, 575 (1936). *Z. phys. Chem.*, B, **33**, 349 (1936).

Rate of Growth of Totally Submerged *Cardium edule*

BY good fortune, data on the growth of *Cardium edule* have now been collected covering four summers' growth.

This bivalve is usually found between tide-marks, but it occurs also below low-water mark in this and other localities. The material for the present study was taken from the bottom of a Marine Lake constructed near high-water mark at New Brighton and first filled with water in May 1933[1]. In that year, there occurred a fortuitous settlement of cockles which provided a segregated population of known age. The conditions in the lake are not normal for submerged marine animals in that the water is stagnant, except when renewed by those spring tides which rise hereabouts 28 ft. or more. Each year the lake has been emptied about February for inspection, when the bottom is exposed ; collections of cockles have been made yearly, except in February 1934. Significant settlements of young occurred in 1933 and 1936, only rare representatives of other seasons having survived[1].

The growth of the 1933 spat in the second and third summers has already been given[1] and is shown in Fig. 1 at 2 and 3, and that for the fourth summer

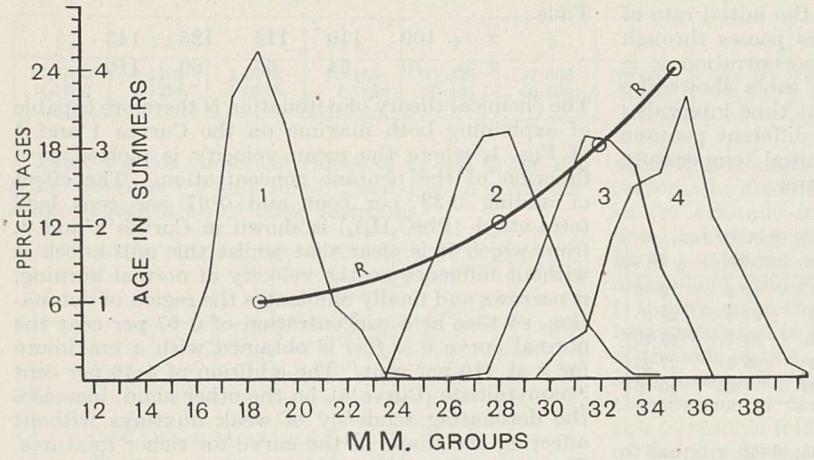

Fig. 1.

LENGTH-DISTRIBUTION IN MILLIMETRE GROUPS OF RANDOM SAMPLES (1, 2, 3 AND 4) OF *C. edule* FOR, RESPECTIVELY, 1, 2, 3 AND 4 SUMMERS' GROWTH, COLLECTED IN NEW BRIGHTON MARINE LAKE; 1 AND 4 IN FEB. 1937, 2 IN FEB. 1935, 3 IN FEB. 1936. *RR* GIVES THE MEAN RATE OF GROWTH FOR ONE TO FOUR SUMMERS OF GROWTH.

is now added from a sample of 286 specimens recovered in February 1937. This year, large samples of the 1936 spat were also obtainable, and the size distribution in 1,000 is given in Fig. 1 in millimetre groups at 1 to represent the 0-year class at the end of the first summer's growth. This class is not serial with the others given in Fig. 1, but is probably sufficiently similar to the 1933 spat at the end of the summer of 1933 to give the trend of the mean rate of growth, *RR*. The latter curve is drawn through the co-ordinates for mean size (length) for each year-group and age in summers. It is of characteristic type and shows that decrease in length with age is not markedly accelerated at an age of four summers. It is known that length at later ages falls off sharply, and it is hoped that adequate samples of the same material may be obtained in the future to give definite expression to this.

Data for each summer group are as follows:

Age in summers	Year spatted	No. of individuals in sample	Range in size (length) in mm. groups	Approx. modal value in mm.	Approx. increment in modal value in mm.
1	1936	1000	13–25	18·5	—
2	1933	1119	21–34	27·5	9·0
3	do.	1004	21–38	31·5	4·0
4	do.	286	29–40	35·1	3·6

The spat have been found to settle in this locality about the end of June, so that age in summers is not the same as age in calendar years.

There is a notable absence of very small spat in the 1936 brood, which was collected on a 1 mm. sieve. Possibly only the early spatfalls survived or, on the other hand, the late spat were eaten by crabs, fishes or other inhabitants of the lake. Although these bivalves have been under water constantly, their growth is less than that found on the shore in the south of England[2], and that on Cark sands, which will be dealt with in the future. In the sea, there can be little doubt that growth below low-water in the same locality would have been much greater; hence the relatively poor growth in the lake may be regarded as a measure of the unfavourable conditions in such a special environment. In the period of observation, there has been heavy mortality—denoted by empty shells—especially in the muddy parts of the lake; whereas 300–400 per square metre were not uncommon quantities in 1935 and 100 per square metre in 1936, the commonest now are 0 and the maximum about 20 per square metre, and relatively few have been collected for consumption.

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[1] Bunting, L. E., Eslick, A., Jones, J. W., and Orton, J. H., NATURE, 137, 705 (1936).
[2] Orton, J. H., *J. Mar. Biol. Assoc.*, 14, 2, 239 (1926).

Production of Uredia and Telia of *Puccinia graminis* on *Berberis vulgaris*

HITHERTO, in *Puccinia graminis* Pers., the uredial and telial stages have regularly occurred on the gramineous hosts, and the pycnial (spermagonial) and æcial stages on the common barberry (*Berberis vulgaris* L.) or on closely-related hosts: no deviation from this host relationship has ever been reported. In the course of greenhouse studies, in which barberry plants were infected with pure cultures of physiological races of *P. graminis Tritici* Erkss. and Henn., we have recently observed that two cultures show a distinct tendency to produce uredia and telia on the barberry.

One of these cultures was derived from a cross between races 36 and 9. In the F_1 and F_2 generations, no deviation from the normal host relationship was observed. An investigation of an F_3 culture, identified as race 36, was undertaken in January 1937. The sporidia of this culture readily infected barberry, but produced pustules with relatively few pycnia and scant pycnial nectar. Pycniospores were, however, present in the nectar. Neither the intermixing of the nectar of these pustules nor the transfer of nectar from pustules of other races to them induced them to form æcia.

Forty-four days after the inoculation was made, we observed small uredia on the upper surface of several of the pustules. Further examination revealed that, in a total of 129 pustules, uredia were present in 50, and that 21 of these contained telia. The uredia and telia may occur on the upper or lower surface of a pustule, but more frequently on the upper surface.

The failure of pustules to produce æcia after intermixing of the nectar is not a new phenomenon. It has been observed from time to time in the F_2, F_3 and F_4 progeny of certain crosses, but uredia and telia were never before found associated with this condition.

The other culture that produced uredia and telia on barberry was obtained from a field collection made in 1934, and was identified as race 21. Sporidia from telia developed in the greenhouse in 1936 produced two types of pustules on barberry in about equal numbers. Pustules of the first type were normal in appearance and, on intermixing of the nectar, produced æcia. The pustules of the second type were almost white, with no pycnia, or only rudimentary ones that rarely produced pycniospores. Uredia were recently observed on five pustules of this type on a barberry plant inoculated 43 days previously. Two of these pustules also contained teliospores. Fig. 1 shows an infected barberry leaf bearing a compound pustule, one component of which contains æcia and the other small uredia.

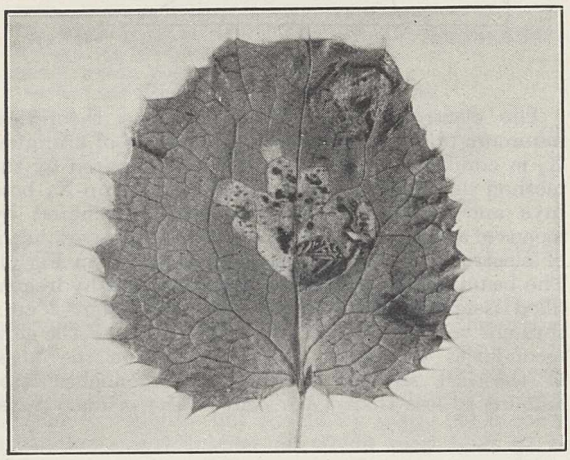

Fig. 1.

LOWER SURFACE OF A BARBERRY LEAF SHOWING A COMPOUND PUSTULE OF *Puccinia graminis Tritici* OF RACE 21. ONE COMPONENT OF THE PUSTULE CONTAINS AECIA, THE OTHER, SMALL UREDIA. (SLIGHTLY ENLARGED.)

The urediospores and teliospores produced on the barberry by both of these races are normal in appearance. The urediospores germinate normally and readily infect wheat seedlings, but are apparently unable to infect barberry leaves. The strains are therefore still heterœcious. The nuclear condition has not been investigated. A fuller report will appear later.

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Flashing of Fireflies in Jamaica

DURING the past summer, the members of the Seventh Botanical Expedition of the Johns Hopkins University witnessed displays of firefly activity in the British West Indies as spectacular in their way as any reported from the Orient.

In front of the expedition's laboratory at Chestervale, in the Blue Mountains of Jamaica, there was a thatch palm which bore below its whorl of leaves an inflorescence a metre in diameter. For about a week in June, and again a month later, this inflorescence was transformed nightly into a sphere of seething flame by the flashes of thousands of fireflies which gathered there. Later, other displays were discovered, particularly on two large acacia trees overhanging the Clyde Valley which harboured such prodigious swarms of fireflies that the nebulous glow was visible half a mile away.

All the fireflies on these trees were of one species, *Photinus pallens*, and the females outnumbered the males in the ratio of 4 : 3. Each firefly flashed regularly about twice a second while walking along the twigs, and entirely independently of any other individual. There was no sign of synchronism or of response between any individuals or between different trees. The flashing was not inhibited by heavy rain, by lightning, or by the beam of a powerful flashlight, but did not occur on moonlight nights. It continued from about 8 p.m. until 3 a.m., and during dull days many of the fireflies remained in the trees all day.

Although these enormous aggregations were particularly brilliant on rainy nights, it is probable that they did not arise as a consequence of the fireflies taking shelter, because displays were also observed on clear nights. Likewise, although some individuals were seen apparently sucking juice from the fresh fruit scars on the palm tendrils, it is probable that food was not the specific cause of the aggregations, since the fireflies collected in several species of trees.

Photinus pallens is conspicuously positive to continuous illumination, and is the only Jamaican Lampyrid firefly which is frequently attracted indoors by lamplight. It was found that when the beam of a flashlight was directed into a bush or on to the grass, specimens of both sexes of *P. pallens* soon begin to fly from all directions, alight in the illuminated area, and flash regularly. Such nuclei, when they came to contain a dozen or so specimens, maintained themselves autonomously by the addition of new individuals from the surrounding area. Accordingly, it seems probable that this photo-positivity is the explanation of the huge swarms which gathered in the palm and acacia trees. Several individuals collected fortuitously in a small area would make sufficient illumination to serve as a focus for the addition of new recruits, like bees joining a swarm, and sufficient individuals remain on the tree during the day to insure its becoming a focus on the following night.

Whatever the cause of the aggregation, it serves an important function in bringing the sexes together for mating, and many coupling pairs were observed on the palm tendrils. The mating, however, appears to be due entirely to accidental contact of the sexes during their peregrinations on the branches. The aggregation habit thus seems to take the place of the accurate systems of flashing signals which serve to bring male and female together in some species of firefly.

I am greatly indebted to the late Prof. D. S. Johnson for laboratory facilities in Jamaica, and to the National Research Council of the U.S.A. for research funds.

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Potassium Permanganate as an Aid to the Production of Asexual Fructifications by *Phytophthora erythroseptica* Pethybr.

WHEN small portions of pure cultures of *Phytophthora erythroseptica* are transferred to water, conidiophores and conidia (zoosporangia) usually develop from the mycelium after a few days, and this behaviour has been found to be stimulated by the addition of a little permanganate solution to the water. Young vigorously growing cultures do not react in this way.

To produce these results the following method is recommended. Portions of the medium (ground Quaker oats agar) in which the fungus has been under cultivation for 6–12 months are placed in drops of tap water on microscopic slides laid on white paper, and permanganate solution (0·01–0·02 per cent) added to the water, until a faint pink colour becomes just perceptible. Cover slips are put on the preparations, and the slides are then placed in Petri dishes lined top and bottom with moist blotting paper, and incubated at 16°–20° C. After 72 hours, sometimes sooner, the production of conidia begins, and their formation reaches its maximum in 84–96 hours. If too much of the reagent is added the medium and hyphæ stain brown, and fructifications may not occur until after 6–7 days. Cultures one month old will give conidia when treated in this way, but older cultures are preferable as germination of some of the oospores in the latter also occurs.

It may be pointed out that this method places this fungus in an exceptionally good position for teaching purposes, as the following facts may all be rapidly demonstrated with it:

(*a*) Inoculation of potato tubers with pure cultures produces typical pink rot in 8–10 days, and the parasite is easily recovered in pure culture from the rotted tubers.

(*b*) Sexual organs are freely produced in culture on ground Quaker oats agar in a comparatively short period.

(*c*) Using old cultures and treating with potassium permanganate as described above, the germination of the oospores, both by long hyphæ and by short ones ending in a conidium, may be observed, as recorded by Pethybridge[1]. In addition, the abundant production of sympodial conidiophores bearing conidia by the old hyphæ can be studied.

(*d*) When the formation of conidia is at its maximum, or abundant, and slides are removed from the incubator to the laboratory bench, germination of the conidia (zoosporangia) by zoospores takes place in about two hours.

I know of no other fungus of this type in which all these points can be studied so easily, and this makes it particularly useful for class work.

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[1] *Sci. Proc. Roy. Dub. Soc.*, **14**, 179–198 (1914).

Specific Ionization by High-speed Particles

THEORETICAL calculation of the interaction between fast electrons and hydrogen atoms (Bethe, Williams[1], etc.) predict an increase of primary ionization when the energy of the incident particle exceeds about one million electron-volts. Wilson chamber experiments have not yet given quantitative results of sufficient precision to ascertain if that increase is real or not.

By a modification of our method[2,3], used for the determination of specific primary ionization of hydrogen by cosmic radiation, we have succeeded in measuring the variation of primary ionization of hydrogen by electrons of energy ranging from $0{\cdot}6 \times 10^6$ eV. up to that of cosmic rays. Contrary to theory, we find that the primary ionization *decreases* for high-energy particles.

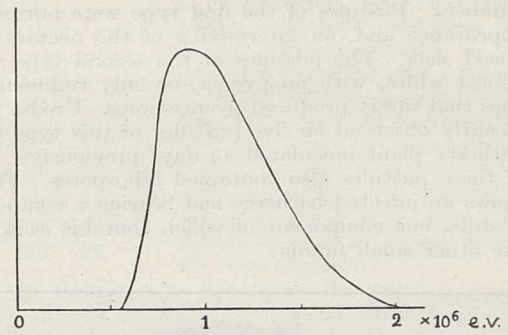

Fig. 1.

The electron source, used near the theoretical minimum ($v/c = 0{\cdot}97$), was a preparation of uranium-X_1 in equilibrium with uranium-X_2 (prepared by the method described by E. Stahel[4]); uranium-X_1 beta rays and secondary electrons were eliminated by means of a magnetic field. The result is a narrow beam of electrons of energy distribution shown in Fig. 1. The beam passes across the diameter of a hydrogen-filled Geiger-Müller counter (diameter about 2 cm.) through very thin walls (0·4 mgm. cm.$^{-2}$); the slow secondaries emitted in the walls and on the edges of the last slit of the magnetic monochromator amount to less than 4 per cent of the primary rays.

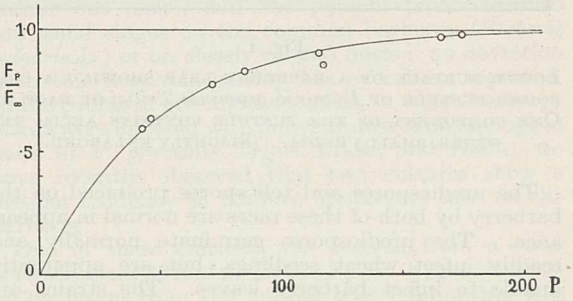

Fig. 2.

The frequency of counter impulses was measured for different pressures of hydrogen, ranging from 40 mm. to 180 mm. of mercury (N.T.P.). To eliminate the effect of residual counts (cosmic and gamma rays), which amount to about 15 per cent of the beta radiation, we automatically register that frequency every 30 minutes, with the shutter of the uranium-X source alternatively open and closed.

Fig. 2 gives an example of a series of measurements; the curve is the result of the calculation, taking the specific ionization as 7·8 cm.$^{-1}$.

The primary ionizations, computed from a series of such measurements, lie between 7·5 cm.$^{-1}$ and 8·5 cm.$^{-1}$. Although we hope to increase the precision of the method, it is already sufficient to show that

the ionization near 10^6 eV. is definitely larger than at cosmic rays energy, where it is between 6·0 [2,3] and 6·2 [5].

A detailed account of this investigation will be published in the near future.

An incorrect reference and some ambiguity in a sentence of my previous letter[3] may have given a wrong idea of my opinion about the priority of the method used. I intended to say that Kolhörster's method[8,9] for measuring the *total* specific ionization was not convenient for the measurement of *primary* specific ionization; the principle of our method was suggested by L. Tuwim[6] and tested by us in 1934[7]. The method was applied to cosmic radiations independently by us (April 1936) and by Danforth and Ramsay (June 1936).

Note added in proof: A better series of measurements gives us a value of 8·2 cm.$^{-1}$ for 10^6 eV. energy.

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March 29.

[1] Williams, *Science Progress*, **121**, 915 (1936).
[2] "Etude des compteurs . . .", *Bull. Tech. A.I. Bruxelles* (1936).
[3] NATURE, **138**, 284 (1936).
[4] Stahel, Thesis. Zurich (1922).
[5] Danforth and Ramsay, *Phys. Rev.*, **49**, 854 (1936).
[6] Tuwim, L., *J. Phys. Rad.*, **3**, 614–620 (1932).
[7] Cosyns and de Bruyn, *Bull. Acad. Belg.*, **20**, 371 (1934).
[8] Kolhörster, W., and Tuwim, *Naturwiss.*, **19**, 917 (1931).
[9] *idem.*, *Z. Phys.*, **73**, 130 (1931).

Origin of Static Electricity on the Surface of Solid Dielectrics

INVESTIGATIONS, which I have carried out at intervals over the past twenty years, into the origin of the static electrical charges on the surface of cellulose during the manufacture and subsequent manipulation of paper, have shown a property—not peculiar to cellulose but shared by many other solid dielectrics—consideration of which may lead to a clearer conception of the origin of static charges by friction and contact.

When two plates of the same solid dielectric having identically similar surfaces are rubbed against each other, there is no sign of electrical charging by friction. I have found, however, that when two such surfaces of the same dielectric are pressed together into intimate contact, under a pressure of 100–120 lb. per square inch, and then separated, the two surfaces which have been in close contact are charged electrically, one positively and the other negatively. The potentials produced in this way are comparable in strength with those arising under the same conditions by pressure on plates of different dielectrics, although in the latter case the charges are much weaker than those produced by friction between the different dielectrics.

This development of an electric field in the bounday layer between two surfaces of the same dielectric pressed into intimate contact I have found to occur in solid dielectrics of such varying composition and molecular structure as ebonite, dry cellulose, dry gelatine and white mica. So far, it has not been found possible to predict which surface will become positively charged, and which negatively, or why, but I have observed that when fairly large surfaces electrified in this way are examined, it is sometimes found that one surface may show patches having a negative charge surrounded by areas having a positive charge, both corresponding to charges of opposite signs on the coincident areas of the second surface with which the first was in contact.

These phenomena cannot be explained in the light of the theories of Owen[1], Jones[2], Lenard[3] or Nernst[4], on the origin of frictional or contact electricity, but a possible explanation may be found in Freundlich's theory[5] of the production of charges by the rupture of surface adsorption layers.

JAMES STRACHAN.

"The Orchard",
Meopham.
March 22.

[1] Owen, M., *Phil. Mag.*, **17**, 459 (1909).
[2] Jones, W. M., *Phil. Mag.*, **29**, 261 (1915).
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The Dependence of the Thermal Expansion Coefficients of Silver Haloids on Temperature

EUCKEN and Dannöhl[1] observed an increase of the expansion coefficients of the haloids of the alkali metals with temperature. Monocrystals of silver chloride and silver bromide also exhibit a peculiar increase of expansion at high temperatures (near the melting point) several times larger than those observed by Eucken and Dannöhl.

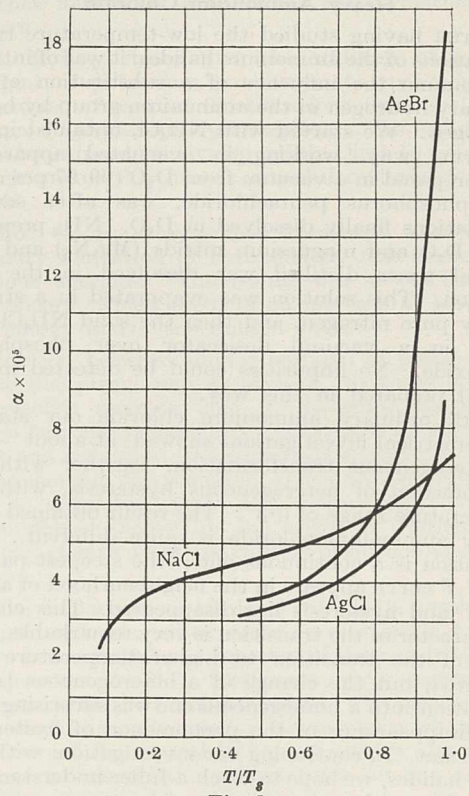

Fig. 1.

In Fig. 1 the expansion coefficients of sodium chloride, silver chloride and silver bromide are plotted as ordinates, while fractions of the absolute melting points T_s are plotted as abscissæ. The dependence increases sharply from sodium to silver and from chlorine to bromine, that is, the change is parallel to the increase of the deformation of the ions.

The character of the change of α with temperature for the group of haloids of potassium, sodium and lithium which crystallize in lattices of the same type is fairly similar. However, it appears from data already given by Eucken and Dannöhl that the expansion of compounds which are more easily polarized shows a tendency to increase from 0·6 T_s.

The replacement of the alkali metals by the strongly deforming ion of silver causes the appearance of a large dependence of the expansion coefficient on the temperature, when with increase of the amplitude of the thermal motion the influence of the polarizing forces increases. Silver chloride appears to represent the limiting case, since silver iodide already crystallizes in a different type of lattice.

As a characteristic of the condition of the lattice of these compounds at high temperatures, it is of interest to recall the following jumps in the electrical conductivities at the melting point: sodium chloride, 3,000; silver chloride, 30; and silver bromide, 5.

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[1] Eucken, A., and Dannöhl, W., *Z. Elektrochem.*, **40**, 814 (1934).

The Low-temperature Transformation of Heavy Ammonium Chloride

AFTER having studied the low-temperature transformations of the ammonium halides, it was of interest to examine the influence of a substitution of the ordinary hydrogen in the ammonium group by heavy hydrogen. We started with ND_4Cl, obtained in the following way, working in evacuated apparatus. DCl prepared in a vacuum from D_2O (99·97 per cent) and phosphorus pentachloride, was after several distillations finally dissolved in D_2O. ND_3 prepared from D_2O and magnesium nitride (Mg_3N_2) and also several times distilled was dissolved in the DCl solution. This solution was evaporated in a stream of dry pure nitrogen, and then the solid ND_4Cl was dried in a vacuum desiccator over phosphorus pentoxide. No impurities could be detected in the ND_4Cl prepared in this way.

With ordinary ammonium chloride our statical dilatometrical investigations showed[1] at about − 30° a heterogeneous transformation, together with the phenomenon of heterogeneous hysteresis, within a temperature range of 0·3°. The result obtained with heavy ammonium chloride is quite different. The transition is a continuous one; the steepest part of the V,T curve appears in the neighbourhood of about − 24° and hysteresis has disappeared. This change in character of the transition is very remarkable. The shift of the transition to higher temperature was expected, but the change of a heterogeneous transformation into a homogeneous one was surprising, and the disappearance of the phenomenon of hysteresis, significant. In continuing our investigations with the other halides, we hope to reach a fuller understanding of the interesting phenomenon of hysteresis.

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April 8.

[1] *Z. phys. Chem.*, A, **166**, 97 (1933).

Magnetic Susceptibility of Mercury Vapour

I HAVE measured the susceptibility of mercury vapour by means of a method already described[1].

The atomic susceptibility of mercury has been found to be

$$\chi_a = -(78 \pm 7) \times 10^{-6}.$$

The susceptibility of the Hg^{++} ion had been measured several times by different investigators, and its most plausible experimental value[2] is

$$\chi_j = -40{\cdot}4 \times 10^{-6}.$$

Thus for the first time we are able to compare χ_a with χ_j and to compute the fraction of the diamagnetic susceptibility given by the two valence electrons of mercury:

$$\chi_e = \chi_a - \chi_j = -38 \times 10^{-6}.$$

We see that the diamagnetism of the two valence electrons of mercury is nearly equal to that of the ion. This result is rather important, because it suggests an explanation of the well-known fact that the diamagnetism of atoms is greatly influenced by the formation of molecules, as was observed, for example, in organic compounds by Pascal.

In the following table we give a comparison of the observed susceptibility of the mercury atom with that calculated by different approximate theoretical methods.

$\chi_a \times 10^6$.

Sommerfeld[3] calculated	Gombas[4] calculated	Slater[5] calculated	Experimental value
40·3	133·3	84·6	78

As may be seen from this table, the calculation carried out by Slater's method gives the most consistent results.

A detailed description of this work will appear in the *Phys. Z. Sow. Union.*

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of the Ural,
Sverdlovsk.

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[2] Kido, K., *Sci. Rep. Tôhoku Univ.*, **22**, 834 (1933).
[3] Sommerfeld, A., *Z. Phys.*, **78**, 283 (1932).
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Phosphorescence of the Sea

WHEN sailing off the western Scottish coast, I found it possible to predict with certainty phosphorescent nights owing to a nipping sensation on the backs of my fingers after immersion in the sea. This seems to indicate some marine organism. As Dr. R. E. D. Clark's letter in NATURE of April 3 suggests, the phosphorescence is doubtless due "to the agitation of phosphorescent marine organisms".

If a boat-hook is pressed gently downwards into the water on a suitable occasion, there is little observable effect. The slightest jerk, however, that violently disturbs the water, at once produces luminosity but only in the disturbed region. During a very squally night when anchored in Mallaig Bay, I saw a beautiful display. The sea was black but the crest of every small wave that broke was brilliantly

illuminated. May the streak effect be due, not so much to the accumulation of organisms in a particular region such as the meeting line of two currents, but rather to the agitation and consequent alarm of the organisms in the particular disturbed region ?

I once described in NATURE[1] the production of the characteristic luminosity so familiar at sea resulting from the sudden distortion of globules of certain viscous materials, and suggested that the organism displays its light—it may be voluntarily or otherwise—by a sudden muscular extension of cells containing such material.

JAMES WEIR FRENCH.

Friarscrag,
23 Kirklee Road,
Glasgow, W.2.
April 4.

[1] NATURE, 115, 944 (1925).

Points from Foregoing Letters

EXPERIMENTS interpreted as evidence for the disintegration of the neutron have been described by Kikuchi, Aoki and Husimi, and the probability of the reaction has been calculated by them in terms of a collision cross-section varying from about 10^{-24} to about 10^{-25} sq. cm. C. W. Gilbert, C. L. Smith and J. H. Fremlin, by two different types of experiment, fail to confirm the disintegration of the neutron by bombardment with heavy hydrogen nuclei (deuterons). They consider that the cross-section for the disintegration of the neutron, if it takes place, is less than 3×10^{-26} sq. cm.

Prof. F. A. Paneth and Dr. C. Rosenblum state that the method of 'thermal precipitation' can be used for the separation, from the gas phase, of the active deposit of radium.

The ratio between the probability of absorption of a *K*-electron by a nucleus and the total probability of emission of a positron by the same nucleus has been calculated by Dr. A. Mercier on the assumption that the interaction term in the neutrino theory of β-radioactivity contains the five possible invariants to be obtained from Dirac matrices without introducing derivatives. Numerical values are given as functions of the maximum energy of particles emitted.

Drs. W. T. Astbury and D. M. Wrinch, while indicating the keto-enol interchange as an alternative mechanism to the lactam-lactim interchange recently proposed for the intramolecular folding of protein molecules, point out that the former offers a reason for folding in certain places only, given specific sequences of amino-acid residues, in that the hydrogen transference would take place at carbon atoms carrying side-chains.

A table giving the increase in pressure in pentane-air mixtures of various concentrations, at a series of very short time intervals after spark ignition, is submitted by A. V. Belov and Prof. M. B. Neumann. The initial rate of combustion passes through a maximum when the pentane concentration is 110 per cent. Graphs showing the mean velocity as a function of pentane concentration, and the influence of lead tetra-ethyl and of isoamylnitrite are given. The authors state that their experiments support the chemical theory of detonation in motors.

The size (length) distribution of cockles of one, two, three and four summers' growth, from the Marine Lake at New Brighton, has been determined by a group of investigators from the University of Liverpool. The trend of the mean rate of growth deduced from the graphs indicates that even at the age of four summers there is no marked decrease in the rate of growth.

The production of urediospores and teliospores of wheat stem rust (*Puccinia graminis Tritici*) on the common barberry (*Berberis vulgaris*) is reported by Drs. Margaret Newton and T. Johnson. These types of spores normally appear on the gramineous host only. They appeared in selfed cultures of two physiological races of this rust.

The swarming behaviour of fireflies of the species *Photinus pallens* in Jamaica is described by J. B. Buck. The fireflies gather in large numbers, apparently due to the fact that they are attracted by light, so that a few individuals collecting by chance serve, by their flashes, as a focus for the formation of a swarm.

R. McKay states that the addition of a small amount of potassium permanganate speeds up the formation of asexual fructifications (conidia) in the fungus *Phytophthora erythroseptica*. The conidia can thus be induced to develop within three to four days, which makes this fungus a useful material for class work.

Max G. E. Cosyns has measured the specific primary ionization of hydrogen by fast electrons of various energies. The results are in conflict with the theory, which predicts an increase of ionization for energy above one million volts.

Friction between similar surfaces of plates of the same dielectric, such as ebonite, does not give rise to electric charges, but J. Strachan states that when two such plates are pressed into intimate contact and separated, the contacted surfaces are found to be charged, one positively and the other negatively. It is suggested that this observation confirms Freundlich's theory for the origin of frictional and contact electricity by the rupture of surface adsorption layers.

The expansion coefficients of single crystals of sodium chloride, silver chloride and silver bromide have been plotted as a function of their melting-point temperatures by P. G. Strelkov, to show the abnormal increase near their melting points. The author points out that this behaviour is connected with the behaviour of the crystal lattice, as shown also by the jumps in electrical conductivities at the melting points.

Prof. A. Smits and G. J. Muller find that ammonium chloride containing heavy hydrogen in its molecule differs in its behaviour at low temperatures from the normal salt. The volume-temperature curve of the 'heavy' compound shows a homogeneous transition without hysteresis at − 24°, unlike the normal compound which shows a heterogeneous transformation with hysteresis at − 30°.

Research Items

Leg Muscles of Birds

IN a thorough study of the "Muscles of the Pelvic Appendage in Birds", George Elford Hudson has examined representatives of sixteen out of the twenty orders of North American birds (*American Midland Naturalist*, **18**, 1; 1937). He has standardized so far as possible the terminology of the muscles with the recognized Basle Nomina Anatomica, and has introduced a method, new for bird anatomy, of illustrating cross-sections of the leg. The hind limb of a bird is worked by a full complement of forty-one muscles, and all these muscles are present in representatives of the order of game birds (Galliformes), suggesting a generalized and primitive condition. In the other orders examined, from one to nine muscles were missing from the full complement, and this indication of specialization was specially marked in *Colymbus* (eight missing), *Dryobates* (7), *Chaetura* (9), and the perching birds (8). On the other hand, *Cathartes* and *Zenaidura* had only one missing muscle. The leg musculature showed distinctive peculiarities for each major taxonomic group, and the author is of opinion that more weight ought to be placed upon the anatomy of soft parts in determining the systematic position and relationships of birds.

The Origin of Insects

IN his presidential address delivered before the Linnean Society of London on May 28, 1936, and published in the *Proceedings* of that Society (Part 4, December 1936), Dr. W. T. Calman discusses the above subject. It is maintained that the earliest insects were probably wingless forms not very different from the existing Thysanura. The idea of any relatively close affinity between insects and crustaceans meets with many obstacles. Some of the features which appear to link together the two groups are undoubtedly the result of convergent or parallel evolution. Furthermore, the fact that embryology has failed to produce any clear evidence of a head-segment, corresponding to that bearing the maxillulæ in Crustacea, discounts Hansen's belief that these organs are homologous with the so-called 'paraglossae' of the thysanuran *Machilis*. The discovery of Collembola from the Middle Devonian of Scotland led Tillyard to place these creatures at the very base of the insect series. The structure of the Collembola seems, however, to be of a specialized character suggesting that they are less primitive than the Thysanura. While it is claimed that the origin of insects is obscure, it is believed that the Symphyla reveal features that indicate what the immediate predecessors of the insects may have been like. An interesting problem raised in this address is the possibility that, in various groups of arthropods, there is a limit of size below which morphological differentiation is unable, as it were, to find adequate scope for expression. The number of segments in the appendages tends to be reduced, setæ are fewer and relatively larger in size, while the appendages themselves are less completely formed as compared with larger species. The primitive thysanuran *Campodea* and the Symphylan *Scolopendrella*, therefore, on these grounds are small enough to discount the absence or incomplete development of some features which would be expected to prevail in primitive forms. (See also NATURE of March 6, p. 399.)

Influence of Temperature Fluctuations on Animals

J. S. MIKULSKI (*Bull. internat. l'Acad. Polonaise*, 11, No. 5; 1936) reports the results of experiments on the influence of alternating temperatures upon the development of *Bufo americanus* and *Ambystoma tigrinum*. The experiments were carried out within the vital range of the animal and the rhythm of the changes of temperature were close to the natural ones. The acceleration in development at constant higher temperatures is offset by the fall in survival value and so they do not represent optimum conditions. Symmetrical alternating temperatures have a different influence as compared with that of constant temperatures in the two animals. The influence is shown by a change in velocity and a change in survival rate. *Ambystoma* exhibits a greater resistance to lower temperatures and the average resistance of *Bufo* is small in the extra-optimal range. The experiments show the necessity of observing the course of temperature fluctuations during the period of development.

Plants Poisonous to Stock

A VERY valuable account of American work upon plants poisonous to stock by J. F. Couch has recently been published (*J. Chem. Educ.*, **14**, Jan. 1937). The annual losses of livestock in the United States are estimated to exceed two million dollars, and in Texas during one spring, animals valued at 300,000 dollars died from the effect of one species. It is pointed out that, though poisonous wild species are widespread in the pastures, well-fed animals are usually reasonably safe; when the ranges are over-stocked, the hungry animals turn to the less palatable species of plants, and then the damage is done. Among the poisonous types of plants described are larkspurs, lupins and senecios containing alkaloids; glucoside-containing plants in which the aglycone may be cyanogenetic or phenolic or in which the glucoside is a saponin; solanine-containing plants in which the solanine is at once both alkaloidal and solaninic—it is responsible for the occasional poisoning from sprouting potatoes; plants containing proteins antigenic like the bacterial toxins such as the ricin in the castor oil bean, and the resinoid-containing plants of the Ericaceæ. The chemical nature of these resinoid substances, which are difficult to crystallize, is little understood. It is very interesting to learn that the resinoid andromedotoxin is taken up by the bees from the flowers of some of these Ericaceous plants, and the honey then made may be very poisonous. Another obscure poison is the resinoid galitoxin found in the milkweed, *Asclepias galioides*. This makes this plant one of the most poisonous in the States, three ounces of the fresh plant being sufficient to cause the death of an adult sheep.

White Mould Disease of the Narcissus

THE fungus *Ramularia vallisumbrosæ* causes a white mould disease of narcissus plants, which is particularly severe in Devon and Cornwall. Greyish streaks appear on the leaves, and later bear masses

of white, powdery spores. The streaks may occupy considerable areas of the leaves, which are thus unable to manufacture an adequate supply of food. Dr. P. H. Gregory has recently published an account of the disease and its control (*J. Minis. Agric.*, **43**, No. 9, 865–69, December 1936). Spores are borne from February until May, and are readily distributed by wind and the splashing of rain, so that the disease can attain epidemic proportions in moist weather. Black sclerotia are formed by the fungus upon withered leaves in summer, and serve to perpetuate the disease. Control methods are mainly along the lines of general sanitation—the removal of leaves from infected plots, and appropriate rotation. There is no evidence that the fungus can contaminate the ground for more than one year, so that a rest of this duration will control the disease. The shoots of susceptible varieties of narcissi should also be sprayed with Bordeaux mixture, when the shoots are 3–6 in. high, in order to eradicate the sporing stage of the fungus. The waxy 'bloom' upon narcissus leaves makes it imperative that a suitable wetting agent be added to the spray fluid, in order that the greatest fungicidal action may be exerted.

Structure of Thin Metallic Films at Low Temperatures

THE properties of thin metallic films deposited at low temperatures are known to be anomalous. Such films possess high electrical resistance and poor optical reflecting powers. When the film is warmed there is an increase in conductivity, which Zahn and Kramer have reported to be discontinuous for films deposited by cathodic sputtering. They conclude that below a certain transition temperature characteristic for each metal, the film is amorphous. Tammann, on the other hand, believes that the difference in properties cannot be thus accounted for. G. Hass (*Naturwiss.*, **25**, 232; 1937) describes electron diffraction experiments by which the structure of thin films of silver and antimony, deposited by condensation at low temperatures, has been determined. For silver, well-defined interference rings were obtained even at low temperatures (− 175°), which became sharper as the temperature was raised, thus indicating that the smaller crystals present at − 175° became larger with rise of temperature. This process of crystallization was more important with the thinner films (50 A. thick) than with the thicker ones (700 A.). For antimony, at low temperatures only two broad, diffuse rings were obtained, showing the predominance of a colloidal structure. At room temperature, however, the diagram indicates the existence of fairly large crystal units with thread structure. No transition temperature could be detected in either case, and the films were not amorphous at low temperatures.

Permonophosphoric Acid

ALTHOUGH permonophosphoric acid is a powerful oxidizing agent, converting manganous salts in the cold to permanganate, and is thus perhaps capable of useful application, its preparation by the interaction of phosphorus pentoxide and concentrated hydrogen peroxide is difficult. G. Toennies (*J. Amer. Chem. Soc.*, **59**, 555; 1937) has found that the heterogeneous interaction between these two substances in acetonitrile as an inert solvent yields solutions of permonophosphoric acid which are relatively stable even at room temperature. In two experiments, 65·3 and 68·0 per cent of the phosphorus pentoxide were converted into the peracid by the reaction $P_2O_5 + 2H_2O_2 + H_2O = 2H_3PO_5$. The solution, even in the cold, gave the characteristic reaction with manganous salt. Some experiments on the rate of formation and of decomposition of the peracid and the stabilizing effect of low temperature (− 12°) are recorded.

Metal Spraying

DEVELOPMENTS in metal spraying were considered by E. C. Rollason at the annual meeting of the Institute of Metals held in London on March 10–11. Twelve years have elapsed since the last paper on this subject was presented to the Institute of Metals. During the interval, radically new designs of apparatus have been evolved using powdered and molten metal as well as wire. Many new applications have been successfully exploited, some of which, such, for example, as in the building up of worn machinery, are becoming of great importance to the engineer. The author concludes that each of the three types of metal spraying equipment has its own characteristic advantages which will allow it to survive competition. Owing to its low costs, the powder process will, in the author's view, prove successful in spraying large surfaces with zinc, especially where the coat is afterwards to be painted. The powder spraying pistol also offers possibilities in connexion with the spraying of brittle metals and alloys of high melting point which cannot be drawn into wire. The molten metal instrument, on the other hand, can produce thick coatings of the lower melting point metals at a reasonable price, especially since the metal can be used in ingot form and neither acetylene nor oxygen is required. The wire pistol will, he believes, hold the field in building up thick deposits on worn articles as well as for producing heat resisting surfaces. Even in the production of zinc coats, the wire pistol offers important advantages in connexion with the spraying of internal surfaces, although the cost is higher than that of the other processes.

Meteor Heights from the Arizona Expedition

A NOTICE by Ernst Öpik of the results of this expedition, which deals in the first report with meteor heights and velocities, has appeared (*Proc. Nat. Acad. Sci.*, **22**, 525; 1936). Out of 22,000 meteors recorded during the expedition, 3,540 were observed simultaneously from two stations separated by twenty-two miles. It was found that meteors meeting the earth were vaporized fifteen miles higher than those overtaking it, the higher kinetic energy being predominant in spite of the much less air-mass encountered. Sporadic meteors provided 80 per cent of the whole material, and only 7 per cent was contributed by the well-known major showers. The sporadic meteors were mostly extra-solar with high hyperbolic velocities, nevertheless their heights at the beginning and ending were nearly the same as those deduced for the solar meteors. The suggestion is made that this fact, which apparently contradicts the previous statement that the fast meteors were vaporized higher, can be explained by a difference in composition of the bodies. Solar-system meteors are mostly stone and sporadic meteors iron, and they would differ considerably in the time and heat required for vaporization. This explanation will scarcely satisfy everyone in spite of the fact that there appears to be some independent evidence of this difference in the composition of the meteors. Some light is thrown on the conditions prevailing in the upper atmosphere. One deduction is that a hydrogen atmosphere cannot exist below a height of about 130 km.

The First International Electrodeposition Conference

IN opening the first International Electrodeposition Conference, which was held at British Industries House, London, on March 3–4, Lord Melchett referred to the rapid advance which has been made in recent years in the science and practice of electroplating and other electrodeposition processes, and paid a tribute to the work of the Electrodepositors' Technical Society in furthering these developments and in organizing this first International Conference.

In the four sessions of the Conference, which were presided over by Mr. A. E. Ollard (president of the E.T.S.), Mr. C. Francis Carter, Mr. D. J. Macnaughtan and Mr. S. Field respectively, practically every aspect of electrodeposition was discussed. Four general papers by M. M. Ballay (France), Mr. E. J. Dobbs (Britain), Mr. G. B. Hogaboom (United States) and Dr. R. Springer (Germany) provided surveys of current practice and tendencies in the authors' respective countries. As would be expected in view of the present wide dissemination of ideas and information through the medium of scientific and technical publications, differences in practice between various countries are mainly those arising from differences in public taste and range of demand, or from differences in availability of certain materials. Thus, preference in Great Britain for cadmium plate with a matte surface has limited the use of baths for the direct production of bright cadmium deposits, which are largely operated abroad. Shortage of certain non-ferrous metals in Germany has led to the development of improved methods for electroplating on aluminium; to the more extensive use of anodized aluminium; to the use of insoluble anodes in nickel-plating baths, the composition of which is maintained by additions of nickel carbonate, or to the production of nickel anodes by electrodeposition from such baths on lead strip; and to the elaboration of methods for producing firmly adherent electrodeposits on articles of non-metallic composition such as bakelite and celluloid, which are so successful that they will undoubtedly retain their importance when normal supplies of metal become available.

Among special features of technique, particular reference was made to the 'copper degreasing process' employed mainly in France. M. A. Chabany (France) showed that this process, which consists of cathodic treatment of the basis metal in an alkaline cyanide solution containing copper, so that degreasing is accompanied by copper deposition, needs slight modification when applied to zinc surfaces. Loss of cyanide from the solution during operation is attributed to its oxidation to cyanate.

In the United States, Germany and Great Britain, rapid advances are being made in the development and utilization of 'automatic plant', in which articles of standard shapes and sizes are carried by means of conveyor chains through a succession of tanks in which preliminary cleaning operations, electrodeposition, and certain finishing processes are carried out, each for predetermined times. One automatic nickel-plating plant in Great Britain is using 12,000 amperes and turns out more than a million articles per week. Dr. J. Kronsbein (Britain) described a new type of automatic plant for nickel deposition in which the work bars are transferred from tank to tank by means of electromagnets, with arrangements for varying the time occupied in the transfer; and a novel chromium-plating plant in which the articles to be plated are held on the periphery of a magnetized double-disk wheel which revolves on a horizontal axis and thus carries the work through the plating solution. In Germany and the United States, electrolytic 'galvanizing' of wire is carried out on a large scale: sixty large plants in Germany consume about 300,000 amperes. Electrotinning of steel strip is practised in Germany, and is in course of commercial development in the United States.

The possibility of electrodepositing nickel and then chromium in a single automatic plant has been difficult to realize owing to the necessity for polishing the nickel undercoat before depositing chromium on it. Much attention has therefore been given to the direct deposition of 'bright nickel', and several types of plating bath for this purpose are now in operation. Dr. Schlötter's solution, which contains aromatic sulphonic acids, and baths with other organic addition agents are widely used, but several speakers stressed the value of the nickel-cobalt type of bath, which is claimed to give deposits equal in physical characteristics to an ordinary nickel deposit and to be the only bright nickel solution which can be completely controlled by chemical analysis. Methods for the production of bright deposits of several other metals are in use, and Dr. B. Egeberg and Mr. N. E. Promisel (United States) described the principles of a method which they are developing for evaluating the relative brightness of electrodeposits.

The introduction of simple and reliable tests for adhesion, porosity, thickness, and corrosion resistance of electrodeposits is making it possible to lay down specifications for plating to meet various conditions of service. Several contributors gave examples of such specifications which have been adopted by certain industries in their respective countries, and some speakers directed attention to the importance of specifying the minimum thickness required on 'significant surfaces' instead of or in addition to the average thickness over the whole article. Examples of the extent to which the thickness of silver plate may vary on various parts of the surface of articles of specified shapes were furnished in the survey of silver-plating practice presented by Mr. F. C. Mesle (United States).

Papers dealing with the development and practice of electrodeposition of particular metals were also furnished by Dr. G. Soderberg (United States) for cadmium from cyanide baths; by Mr. R. H. Atkinson (Britain) and by Messrs. E. C. Davies and A. R. Powell (Britain) for platinum; by Mr. H. W. J. Pope (Britain) for gold; and by Dr. K. Schumpelt (United States) for the platinum metals—especially rhodium. Electrodeposited platinum and palladium are considerably harder than the corresponding rolled metals, and the hardness of electrodeposited platinum and rhodium is exceeded only by electrodeposited chromium. Owing to its exceptional resistance to attack by most chemical reagents and its fine white lustre, rhodium plating is applied not only to jewellery and as a non-tarnishing coating on silver ware, but also with considerable success to reflectors: it is

unaffected by carbon particles sputtered from arc lights.

By means of a specially devised technique, Mr. A. W. Hothersall (Britain) showed that the adhesion of electro-deposits to nickel surfaces may be notably decreased by the presence of an invisible oxide film on the latter, and for securing the highest adhesion he recommended anodic etching of the nickel in sulphuric acid solution, the current being finally reversed for a moment. The special difficulty in securing adhesion of electrodeposits to chromium and its alloys is also due undoubtedly to the presence of an oxide film, and in order to overcome this Mr. G. E. Gardam (Britain) recommended cathodic treatment of the degreased surface in strongly acid nickel sulphate solution at high current density, which causes simultaneous removal of the film and deposition of nickel. It is advantageous to deposit a layer of copper (from the acid bath) on the resulting surface before plating with nickel from the regular nickel bath.

M. P. A. Jacquet (France) has established that whereas on a practically amorphous copper surface, produced by mechanical polishing, electrodeposition of copper begins from randomly distributed nuclei; a surface which has been electrolytically 'smoothed' by his method of anodic treatment in phosphoric acid retains its original crystal grain structure, and this structure is continued when copper is electrodeposited on it from the acid bath. In the initial stages of deposition, the deposit forms preferentially on grains which are favourably orientated with respect to the surface, and the character of its growth is affected by this orientation. Modifications of the phenomena observed when 'aged' baths are used are attributed to the presence of cuprous ions.

The various modifications of the crystal structure of electrodeposits which may arise through inclusion in the deposit of substances added to the bath (addition agents) or of insoluble substances formed in the solution adjacent to the cathode surface, were shown in a remarkable series of photomicrographs presented by M. M. Cymboliste (France). Such inclusions are classified with reference to their character, origin and effect on the structure and properties of the electrodeposit; and the effects of varying the conditions of electrolysis are interpreted in terms of the influence of these conditions on the formation of inclusions. Prof. A. Phillips and Mr. W. R. Meyer (United States) reported results of an investigation of the upper limits of current density at which copper deposited from the acid bath on a copper surface ceased to continue the structure of the basis metal. From the cyanide bath no such continuation of structure was observed even at very low current densities. Even minute traces of lead in the acid copper bath were found to affect the character of the copper deposit, tending to make it dense, bright and somewhat brittle; but notable amounts of zinc in the bath scarcely affected the structure.

Papers by Dr. N. A. Isgarischev (U.S.S.R.) and by Prof. A. Glazunov (Czechoslovakia) and Dr. M. Schlötter (Germany) dealt with the mechanism of deposition of metals from complex salt solutions; and contributions from Prof. L. S. Ornstein in collaboration with B. Baars and P. J. Haringhuizen (Holland) were concerned with a comparison of the behaviour of electrodeposited and evaporated metallic films towards corrosive agencies, which had been investigated by means of a specially devised optical method.

Permanence of Oceanic Basins and Continental Masses*

IN his presidential address to the Geological Society of London in 1870, Huxley brought into correlation with geological science the scheme of zoological provinces which he had proposed to the Zoological Society two years before. He recognized the fact that the distribution of life, as then known, implied "a vast alteration of the physical geography of the globe", but he nevertheless conformed to the orthodox view of the time regarding the persistence of a general uniformity in the positions of the four great oceans from Devonian or perhaps earlier times.

That the oceanic basins and continental masses had, from the earliest geological times, occupied their positions, with little more than marginal changes, was an idea that originated in its geological bearing with J. D. Dana in 1856. Taken in conjunction with the then prevailing notion, developed by W. Hopkins, that the earth was solid to great depths, the doctrine of permanency persisted for many years unchallenged; it is still held by many geologists in an attenuated form.

After the publication of the "Origin of Species" in 1859, showing, in the words of Darwin, that "each species has proceeded from a single birthplace", the distribution of animals and plants became a critical test of the validity of the doctrine of permanency. Edward Forbes had challenged the idea, but Darwin considered that, when he wrote in 1859, we knew very little about the strange accidents by which living beings secured transport over oceanic barriers; and accordingly he, followed by Lyell in 1868, considered that Dana's views could not justifiably be put aside.

W. T. Blandford, however, speaking as president of the Geological Society, twenty years after Huxley, with far more extensive data at his command, demonstrated that the distribution of animals and plants could not be explained without the previous existence of land surfaces across regions now occupied by oceanic deeps. Although Blandford at that time confined himself to arguments based on biogeography, his previous work in India had led him independently to the same conclusion regarding the southern oceans. It was Blandford who discovered in 1856 the glacial beds at the base of the Gondwana system of 'continental' rocks in India. Later work in the southern continents led to similar discoveries, and ultimately established a correlation between India, Australia, Africa and South America.

So long ago as 1879, Blandford pointed out, in the official "Manual of the Geology of India", that the fossil plants and land animals of the Gondwana system in India were related so definitely to those on the southern continents that land connexions must have existed at certain times, if not continuously, between these areas across the positions now occupied by the

* Summary of the Huxley Memorial Lecture delivered by Sir Thomas Holland, K.C.S.I., F.R.S., on May 4.

Indian and South Atlantic Oceans. This was well before Eduard Suess gave the name Gondwanaland to the supposed pre-Tertiary southern continent.

Work by C. Schuchert published in 1932 on the distribution of Tertiary fossils confirmed the conclusions established by Blandford from living forms. Schuchert similarly required land communications over some of the present oceanic areas, but demanded relatively small land bridges, thinking, as he said, that it would be "easier to sink smaller continental-like masses than larger ones".

Another, wholly different, explanation for the distribution of life has been elaborated in the last twenty-seven years, mainly by the late Alfred Wegener, who maintained that an ancient continental mass, which he named Pangæa, existed in the South Atlantic and Antarctic region and broke up during the Mesozoic period; that fragments of it drifted away to form most of South America, South and Central Africa, Madagascar, India and Australasia, taking with them their records of geological activities during Palæozoic times. This theory is thus assumed to account for the glaciation of lands like India which are in the northern tropics, as well as continents which are still south of the equator; it explains, too, the correspondences between the Gondwana rocks of India and those on the southern continents.

Wegener's hypothesis, according to many geologists, is based on insufficient and often discordant data, whilst mathematicians assert that the mechanics involved in these horizontal movements of continental masses are quite impossible.

Following a suggestion made by R. H. Rastall in 1929, it is now urged that discussion of the purely theoretical implications of this hypothesis should await the accumulation of geological data by work on the lines undertaken by A. L. du Toit in comparing Africa and South America. Du Toit has demonstrated the remarkable duplication of geological features between these two areas, from Lower Palæozoic, age by age, to Upper Mesozoic times. He has also noticed that when the formations vary in the usual way laterally, the variation eastward in Africa and westward in South America is generally greater than that between the corresponding formations on the opposed present shores, although these are now separated by the width of the South Atlantic. Du Toit reasonably concludes that the agreements are too frequently concordant to be regarded as fortuitous, and that the only explanation which best fits the facts is the assumption that these two continents were at one time near one another if they were not actually confluent continental masses.

If it be true that these continental masses have moved horizontally in late geological times away from one another, there is no reason why others should not have done so too, in spite of the circumstance that no completely satisfactory explanation of the mechanics involved can be offered at present. Further work on the lines so ably undertaken by du Toit is now more necessary than mathematical criticism with insufficient quantitative data regarding the physical state of the earth's sub-crust under the continents and oceans.

Magnetic and Optical Properties of Crystals

UNDER this title, Prof. K. S. Krishnan of the Indian Association for the Cultivation of Science (Calcutta) delivered three lectures in the Cavendish Laboratory, Cambridge, on April 26, 29 and 30. In the first lecture he dealt with recent studies of the diamagnetic properties of single crystals, particularly aromatic compounds. The method of deriving the principal susceptibilities of aromatic molecules by combining magnetic measurements with crystal structure determination was described and also the way in which molecular orientation may be predicted on the basis of magnetic measurements alone. A summary of Pauling's method of calculating the principal susceptibilities of any aromatic molecule was given. The experimental method for measuring anisotropy in magnetic susceptibility was demonstrated and also the remarkable property of graphite crystals both as they occur naturally and after exposure to potassium vapour or to oxidizing agents.

The second lecture was devoted to the recent work on paramagnetic crystals. Prof. Krishnan's study of the magnetic properties of $CuSO_4.5H_2O$ has confirmed the predictions concerning the ionic environment made on the basis of theoretical studies and has afforded a remarkable correlation of the magnetic properties with the details of the crystal structure. The influence of the co-ordination on the magnetic anisotropy of the cobalt ion is shown by the comparison of the susceptibilities of $CoSO_4.K_2SO_4.6H_2O$ with those of $Cs_3[CoCl_4]Cl$. The former salt, in which the paramagnetic ion is six co-ordinated, is of great magnetic anisotropy, while the second salt, in which the cobalt is four co-ordinated, has a very small magnetic anisotropy. This result also confirms predictions made on the basis of other physical data. The study of very small magnetic anisotropy of certain manganese salts has made possible the prediction of the entropy of these substances at temperatures near to absolute zero—an important quantity in view of the use to which these salts are put in obtaining very low temperatures by adiabatic magnetization.

The third lecture dealt with the absorption and fluorescent spectra of certain aromatic compounds. Anthracene, naphthacene and chrysene have well-marked pleochroic characters. The absorption spectrum in the ultra-violet region has strong bands for rays vibrating in that principal plane which is most nearly parallel to the plane of the molecules, and weak bands for rays vibrating in that principal plane which is most nearly perpendicular to the planes of the molecules. Naphthacene is a common impurity in anthracene and chrysene, and even when only a few parts per million of the impurity are present a strong fluorescent spectrum is observed. This has the remarkable property of being strongly excited in one plane only, no matter what the relative orientation of the plane of vibration of the incident light. This plane, corresponding to the vibration of the strongly excited spectrum, is coincident with that principal plane which is most nearly parallel to the molecular planes. Some experiments on the photo-dissociation of potassium nitrate in ultra-violet light were also described.

University Events

CAMBRIDGE.—The eighth course of Scott Lectures are being given by Prof. W. J. de Haas, of the Kamerlingh Onnes Laboratory, Leyden, in the Cavendish Laboratory at 4.30 p.m. on May 3, 5 and 7. The subject of the course is "Low Temperature Research".

It is recommended that two additional University demonstratorships be established in the Department of Anatomy from October 1.

Dr. H. H. Thomas is proposed as the representative of the University at the International Congress of the History of Science to be held in Prague on September 22–27.

LIVERPOOL.—Dr. Hugh Gordon, lecturer in botany, has been appointed to a lectureship in botany, University of Tasmania, as from June 30.

MANCHESTER.—The completion of the New Arts Library, which will be formally opened by Sir Walter H. Moberly on June 2, releases the whole of the Christie Library for the housing of scientific books.

The University has launched an appeal for £300,000 for development and a further annual income of £10,000. Among the proposed extensions are a new dental school and hospital, presented by Mr. Samuel Turner of Rochdale, and a new laboratory for the school of physico-chemical research directed by Prof. M. Polanyi, which at present is most inadequately housed.

The Rockefeller Foundation has made a grant of £5,000, to be spread over four years, in aid of the biochemical research work being carried out under the direction of Prof. I. M. Heilbron.

Mr. R. W. James, reader in experimental physics, has resigned his post on appointment to the chair of physics in the University of Capetown. Dr. D. Sheehan, lecturer in neuro-anatomy, has resigned on his appointment to the chair of anatomy in the College of Medicine, University of New York.

Among the appointments announced this year are: Dr. Samuel Tolansky to be lecturer in physics; Mr. W. S. Walker and Mr. W. G. Wainwright, to be demonstrators in chemical technology; and Mr. H. B. May, to be assistant lecturer in bacteriology.

OXFORD.—G. R. Girdlestone, New College, has been appointed Nuffield professor of orthopædic surgery while holding the post of clinical director of the Wingfield-Morris Orthopædic Hospital.

Prof. J. A. Gunn, Balliol College, has been appointed to become Nuffield professor of therapeutics, while holding the directorship of the Nuffield Institute for Medical Research, on his ceasing to be professor of pharmacology.

Dr. J. C. Moir has been appointed Nuffield professor of obstetrics and gynæcology as from October 1 next. This professorship carries with it a fellowship at Oriel College.

C. G. T. Morison, Christ Church, has been re-elected University reader in soil science for seven years from October 1 next.

The following have been elected or re-elected to University lectureships in their subjects, for five or three years, as from October 1 next: J. H. C. Whitehead (mathematics), R. L. Hall (economic science), Dr. D. A. Jackson (spectroscopy) and G. D. Amery (history and economics of agriculture).

Science News a Century Ago

The Royal Geographical Society

AT a meeting of the Royal Geographical Society held on May 8, 1837, William Richard Hamilton (1777–1859) the president-elect being in the chair, the Royal Premium for 1836 was presented to Captain R. FitzRoy for his work done while in command of H.M.S. *Beagle*. Addressing FitzRoy, Hamilton said, "one of the first of your discoveries laid open to the commercial and scientific world the harbour of Bahia Blanco, the only one upon the eastern coast of South America, in which a considerable number of line-of-battleships can be at anchor. On the same coast, in the face of numerous difficulties, you explored for the first time, the deep and rapid river of Santa Cruz. You surveyed, at your sole expense, the Falkland Islands. On the western side of South America, you have for the first time laid down the archipelago of islands lying to the south of Chiloe, called Chonos, in lat. 45° S. When your term of service was on the point of expiring, and you were about to proceed on your way home, your zeal for science prompted you to engage a vessel, at your own expense, for completing the survey of the coast of Peru as far as Guayaquil. In circumnavigating the globe, you have for the first time, carried a complete chronometric chain of measurement, by twenty-two chronometers—many of them your own property—from east to west around the globe. You have also enabled Mr. Darwin, the well-known naturalist, to add greatly to our knowledge of the history of those regions."

Darwin was present at the meeting, and in his reply to the chairman's speech, FitzRoy remarked: "Mr. Charles Darwin embarked in the *Beagle* in 1831 as a zealous volunteer in the cause of science. At his own expense, he passed five years aboard the *Beagle*, on travelling in those countries she visited. When it is considered that Mr. Darwin never ceased to be a martyr to sea-sickness, his perseverance may be appreciated. Of the value of his labours, I understand you have been made partially aware; and I believe I am quite correct in saying, that the best judges estimate those labours very highly."

Bulwer's Petrel in Britain

IT was on May 8, 1837, that the first specimen of Bulwer's petrel (*Procellaria bulweri*, Jardine) in the British Isles was picked up dead, on the banks of the River Ure near Tanfield, Yorkshire. Gould describes the record in Part 22 of his "Birds of Europe" and Yarrell on p. 664 of vol. 3 of his "History of British Birds". The specimen is preserved in the York Museum. An inhabitant of the temperate North Pacific and North Atlantic, plentiful off Madeira, the Canaries, Salvages, Sandwich Isles and Japanese isles, this petrel is sooty black all over, with a pointed tail, and reaches 10½ inches in length. There are traces of grey on the throat and head, and brown margins to some of the wing feathers, the irides are deep brown, bill black, legs black and grey, male and female being similarly coloured. The call of the bird, heard at its nesting haunts at night, is a pleasant one, consisting of four high notes and a lower, prolonged one, in marked contrast to the harsh calls of the great shearwaters which also nest on their islands.

The Kingston Valves for Steamships

AT a meeting of the Society of Arts on May 10, 1837, a Gold Isis Medal was awarded to Mr. Ross for an improvement in the adjustment of the object glasses of compound microscopes of high magnifying powers, and the large silver medal was awarded to Mr. Kingston of Woolwich Dockyard, for a safety blow-off pipe for the boilers of marine steam-engines.

When steam was applied to ships, it was necessary to cut holes through the skin of the ship for admitting water to the condensers and for the purpose of blowing-down the boilers. The early plan was to fit a cast-iron pipe through the wooden planking and place a valve or cock on the inboard side. If this valve or cock became defective, it was difficult to repair with the ship afloat. John Kingston, a foreman at Woolwich, therefore devised a form of conical valve with a long spindle of very simple construction, having the great advantage that the pressure of water outside the ship tended to keep it on its seating.

Sir David Brewster on the Absorption of Light

ON May 11 and 25, 1837, a paper by Sir David Brewster was read to the Royal Society entitled "On the Connexion between the Phenomena of the Absorption of Light and the Colours of Thin-Plates". An abstract of the paper said: "The phenomena of the absorption of light by coloured media have been regarded by modern philosophers as inexplicable on the theory of the colours of thin plates, and therefore irreconcilable with the Newtonian hypothesis, that the colours of natural bodies are dependent on the same causes as the colour of thin plates. The discovery by Mr. Horner of a peculiar nacreous substance possessing remarkable optical properties, furnished him [Sir David] with the means of instituting a more accurate comparison between these two classes of phenomena. From the phenomena of thin plates, of polarized tints and of absorption, the existence of a new property of light is deduced, in virtue of which the reflecting force selects out of differently coloured rays of the same refrangibility, rays of a particular colour, allowing the others to pass into the transmitted ray, a principle not provided for in either of the theories of light to which the phenomena of absorption are ultimately referable."

J. A. F. Ozanam (1773–1837)

JEAN ANTOINE FRANÇOIS OZANAM, the eminent medical historian and epidemiologist, who died on May 12, 1837, of tetanus following an accident, was born on July 9, 1773, at Chalamont near Bourg-en-Bresse, the son of a notary. After studying philosophy at Lyons in 1790–91, he passed six years in the French army and took part in the campaign in Italy, where he was present at the most important battles. In 1797 he obtained with some difficulty his discharge from the army, and after an unsuccessful venture in business, took up medicine on the suggestion and encouragement of the celebrated surgeon Marc Antoine Petit. In December 1810, at the comparatively late age of thirty-seven years, he qualified at Milan, where he devoted his attention to the sick and wounded French and Italian soldiers taken prisoners by the Austrians. In 1816 he left Milan for Lyons.

Ozanam's chief work was a history of epidemic, contagious and epizootic diseases in Europe from the earliest times and especially the fourteenth century down to his own day. The first edition was published at Lyons in five volumes in 1817–23, and the second in four volumes at Paris in 1835.

Societies and Academies

London

Royal Society, April 29.

H. H. POOLE and W. R. G. ATKINS: The penetration into the sea of light of various wave-lengths measured by emission or rectifier photo-electric cells. Further measurements of submarine daylight, using emission cells, gave for the vertical extinction coefficient 20 miles from land, $\mu_v = 0{\cdot}11$ for blue and 0·19 for near ultra-violet. The light travelling upwards was about two per cent of that going downwards. Measurements were made with Weston selenium rectifier cells, corrected for the curvature of the illumination current relation, using a modified form of the Campbell Freeth zero-resistance circuit. Infra-red is eliminated in less than 2 m. Red is reduced to 1 per cent at 10 m. The deeper water, 35–50 m., was clearer than that near the surface in the English Channel 10 miles from land. Near the shore the difference between red and green is lessened, but blue is relatively more heavily absorbed and differs more from green.

A. KEYS, B. H. C. MATTHEWS, W. H. FORBES, R. A. MCFARLAND and D. B. DILL: Individual variations in ability to acclimatize to high altitudes. The International High Altitude Expedition made observations at sea-level, 9,000, 12,000, 16,000 and 20,000 ft., of the physiological constitution of ten normal subjects. The capability of acclimatization of the members of the party was graded by a questionnaire as to the deviation in physical and mental performance from their sea-level values, of all members of the party. By this classification, the members of the party were arranged in order at each altitude. A number of physiological properties were observed at sea-level and at each station. No one of these yielded a good correlation with the classification referred to above, but the whole series taken together with suitable empirical coefficients yield a good correlation with the acclimatization classification.

G. A. MILLIKAN: Experiments on muscle hæmoglobin *in vivo*; the instantaneous measurement of muscle metabolism. A photo-electric arrangement is described by means of which the degree of oxygen saturation of the naturally occurring intracellular muscle hæmoglobin in a cat's soleus muscle may be measured instantaneously and recorded continuously. This instrument provides both a chemically specific and time-sensitive method of measuring muscle metabolism, and neither the nerve supply nor the blood supply need be disturbed. Muscle hæmoglobin acts as a short-time oxygen store, helping to tide the muscle over from one contraction to the next. When the muscle contracts, its oxygen demand rises to its maximum value in less than 0·2 sec. from the onset of contraction. There is good general agreement between both resting and active oxygen consumption as measured photo-electrically in the muscle fibre, and in metabolic experiments of the usual kind made on repetitively contracting mammalian skeletal muscle. Resting value: 0·07 mm.^{3} O_2 per gm. per sec. During tetanic contraction: 1·0 - 3·5 mm.^{3} O_2 per gm. per sec. Blood flow appears not to be greatly affected in the first few seconds of tetanic contraction. These results are in agreement with those of Rein and Kramer, and differ from those of Anrep.

Paris

Academy of Sciences (*C.R.*, **204**, 1017–1048, March 31).

G. BERTRAND : Obituary notice of Amé Pictet.

GABRIEL BERTRAND and LAZARE SILBERSTEIN : New determinations of the amount of boron in plants cultivated on the same soil. The results confirm those previously published. The proportion of boron in the Leguminaceæ is higher than in the Gramineæ.

D. MANGERON : The periodic solutions of a certain class of partial differential equations of higher order.

JEAN DELSARTE : Certain series connected with Bessel's functions.

MME. CHRISTIANE PAUC : The geometrical study of a group of infinitesimal transformations.

GODOFREDO GARCIA and ALFRED ROSENBLATT : Regularization of the plane problem of three bodies.

JEAN CAPELLE : The generalization of the method of roulettes and the possible applications to the construction of skew gear.

SVETOPOLK PIVKO : The influence of the finite number of blades of supporting screws.

LÉVY HERMAN : The absorption of oxygen at the limit of the solar spectrum. Experiments leading to the conclusion that the absorption due to oxygen has no practical effect in limiting the solar spectrum.

JEAN PERREU : The solubility equation of hydrates.

MARC DE HEMPTINNE, JEAN SAVARD and PAUL CAPRON : The energy of dissociation of the molecule of carbon monoxide.

FÉLIX FRANÇOIS and MLLE. MARIE LOUISE DELWAULLE : The oxidation of nickel hydrate by sodium persulphate in alkaline solution.

RENÉ MORICARD and RENÉ BIZE : The development of the penis produced in the child by the injection of testosterone acetate.

GEORGES BLANC and M. BALTAZARD : The long preservation in the dry state of the virus of murin typhus in the excrement of infected fleas.

Amsterdam

Royal Academy (*Proc.*, **40**, No. 3, March 1937).

F. K. T. VAN ITERSON : Separation of substances by flotation (2). Scientific principles underlying the practical application of the method.

W. H. KEESOM and A. BIJL : Determination of the vapour pressures of liquid nitrogen below one atmosphere and of solid β nitrogen. The boiling point of nitrogen is $77{\cdot}35_7°$ K. and the triple point $63{\cdot}15_0°$ K.

J. A. SCHOUTEN : Differential geometry of the groups of contact transformations (2).

F. M. JAEGER and L. BIJKERK : Investigations on the complex salts of the racemic and optically active cyclohexanediamines with trivalent cobalt and rhodium (3). Tri-cyclohexanediamine salts of trivalent cobalt. Crystallographic data and specific rotations.

E. MATHIAS, C. A. CROMMELIN and J. J. MEIHUIZEN : Density curve and the rectilinear diameter of krypton. The critical temperature is 209·39° K. and the critical density 0·9085.

C. S. MEYER : Products of Whittaker functions (2).

J. POPKEN : An arithmetical property of certain integral functions (2).

C. VISSER : Note on linear operators.

W. BEIJERINCK : Periodicity of flower formation in *Calluna vulgaris* (L.) Hull.

E. A. HANSON : Notes on some physical properties of chlorophyll films. Spreading of monomolecular layers of chlorophyll on water.

H. BAGGELAAR : Tertiary rocks from the Misool Archipelago (Dutch East Indies).

P. DE WIJKERSLOOTH : The metalliferous region of Moresnet-Bleyberg-Stolberg, Dutch Limburg.

H. G. BUNGENBERG DE JONG and G. G. P. SAUBERT : (1) Phosphatide auto-complex coacervates as ionic systems, and their relation to the protoplasmic membrane (ii). (2) Models for the stimulation of the organ of smell. Application of the results of the preceding communication.

S. BERGGREN : A direct connexion from the cortex of the cerebellum to the nucleus of Deiters.

Brussels

Royal Academy (*Bull. Classe Sci.*, 22, No. 12, 1936).

L. GODEAUX : A canonical surface belonging to the variety of Segre representing pairs of points of two planes.

F. H. VAN DEN DUNGEN : Remarks on the vocabularies of acoustics.

M. LERICHE : The Ypresian in the country lying between the Sambre and the Meuse.

P. V. PAQUET : The integral form H_n in the invariant theory of the calculus of variations.

P. BURNIAT : Surfaces of genera one.

S. DE BACKER : Viscous fluids and waves which can be propagated. Evolution of a monatomic and polyatomic gas.

P. SWINGS and M. DÉSIRANT : Remarks on the formation of the nebulous emissive layers in *Be* stars.

P. BOURGEOIS and J. F. COX : Origin of comets.

R. DUGAS : The axiom of the initial conditions and 'legality' in quantum mechanics.

P. VAN RYSSELBERGHE : Application of affinity to coupled reactions.

L. MARTON : Electronic microscopy of biological objects (4).

J. P. BOSQUET : The definition of energetic quantities in acoustics.

M. FLORKIN : The rate of true plasmatic glycæmia in the decapod crustaceans.

T. DE DONDER and MISS Y. DUPONT : New theory of the dynamics of continuous systems (3).

W. H. BENEDICTUS : The generalization of the direct theorem of Jacobi.

Moscow

Academy of Sciences (*C.R.*, **14**, No. 2, 1937).

A. D. ALEXANDROV : The problem of the existence of a convex body, in which the sum of radii of the main curvature is a given positive function satisfying the conditions of *Geschlossenheit*.

V. G. LIVENKO : Attempt at a general definition of the integral.

W. ROMBERG : A method for simultaneous approximate determination of specific value and specific function.

V. I. SMIRNOV : Solution of the problems of limits in the elasticity theory in the case of a circle and a sphere.

F. DUŠINSKIJ : The 'concentration extinction' of the fluorescence of dye solutions.

V. ČERNIAJEV and M. VUKS : Spectrum of the twilight sky.

B. A. PETRUŠEVSKIJ : Discovery of the Palæocene fauna in Tadzhikistan.

D. TRETIAKOV : Microreflectors in the skin of fishes.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Monday, May 10

UNIVERSITY OF CAMBRIDGE, at 5.—Prof. A. V. Hill, F.R.S.: "The Heat-Production of Muscle and Nerve: A Critical Survey" (Linacre Lecture).

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Dr. C. B. Warren: "Medical and Physiological Aspects of the Mount Everest Expeditions".

UNIVERSITY OF LONDON ANIMAL WELFARE SOCIETY, at 5.30—(at University College, London).—Dr. N. K. Adam, F.R.S.: "The Destruction of Sea-Birds by Oil Waste".*

Tuesday, May 11

INSTITUTION OF CIVIL ENGINEERS, at 6.—Annual General Meeting.

Thursday, May 13

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (ROYAL SCHOOL OF MINES), at 5.30.—J. Henderson Smith: "Virus Diseases of Plants" (succeeding lectures on May 20 and 27).*

Friday, May 14

ROYAL ASTRONOMICAL SOCIETY, at 5.—Prof. N. E. Nörlund: "Astronomical Longitude and Azimuth Determinations" (George Darwin Lecture).

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

DEMONSTRATOR IN CHEMISTRY in the Woolwich Polytechnic, London, S.E.18—The Secretary (May 13).

ASSISTANT (grade III) at the Aeroplane and Armament Experimental Establishment, Martlesham Heath—The Secretary, Air Ministry, S.2.D (Room 405), Adastral House, Kingsway, W.C.2 (May 14).

ASSISTANT (grade III) in the External Ballistics Department of the Ordnance Committee, Woolwich—The Secretary, Ordnance Committee, Royal Arsenal, Woolwich, S.E.18 (May 14).

LECTURER IN GEOGRAPHY in the Darlington Training College—The Principal (May 14).

LECTURER IN GEOGRAPHY in Bingley Training College—The Education Officer, County Hall, Wakefield, Yorks (May 15).

RESEARCH PHYSICIST for the Printing and Allied Trades Research Association—The Director of Research, 10 Robin Hood Court, London, E.C.4 (May 17).

RESEARCH OFFICER at the Ministry's Veterinary Laboratory, New Haw, Weybridge—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1 (May 17).

ASSISTANT in the Department of Mathematics in University College, Dundee—The Secretary (May 28).

ASSISTANT LECTURER IN BOTANY in the University of Birmingham—The Secretary (May 29).

LECTURER IN GEOGRAPHY in the College of St. Mark and St. John, Chelsea, S.W.10—The Principal.

LECTURER IN MECHANICAL ENGINEERING in the County Technical College, Worksop—The Principal.

Official Publications Received

Great Britain and Ireland

Economy Advisory Council: Committee on Locust Control. The Locust Outbreak in Africa and Western Asia in 1935. Survey prepared by Dr. B. P. Uvarov and Miss W. Milnthorpe. Pp. 63. (London: H.M. Stationery Office.) 3*s.* net. [94

Report of the Marlborough College Natural History Society for the Year ending Christmas, 1936. (No. 85.) Pp. 72+2 plates. (Marlborough: Marlborough College.) 5*s.*; to Members, 3*s.* [94

Proceedings of the Royal Society of Edinburgh. Vol. 57, Part 2, No. 7: On the Geometry of Dirac's Equations and their Expression in Tensor Form. By Prof. H. S. Ruse. Pp. 97–127. (Edinburgh: Robert Grant and Son, Ltd.; London: Williams and Norgate, Ltd.) 2*s.* 6*d.* [124

International Society for Microbiology. Second International Congress for Microbiology, London, 25 July–1 August 1936. Report of Proceedings. Edited for the Executive Committee by R. St. John-Brooks. Pp. xiii–580. (London: Lister Institute.) [154

Transactions of the Royal Society of Edinburgh. Vol. 59, Part 1, No. 2: On the Feeding Mechanism of *Apseudes talpa*, and the Evolution of the Peracaridan Feeding Mechanisms. By Ralph Dennell. Pp. 57–78. (Edinburgh: Robert Grant and Son, Ltd.; London: Williams and Norgate, Ltd.) 2*s.* 9*d.* [154

World Power Conference. Annual Report, 1936. Pp. 21. (London: World Power Conference.) [154

International Tin Research and Development Council. Information Circular No. 2: The Wholesomeness of Canned Foods. By Dr. H. B. Cronshaw. Pp. 19+4 plates. (London: International Tin Research and Development Council.) Free. [154

Other Countries

Indian Lac Research Institute. Annual Report for the Year 1st April 1935 to 31st March 1936. Pp. 30. Bulletin No. 23: Some Simple Methods of Reducing the Damage done by Insect Enemies to the Lac Crops. By P. M. Glover. Pp. 4. 1 anna. Bulletin No. 25: Use of the Quinhydrone and Antimony Electrodes for Potentiometric Titrations of Resin Solution. By N. Narasimha Murty and Harold Weinberger, with Wm. Howlett Gardner. Pp. 4+4 plates. 3 annas. (Namkum: Indian Lac Research Institute.) [134

U.S. Department of the Interior: Office of Education. Supplement to Bulletin, 1934, No. 17: Accredited Secondary Schools in the United States. Pp. 29. (Washington, D.C.: Government Printing Office.) 10 cents. [144

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 88, 1936. Pp. iii+635+16 plates. (Philadelphia: Academy of Natural Sciences.) 6.25 dollars. [144

Ministry of Public Health, Egypt: Research Institute and the Endemic Diseases Hospital. Fourth Annual Report, 1934. Pp. x+106+26 plates. (Cairo: Government Press.) [144

Contributions from the Physical Laboratories of Harvard University for the Year 1935. Series 2, Vol. 2. 57 papers. (Cambridge, Mass.: Harvard University.) [144

Smithsonian Miscellaneous Collections. Vol. 95, No. 22: Third Contribution to Nomenclature of Cambrian Trilobites. By Charles Elmer Resser. Pp. 29. (Washington, D.C.: Smithsonian Institution.) [144

Report of the First Scientific Expedition to Manchoukuo under the Leadership of Shigeyasu Tokunaga. Section 3: Geography of Jehol. By Fumio Tada. Pp. iv+132+29 plates. Section 5, Division 2, Part 2: Amphibia and Reptilia of Jehol. By Yachirô Okada. Pp. iv+76+3+17 plates. (Tokyo: Waseda University.) [164

Meddelanden från Statens Skogsförsöksanstalt (Reports of the Swedish Institute of Experimental Forestry.) Häfte 29: 1936–37. Pp. iv+696. (Experimentalfältet: Statens Skogsförsöksanstalt.) 12.00 kr. [164

Sveriges Geologiska Undersökning. Ser. C, No. 389: Skelleftefältet med angränsande delar av Västerbottens och Norrbottens län; en översikt av berggrund och malmförekomster. Av Alvar Högbom. Pp. 122+2 plates. 6.00 kr. Ser. C, No. 403: Upper Didymograptus Shale in Scania. By Gunnar Ekström. Pp. 53+11 plates. 2.50 kr. Ser. C, No. 405: Sjösediment från mellersta Norrland; Indalsälvens, Ångermanälvens och Umeälvens vattenområden. Av G. Lundquist. Pp. 152. 2.50 kr. (Stockholm: P. A. Norstedt and Söner.) [164

Survey of India. General Report 1936, from 1st October 1935 to 30th September 1936. Pp. xi+80+15 plates. (Calcutta: Survey of India.) 1.8 rupees: 2*s.* 6*d.* [194

Thalès: Recueil annuel des travaux de l'Institut d'Histoire des Sciences et des Techniques de l'Université de Paris. Deuxième année, 1935. Pp. 292. (Paris: Félix Alcan.) 40 francs. [194

Académie des Sciences de l'URSS. Travaux du Congrès jubilaire Mendeléev. Vol. 2. Pp. vi+471+10 plates. (Moscow and Leningrad: Académie des Sciences de l'URSS.) 17 roubles. [194

Gouvernement Egyptien: Ministère de la Justice. Recueil des lois, décrets et rescrits royaux. Année 1936, Premier trimestre. Pp. vi+96. (Le Caire: Imp. Nationale.) 7 P.T. [194

Journal of the Faculty of Agriculture, Hokkaido Imperial University. Vol. 38, Part 3: Erysiphaceæ of Japan. By Yasu Homma. Pp. 183–461+plates 4–11. Vol. 39, Part 4: The Influence of the Temperature of the Culture Water on the Water Absorption by the Root and on the Stomatal Aperture. By Takashi Tagawa. Pp. 271–296. (Tokyo: Maruzen Co., Ltd.) [194

Field Museum of Natural History. Department of Botany Leaflet No. 20: House Plants. By Robert Van Tress. Pp. 36. (Chicago: Field Museum of Natural History.) 35 cents. [194

Commonwealth Bureau of Census and Statistics, Canberra. Official Year Book of the Commonwealth of Australia. No. 29, 1936. Prepared by Dr. Roland Wilson. Pp. xxxii+1015. (Canberra: Commonwealth Government Printer.) 5*s.* [194

Catalogues, etc.

Selected List of Publishers' Remainders: being New Books offered at Greatly Reduced Prices. (Catalogue No. 611.) Pp. 20. Modern Private Presses and Limited Editions. (Catalogue No. 612.) Pp. 62. (London: Francis Edwards, Ltd.)

Dermatologie, Syphilis, Urologie: Zeitschriften, Sammelwerke, Bücher, Dissertationensammlungen, Handapparate, hierin u.a. die Bibliothek des Sanitätsrats Dr. E. R. W. Frank. (Antiquariatskatalog Nr. 713.) Pp. 40. (Leipzig: Gustav Fock G.m.b.H.)

The Newton Projection Microscope. Pp. 12. The "Ampro" 16 mm. Motion Picture Equipment. Pp. 8. (London: Newton and Co.)

Wild-Barfield Electric Furnaces for hardening High Speed Steel Tools. Pp. 12. (London: Wild-Barfield Electric Furnaces, Ltd.)

'Tabloid' Guide to Photography. Pp. 16. (London: Burroughs Wellcome and Co.)