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University Staffs and Salaries.

WHAT reforms in the present organisation of the universities of Great Britain, other than Oxford and Cambridge, may be deemed necessary for the continuance of their professed functions ? So long ago as September 1924, in the course of an article on university staffs and university finance, we suggested that drastic changes were inevitable and probably imminent, however unprepared for them the universities might be. The publication of the Returns of the University Grants Committee for last year [1] encourages us to resume this urgent topic. The Commissioners' survey " does not suggest that there has been any material change in the general financial position of the University Institutions concerned ". By a process of logic which must be somewhat unconventional, the Commissioners infer from this statement that " Steady if unsensational progress continues to be made ". Nothing stands still : no disaster has attended the affairs of the universities, so they must be progressing.

The Commissioners have, of course, a very delicate and difficult task before them. They represent a degree of official enlightenment rare in affairs of State. The old order is still very much the old order in the universities. The State's contribution last year represented very little short of three-quarters of the salaries paid. The policy of the Grants Committee is well known. It is to make an end, if possible, of the prevailing gross under-payment of staffs. The salary bill is by far the largest presented to the universities—more than half the total expenditure, which for the first time exceeds £5,000,000. The Grants Committee allocates £1,523,772. The total parliamentary grants reach £1,841,005. The first of these figures represents actually an excess over the million and a half promised. The commitment was formerly only a million, and in agreeing to increase it the Committee expressed the opinion that the greater part of the extra amount should be devoted to raising salaries. This has not been done. Some of the universities claim that it has been done ; but the figures contradict them. The sum of £90,000, under the heading ' Salaries and Superannuation ', by which university expenditure for last year exceeded that in the previous year, covers both increased salaries and the cost of new posts. Since new posts number eighty-four, the sum devoted to correcting total inadequacy of remuneration could not have

[1] University Grants Committee: Returns from Universities and University Colleges in receipt of Treasury Grant, 1927–28. Pp. 24. (London: H.M. Stationery Office, 1929.) 3*s*. net.

been enough for the needs of a single one of the larger institutions.

We are where we were, and the optimism which leads the Commissioners to interpret some movements as necessarily progressive appears scarcely to be justified. Had there been any real deference to the wishes of the Committee, it is evident that it would be revealed in an alteration in the proportion which salaries bear to total expenditure. An approximation which takes us back to 1922–23 can be gained from the whole maintenance table in the Return which excludes Oxford and Cambridge: 65·3 per cent in 1922–23, 65·3 per cent in 1926–27, and 65·9 per cent last year. Another table provides the actual figures for the past two years for salaries and superannuation alone: 50·03 per cent in 1926–27 and 50·4 per cent last year.

From under-payment of university staffs a whole train of evils proceeds. While a sufficient number of eminent representatives of an earlier social and intellectual environment remain to give an appearance of dignity to academic pursuits, there is and can be no assurance for the future so long as the standard of remuneration is one far exceeded by the earnings of many shop assistants, let alone professional men and those engaged in the vague if profitable service of the community 'business'; so long as every 'interest', professional, commercial, or industrial, can attract the livelier and more competent from concern with fundamentals to concern with applications; so long as modern educational demands, however legitimate, are permitted to prevent the performance of the avowed intentions of founders and patrons.

In every human activity much depends upon the actual human beings engaged in its maintenance; but it is doubtful whether this dependence upon the quality and devotion and performance of individuals is so absolute anywhere else as in the universities. Their fellow-citizens, even those of them who have personal acquaintance with a university, still retain a sort of inertia of reverence for it and for its sister institutions, as the fount and origin of knowledge. The creative spirit in the arts and humane letters may and does rise to greater altitudes elsewhere; the same spirit in discovery, the fundamental natural law-giving, whence all other discovery and invention proceed, can in modern conditions thrive nowhere else. Here alone is the living knowledge, undiminished by secondary understanding and uncontaminated by the ageing falsity of books. Shelley's question " as to how far a thirst for a happier condition of moral and political society survives among the enlightened and refined, the tempests which have shaken the age in which we live " is answered in our own time, if the recompense of these excellencies is only penury and social excommunication.

To advance knowledge and to extend science strictly interpreted—interpreted, that is to say, as W. K. Clifford interpreted scientific *thought* as distinct from the slightly humbler use of other people's scientific thoughts—is a work for genius. Those who possess it are a minority of academic workers, as they are a minority in the community as a whole. They will always be attracted to university work irrespective of the conditions. But that does not absolve the community from its responsibility. If the flame of intellectual conquest burns so consumingly in such men that they will sacrifice every human and humane obligation for its satisfaction, the social conscience is surely guilty if, while it is aware of the sublime benefits which are bestowed, it neglects to intervene for the protection of needy dependents. If it seems, then, an act of folly or of genius to accept the present terms of most of the universities in Britain, must we conclude that the majority who do accept these terms cannot be of the stuff which gives body to the intellectual resources of the country? The time must come when that will be true. Those who possess what is after all a marketable talent can be retained in the service of the universities only at a just price.

The earnest local patriotism and idealism which brought the newer universities into being did not in the first place correctly envisage the human and financial obligations involved, and are now inadequate to rectify the evils which have ensued. State aid is directed particularly to reform; but reform is refused. Why? The scarcity of relevant facts upon which an answer to this question might be based is one of the reasons which render the appointment of a commission with full powers so urgently necessary. There is no common recognition of the claims of disinterested inquiry. The politician in all his forms, parochial to imperial, promises wider and wider educational advantages; scholarships increase; but the real philanthropist is the academic worker. The rich donor supplies only the bricks and mortar; it is the teacher and research worker who supply the human material at their own cost. For true education or for self-advancement the community must be supplied with a superabundance of facilities, and the academic worker must pay the cost. Organisation would of course soon bring the administrative mind to its senses; but organisation is prevented by cross-currents of sectional interest, by fear, by pride, and not least by ignorance. One faculty does not know what another does. In consequence, the presentation of the just claims of one against another is sometimes embittered and the sources of defeat may be disguised and concealed.

Some incredulity may be occasioned by the statement that the universities have recently made an official representation for the purpose, not of bettering the condition of staffs, but of securing the withdrawal of existing forces which might be expected to achieve that end. Resistance to trade union action is intelligible, and these facts are not put forward without some sympathy with that view. Nevertheless, they indicate the danger underlying sectional and particularly professional representation of the university opinion. One of the newer universities recently defended itself against a public charge by stating that the universities were powerless in the matter, having merely to obey the General Medical Council. Sixty-six per cent of the Council are elected by the universities and colleges. Powerlessness is, therefore, not apparent. Too often faculties act for universities, and in medicine the faculties are virtually the practising profession.

At some time between the summer of 1926 and the end of 1927 the 'governing bodies of the universities' asked for the withdrawal of a modest scale of remuneration for non-professorial university workers which the British Medical Association had proposed to enforce. In consequence, a conference was held on Feb. 10, 1928, between representatives of the Association and representatives of the medical schools, mostly deans. These representatives created the impression that non-professorial medical workers had many privileges and were at all events merely using the universities as stepping-stones to lucrative practice. A *non possumus* resolution was passed. Last summer not this resolution but another exempting temporary workers, and temporary workers only, from the operation of the scale was passed by the Representative Body of the Association. An amendment by the Hendon division, which insisted that in no case could anatomists and physiologists be regarded as temporary workers, was accepted rather dubiously by the chairman, making this meaning clearer. Very few weeks had passed, however, before the *British Medical Journal* contained advertisements for anatomists and physiologists at salaries £200 below the scale. Inquiry elicited the information that the appointments were 'temporary', although one man (at Sheffield) was to be equipped in every imaginable non-clinical direction and able to take the place of the professor in his absence. The medical profession fears—quite unnecessarily—that the present wasteful and absurd system of artificially favoured seniority will be jeopardised if young and brilliant men are made independent of patronage. Other faculties fear preferential treatment which, admittedly, would be disastrous to the university idea. But the example given is but one of the pernicious results of professional patronage and is worthy of the consideration of members of all faculties.

Naturally, the Returns refer to the "comparative neglect of the Biological Sciences other than Medicine". May we suggest that one of the matters considered by the Joint Committee which has been appointed "to examine the practical steps which should be taken to secure the development of the teaching of Biology by co-operation between the Universities and the secondary schools" would very appropriately be the desirability of remunerating the teachers at least as well as the taught? At one university, where a scale has been sanctioned and re-sanctioned, it is impossible under the scale for any non-professorial teacher to attain to a salary of £500 a year in less than thirteen years. In some cases the men concerned could not be employed elsewhere at a salary below £600 for the first of these thirteen years.

Sufficient has been said to show that inquiry, and inquiry alone, can now disentangle the multitude of interests involved. Four years ago we said: "It is absurd to pretend that under such conditions their normal duties can be efficiently conducted, and an inquiry into the whole question of payment and the evils that are arising from continued under-payment is undoubtedly urgent before the rot has time to inflict permanent harm on university teaching." The rot advances. Time which should properly be spent in research or recreation is used to supplement meagre and insufficient incomes. Financial pressure and the vastly wider facilities for research under Government supervision drain from university service many men of superior ability. The universities afford fewer and fewer opportunities of instruction at first-hand by men actually engaged in the advancement of their subjects, and the loss to students denied personal contact with original and creative minds will speedily destroy the whole significance of university training. Already there are fundamental departments of science which have been neglected in England for a quarter of a century. "No material change" does not mean "steady progress". It means that decline is inevitable unless there is a substantial improvement of existing conditions.

Ancient Knossos.

The Palace of Minos: a Comparative Account of the Successive Stages of the Early Cretan Civilisation as illustrated by the Discoveries at Knossos. By Sir Arthur Evans. Vol. 2, Part 1: *Fresh Lights on Origins and External Relations; the Restoration in Town and Palace after Seismic Catastrophe towards close of M.M. III., and the Beginnings of the New Era.* Pp. xxii + 390 + 10 plates. Vol. 2, Part 2: *Town-houses in Knossos of the New Era and restored West Palace Section, with its State Approach.* Pp. xiv + 391-844 + 18 plates. (London: Macmillan and Co., Ltd., 1928.) 147*s.* net.

IT is now nearly thirty years since the political liberation of Crete from Turkish rule made excavation possible on the site of ancient Knossos; and the knoll then called Kephála had been recognised, some ten years earlier still, as concealing a pre-Hellenic building, one or two chambers of which—part of the famous 'palace magazines'—were indeed partially opened by a Cretan gentleman who had been appropriately christened Minos. Almost without intermission since 1900—except in the War years—and under the single direction of Sir Arthur Evans, the dissection, and latterly also the reconstruction, of a 'Palace of Minos' has gone on, with ever-widening scope outside the palace-area, and ever-growing wealth of experience suggesting re-examination of structures and substructures already recognised and cleared.

In the first years of tentative discovery, a bulletin of each season's proceedings, in the *Annual* of the British School of Archæology at Athens, was publication enough. Later came monographs, in *Archæologia* and elsewhere, on special enterprises, such as the opening of the 'Royal Tombs' hard by; and the first volume of "Scripta Minoa" on the earlier and mainly pictographic phases of the Minoan script. The later 'linear' scripts still remain for the most part unpublished, though most of the documents were found quite in the earliest seasons' work. Then in 1921 appeared the first volume of "The Palace of Minos at Knossos", bringing together in masterly perspective the main results so far as they concern the history of the site, and the chief phases of its civilisation down to the point at which it begins to be proper to speak of a 'palace' there at all. Next came another interval punctuated with published studies of special problems, the paper on the "Ring of Nestor" and other remarkable pieces of engraved gold work from the Greek mainland, and the Huxley Lecture on early connexions between Crete, Libya, and the Nile Valley; and now we have the second volume of "The Palace of Minos at Knossos", ampler even than the first, but happily bound up in two sections, which make it a much less formidable implement of study and reference.

This new volume does not merely take up the story where it was left by its predecessor. As the author frankly says, "the excavation of Knossos itself may almost be said to have renewed its youth"; it has been "a perpetual source of wonderment" to the excavator, supplementing, and almost invariably substantiating earlier observations and conjectures. So multiple and diverse are these discoveries, that merely to marshal them in intelligible order is a notable achievement. Habitual users will note with satisfaction that the pagination of the two parts of volume 2 is continuous, and also that the numbering of the sections is continuous with that of volume 1, a very great aid to concise reference.

The sections contained in the two parts of volume 2 run from § 33 to § 67 inclusive, and deal mainly, though not by any means exclusively, with the latter part of the Middle Minoan and the beginning of the Late Minoan phases; that is to say, from about 1750 to 1500 B.C. Each deals at the same time with a separate topic or problem, and advances the general argument and historical reconstruction. But since the appearance of volume 1 in 1921 a good deal has been done to clear up obscurities and supplement what was known then about the earlier periods; and §§ 33-34 serve also as a retrospect both of these years of work of the early Minoan and adolescent Middle Minoan phases; and of the general position of Crete and its culture in the ancient world.

Beneath the central court of the later palaces, the discovery of late neolithic houses gives occasion (§ 33) to a revised estimate of the connexion between the earliest occupants of this part of Crete and the people of Asia Minor, which is represented as more directly concerned than the Greek peninsula; though it is still over-early to decide this point. Western Crete has scarcely been touched yet, and very little has been done in mainland districts south of Argolis. Moreover, even in Asia Minor the rugged south-western districts are still almost unknown, and comparisons between Crete and Cappadocia are necessarily provisional. Geographically, however, access has always been comparatively easy from southern Asia Minor to Crete, thanks to the set of the current and the regularity of the *imbat* winds, far more important for coastal traffic than the seasonal *meltem*.

For this reason it may well be that eventual intercourse with the Nile Valley (§ 34) was for Crete rather an extension of this coastal traffic than the result of transmarine exploration. Probably what gave this intercourse its vogue and vitalising force at both ends was the discovery that at the far extremity of the "Great Bight"—to modernise an Egyptian phrase about the "great circuit of the lands"—it was possible to spread sail before a *meltem*, as the fruit-boats of Cos do now, and regain the Nile mouths in a few days. It is important, however, to distinguish (as is here done) Nilotic from other Libyan intercourse; and in early days it is the latter that appears to have been primary, as a number of distinct elements show; types of boats, hair-dressing, costume, stone-worked vessels, cupola-tombs, and so forth. In early dynastic times, when the Delta became Egyptised, Egyptian influence succeeds to Libyan in this Cretan 'staple' or depot.

How did this oversea traffic come? By a 'transit road' traced (§ 35) from minute ports nestling under the Asterusian ridge south of the Messarà plain, over the well-guarded pass east of Mount Ida, and round the west shoulder of Mount Juktas, entering Knossos eventually by the Minoan viaduct (§ 36) with its caravanserai, bath-house, and 'partridge-fresco' (§ 37), and the 'stepped portico' (§ 38) rising into the south end of the 'palace'-site. Special problems of technique and procedure confronted the excavator here, for the sintered soil was as hard as the masonry of the viaduct, and the spirits of the workmen had to be maintained by a fresh plan of remuneration. The technique of Minoan commerce, too, demands special examination of the means of transport, ox, ass, eventually horse and mule; wheeled vehicles for goods, courier-borne palanquins for notables, as a fragmentary fresco shows.

What went by this age-long road, and whither? The answer (§ 39) comes from the signs of Minoan influence far away to the west and north, in Malta, the Iberian peninsula, even in Britain. The connexion between early Maltese monuments and Minoan arts and practices has been disputed, more than once, and there is still a question of degree; but it becomes difficult to dissociate the decorative motives, and if these be borrowed from Minoan, the relative date of the Maltese culture seems to be determined, and therewith much in the western Mediterranean. In the other direction, Cretan arts of design, already known to have affected Egyptian decorative work in the Eighteenth Dynasty, are now (§§ 40, 41) detected in a similar relation to the Middle Empire; a conspicuous instance is the recent find at Harageh, dated to the time of Sneferu II., about 1890 B.C.

Corresponding with the ports of the south coast, the harbour-town of Knossos itself has been discovered and partially explored (§ 42); but lying in the outskirts of modern Candia, and moreover in the zone devastated by both Venetians and Turks during the great seventeenth-century siege, it contributes only suggestive details. In addition to her other functions, the 'Great Goddess' looked after seafarers, anticipating both Isis Pelagia in classical times, and the medieval Madonna. Is it, however, certain that all these representations of potent or protective women are attributable to one and the same goddess, or rather (as Nilsson suggests in his "Minoan-Mycenæan Religion") to several, perhaps many, departmental deities? Through this—and probably also through other ports on the north coast, Nirou-Khani, for example (§ 44)—Crete was apparently brought into separate intercourse with Syrian centres, and their cults and manners (§ 43) illustrated by a fashion of bull-headed libation-vessels, and by occasional finds of cylinder-seals. Deeper-seated are those aspects of Cretan religious belief which are illustrated by the insignia of a priest-king from the French excavations at Mallia, and by the curious find at Nirou-Khani, which Sir Arthur Evans describes as a "propagandist depot", of portable altars and double-axes.

After these retrospective and supplementary studies, resulting from the last few years' operations, the main thread of the story is taken up again in § 45 at the moment of the disastrous earthquake which wrecked Knossos during the Third Middle-Minoan period, and profoundly affected its subsequent fortunes. The direct damage was serious enough, especially in the south-east quarter of the 'palace', where the site had been greatly enlarged over substructures which now collapsed and overwhelmed the houses which occupied the slopes below. But the moral effects were more lasting (§ 46). Propitiatory ritual before rebuildings was natural enough, and is illustrated graphically; but the new custom seems to have come to stay, in the form of a 'pillar-cult', and the worship of an 'earth-shaker' incarnate in bull-form, side by side with the god of the 'double-axe' (§ 47) and at times merged in him. The general 'distress of nations' after the disaster is shown directly by the marked reduction of the occupied area at

Knossos, and no less vividly by those emigrations of which the settlements on the Greek mainland about this time are the first fruits. In quite a different direction, widespread ruin meant abundant opportunity for the builder and decorator (§§ 48-54). As we have seen in our own time, at such a period of 'reparations' the arts progress rapidly (§ 48); experiments are tried on every hand; foreign models have their vogue, and the copies of the first imitators pass into the common repertory of their successors. Was it such a change of taste, or another earthquake (such as Crete seems to suffer about twice in a century) that brought about the 'scrapping' of the lovely painted stucco in the 'House of the Frescoes'—the "cultured home of a small burgher"—outside the Palace proper (§ 52)? And why were the 'scrapped' fragments so carefully stowed away in the house itself, to the delight of posterity? It is a further discovery (§ 53), that the decoration of house-walls and other large-scale work is the source and inspiration of the minuscule art and abridged designs of the pottery and perishable gear of everyday life.

In these artistically favourable circumstances arose from the ruins of the 'older palace' the 'broad Knossos' of Homeric folk-memory, in the golden age of Minoan Crete (§ 56). Fearless, because secure abroad, and therefore unfortified and unconfined, the growing population spent growing wealth on commodious suburbs, beyond the Kairatos river, for example (§ 55); and other Cretan towns flourished accordingly. An eloquent signal is the rapid disuse of timber for house-building; as in our own Renaissance, deforestation had begun.

The remainder of the volume (§§ 57-67) surveys the reconstructed 'palace' in systematic order, beginning with the 'state approach' from the north-west (§ 57), the 'theatral area' for receptions and pageantry, the 'west court', and the 'treasure house' (§ 59), with its splendid hoard of bronze vessels and household furniture (§ 60); and the 'west porch' (§ 61) and 'south propylæum' (§ 62) with their processional frescoes, to which the well-known 'cup-bearer' belongs. Here is the occasion for discussing the no less famous 'Keftiu tributaries' from the walls of Egyptian tombs, and the tell-tale offerings which they carry (§ 63). So we pass on into the 'ceremonial corridor' (§§ 64-65), which runs north and south into the main mass of 'palace' structures, and so to the 'central court' (§ 66), where it has even been possible to recover the main architectural features of the façade; and to detect links between the religious ritual of the 'sanctuary quarter' of the 'palace' and the worship of Apollo at Delphi, a striking counterpart to the Greek legend of the Cretan origin of the Delphic priesthood, and to the worship of the 'Delphinian' Apollo at Knossos, and elsewhere in Crete, in Hellenic times.

For the remainder of the Late Minoan buildings, and especially for the magnificent 'north gate' and its decorations, we have still to wait for volume 3, and still more have we to wait for an index; but it is only right to acknowledge the utility, meanwhile, of the marginal catch-titles, and the analysis prefixed to each section; and to admire the skill with which so vast and at first sight heterogeneous a collection of data has been arranged so that each topic occurs, like an episode of saga, in a context which is memorable in itself, and makes subsequent reference easy.

That is in itself a feat of no mean art, as everyone will admit who has had to write reports of excavation. So much that is found is always at first sight negligible or inexplicable, but for this very reason must be all the more scrupulously recorded and conserved. So much, at the same time, that seems essential to any reconstruction at all, is *not* found, but has to be 'restored' with more or less confidence—and 'scrapped' sometimes, like any other hypothesis, as knowledge grows. In Ægean archæology, knowledge has grown amazingly, though very unevenly, while Knossos itself has been under examination; even in Crete, American, French, Italian, Greek, and other British excavators have contributed much, especially to fill certain gaps in the Knossian series; for example, about the time of the great earthquake, and also in respect of those early periods, the deposits from which were levelled away from the top of the Kephála hill when 'palace' construction began. With these exceptions, Knossos has remained, as it began, central and typical; and the record of its recovery is a classic of archæological literature.

Scarcely less unusual than his presentation of results has been the excavator's treatment of the 'palace' as an exhibit and a place of study. Nothing is more dreary or confusing than the litter of displaced fragments which disfigures most sites after excavation, except perhaps the knowledge that this or that important detail is 'now in London' or elsewhere. Now, at Knossos, nothing has been removed, except to the Candia Museum for safe custody; nothing, on the other hand, of which the place could be ascertained, has been allowed to remain out of that place, if the understanding of the whole could be facilitated thereby. This has meant unusual expenditure and labour in reconstruction, the provision of facsimiles of fallen frescoes and other perishable detail, the unpicking and rebuilding of crushed or unstable walls. Examples are apparent in the illustrations to this volume, and some of them are startling in their audacity, when they are judged by other people's practice. But no one, it must be remembered, has ever had a site of this quality to study or to dissect under such favourable conditions, with complete continuity of direction, and concentration of responsibility and initiative. Remote as Knossos is, and must remain, it is a place of pilgrimage for students of archæology—the art and technique of recovering the past—as well of antiquity; and it is only when the attempt is made to reconstruct the Kephála of thirty years ago from the recreated Knossos of to-day that the full meaning of this record is appreciated.

J. L. M.

Incidental Natural History.

(1) *Further Correspondence of John Ray.* Edited by Dr. Robert W. T. Gunther. (The Ray Society Volume for the Year 1928, No. 114.) Pp. xxiv + 332 + 4 plates. (London: Dulau and Co., Ltd., 1928.) 12*s*. 6*d*. net.

(2) *Physiologus: a Metrical Bestiary of Twelve Chapters by Bishop Theobald.* Printed in Cologne, 1492. The Author is believed to have been Abbot of Monte Cassino A.D. 1022–1035, and a Description of the Abbey is appended with Illustrations. Translated by Lieut.-Col. Alan Wood Rendell. Pp. xxvii + 34 + 100 + 15 plates. (London: John and Edward Bumpus, Ltd., 1928.) 10*s*. 6*d*. net.

(1) THE Ray Society has already issued two works, the "Memorials" (1846) and the "Correspondence of John Ray" (1848), which may be said to have achieved their object of keeping alive the memory of "the greatest all-round naturalist of his time". The present addition, made possible by financial assistance from a revered and venerable successor of John Ray, Prof. W. C. M'Intosh, "is the outcome of a re-discovery in the Bodleian Library of a number of letters of John Ray which have not only never been printed *in extenso*, but which form a necessary supplement to the volume of *The Correspondence*". To these have been added materials obtained from the *Philosophical Transactions* and archives of the Royal Society, and from the British Museum. The work has been edited by Dr. R. W. T. Gunther, to whose activities the history of science owes many useful contributions. Although the short lives of Ray by Dale and Petiver are reprinted, Dr. Gunther's volume is not, and does not pretend to be, a final biography of Ray in the form of a coherent narrative, and its interest lies rather in a series of disconnected incidents and opinions which nevertheless will be most valuable to the future biographer of Ray when he appears. Ray is generally believed to have been born in 1628 and to have died in 1705. The dates inscribed on his tomb are 1628 and 1706. Both are now stated to be erroneous, the latter being corrected to 1705; and as regards the former, we have the evidence of the parish register that he was born in 1627.

To give some idea of the contents of the volume, a few samples may be selected. The letter on the anatomy of the "Porpess", dated 1671, is printed in full, and illustrates fairly Ray's powers and limitations as an anatomist and a systematist. It does not compare very favourably with the fuller account of the anatomy of the same animal published in 1680 by Edward Tyson. Ray, however, clearly recognises and demonstrates that the anatomy of the porpoise must be interpreted in terms of the quadruped, which after all is the main point. Nevertheless, in his "Historia Piscium", published in 1686, he still retains the Cetacea among the fishes. He describes also the compound stomach of the porpoise, the lobulate kidneys and the mammal-like genitalia. Although he mentions the elongated larynx, he failed to recognise, as did all the older comparative anatomists, the existence of, and the reason for, an intranarial epiglottis. The brain is briefly and accurately described, but he missed the external auditory meatus, which, though very small, had been seen by Belon and Rondeletius before him, and by Daniel Major and Tyson immediately after.

An interesting account is given of the publication of Ray's work on fishes, the expenses of which plunged the Royal Society into a state of bankruptcy. Samuel Pepys, at that time president of the Society, took a deep interest in this work, which was dedicated to him. In spite of the fact that the cost of a number of the 187 plates had been guaranteed, there was a deficit of £360, and an attempt to dispose of 400 copies abroad at 25*s*. a copy having apparently failed, the Society was unable to pay the stipends of its officers in cash, but offered them instead copies of this unremunerative work. It was sold at the time for 20*s*., and it may be noted that its present market value is about £3, 10*s*.

Ray was naturally familiar with the horn of the narwhal, but had interpreted it as a median structure, and had not been aware, until informed by Edward Lhwyd, that the horn may be paired. He, however, missed the significance of this variation, but regarded the paired condition as normal, " so that we are again to seek for a Monoceros, which we had thought we had found among fishes ". It is somewhat surprising to find that Ray knew the work of Leonhard Baldner, the Strasbourg fisherman, who published the first observations on the metamorphosis of the lamprey in 1666. Ray, however, " not understanding high Dutch ", was unable to make much use of Baldner's work, whose name, by the way, he mis-spells Baltner.

Some of the letters show that the mild and uncomplaining Ray could on occasion scarify his contemporaries, and in this respect he appears in a new light. Walter Charleton comes in for severe treatment. He " did not understand animals ", his " Onomasticon Zoicon " was cribbed and inaccurate, and he is surprised that " such a book should find so much acceptance as to come to a second impression ". Dr. Woodward is arrogant, presumptuous, and highly conceited, his notions are ridiculous, but, adds Ray in mitigation, the interpretation of fossils is so difficult that " a man hazards his reputation that is positive and confident on either side ".

We must express our indebtedness to Dr. Gunther for this important collection of Raviana, and he has increased the obligation by preparing an index which covers not only his own volume, but also the previous collection of letters published in 1848.

(2) This work includes an illustrated description of the famous Benedictine monastery of Monte Cassino, about 90 miles from Rome—a description which has some topical interest, since the Abbey is at the moment celebrating the fourteen-hundredth anniversary of its foundation. This description will therefore be useful to those who are visiting Rome, and may induce them to include in their tour an excursion to Monte Cassino. We have not visited the monastery personally, but we would ask whether there is not something radically wrong with the date ascribed to the arcade figured in Plate 14.

Col. Rendell has performed a very useful service to learning by publishing a photographic reproduction of this important and fascinating incunable. We wish that considerations of expense did not preclude the practice being generally followed. Such a reproduction is practically as good for the purposes of study as the original, and we can only regret that the Bishop's inspiration did not run to the whole of the forty or so chapters of the " Physiologus ". Col. Rendell, however, has done more than reproduce his copy of this rare book—he has provided us with a translation of it, a serious task, of the merit of which there may be differences of opinion, but of which none will question the usefulness. The condensed and at times erratic form of the original makes a literal translation, which Col. Rendell has attempted, particularly difficult, and he has not always succeeded in the double object of abiding by the text and at the same time producing a version in intelligible English. He confines himself largely to the 1492 edition of the Bestiary, and does not concern himself with the extensive literature of the " Physiologus ", nor with discussions of such questions as a comparison of " Physiologus " with the " Nuzhatu-l-Qulûb ", recently attempted by Col. Stephenson.

There are two appendices—one a partial translation of an Italian article on an unpublished moralised Bestiary of the twelfth century from the archives of the Chapter of Fano, and the other a comparison of the Fano version with the Cologne printed text of 1492, and another Latin version known as the Migne.

Popular Astronomy.

(1) *The Sun, the Stars, and the Universe.* By Dr. W. M. Smart. Pp. xii + 291 + 20 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1928.) 12*s*. 6*d*. net.

(2) *Astrophysics: the Characteristics and Evolution of the Stars.* By Dr. W. M. Smart. (Benn's Sixpenny Library, No. 36.) Pp. 80. (London: Ernest Benn, Ltd., 1928.) 6*d*.

RESEARCH in astronomy in these days is so fascinating and exacting a pursuit that one could understand, if not excuse, the neglect of one of the primary duties of investigators—to inform the general public of the progress of their science. It is essential that this should be done by astronomers themselves, for, in the bewildering speed of modern progress, they alone have the least chance of seeing the position steadily and seeing it whole. Fortunately, they have not neglected their duty. During the last few years there has been a remarkable output of popular astronomical literature of a trustworthy type, and there is now no difficulty, as once there was, in directing an inquirer, of whatever intellectual capacity, to a satisfactory account of the astronomical knowledge so far obtained. Dr. Smart is the latest addition to the band of authoritative expositors, and the two books before us make it clear that he is well fitted for the task which he has undertaken.

(1) The larger volume—" The Sun, the Stars, and the Universe "—" has been designed to present, in descriptive language and with an historical background, an account of modern astronomical discoveries and of present-day views concerning the characteristics, constitution, and organisation of the heavenly bodies ". This is a fair statement of its achievements, and indicates better than the title what aspects of general astronomy have been selected for consideration. The order of treatment is not unconventional. The first four chapters are introductory in character, dealing in general terms with the solar system, the celestial sphere, some aspects of early astronomical history, and astronomical instruments—the chapter describing the last named being inadequately entitled " The Telescope ". Then follow two chapters on the sun, and one on the moon, planets, and comets, after which the various departments of stellar astronomy are discussed in eight chapters. Three of these are devoted to the movements of the stars—an unusually large proportion, for which, however, there is much to be said. It scarcely exaggerates the importance which stellar movements are likely to assume in the future progress of astronomy. Two further chapters—on star clusters and nebulæ, and the universe, respectively—bring the book to a conclusion. The illustrations are numerous and well-chosen, and are excellently reproduced.

The treatment throughout is as non-technical as possible, and entirely non-mathematical : it does not, however, on that account suffer in accuracy or precision. In one respect, perhaps, the ideal of precision has been followed too unswervingly. Dr. Smart states in the preface that when the chapter on stellar evolution was written there were three different evolutionary theories in the field, and it seemed advisable " in a popular book to devote the available space to a somewhat detailed account of one theory rather than to attempt to produce a condensed description of all three ". It is at least questionable if the existence of a multiplicity of expert opinions on any matter is a valid reason for describing only one in a non-polemical work—and particularly for giving " a somewhat detailed account " of that one. It is doubtful, too, if the nebulous state of general opinion on stellar evolution can be said to contain anything so definite as " three theories ". An appropriate vagueness in the tone (not the logical meaning) of the account of this subject, condensing here and there into the chief features of the various bodies of thought, would possibly have given a truer account of the actual state of affairs than a clear-cut description of a particular view. It is only fair, however, to add that Dr. Smart makes no attempt to hide or disguise the difficulties and uncertainties of the subject.

(2) The little volume on "Astrophysics", which is a member of Messrs. Benn's admirable Sixpenny Library, necessarily deals with much the same material as the later portion of the larger work. It is carefully planned and is very successful in covering a great deal of ground without giving the impression of undue haste. It is illustrated by several diagrams and is altogether appropriate to the character of the series of books to which it belongs.

Dr. Smart writes clearly and interestingly. His sentences are rarely, if ever, ambiguous, and his accuracy is as great as can be expected of one man who undertakes to survey so vast a field. The inevitable slips and misprints are few and unimportant. He has, however, an unfortunate tendency of aiming at stimulating the imagination by the use of hyperbole. This is sometimes merely ineffective, as in the frequent repetition of such words as 'stupendous' and 'amazing', and sometimes definitely misleading, as in the remark that the radial velocities of spiral nebulæ are 'incomparably' greater than the velocities of galactic objects. (Incidentally, it may be questioned whether it is not the smallness rather than the greatness of the velocities of spirals that is most striking. With a possibility of relative velocities up to the speed of light, is it not surprising and probably significant that independent universes should amble past one another at no more than about 1000 miles per second ?) This characteristic is expressive of the failure—far too general among writers of popular scientific books—to distinguish between the educated, non-scientific man and the child. Dr. Smart is too able an expositor to be allowed to persist in this attitude without protest, and we trust that in his future writings he will give the same careful attention to the mental characteristics of his prospective readers as he does to the subject on which he writes.

H. D.

Our Bookshelf.

The Application of Science to the Steel Industry. By Dr. W. H. Hatfield. (Edward De Mille Campbell Memorial Lecture, presented in Philadelphia, October 10, 1928, at the Tenth Annual Convention of the American Society for Steel Treating.) Pp. vii + 154. (Cleveland, Ohio: American Society for Steel Treating, 1928.)

This volume contains the substance of a series of lectures delivered by the author in the course of a visit to the United States during last autumn, and deals with modern developments in the manufacture and use of steel. As chairman of the Steel Ingots Committee, Dr. Hatfield naturally gives prominence to the work of that committee, and lays stress on the importance of ingot structure for the quality of the finished steel. This section forms a useful introduction to the subject, and is well illustrated. The principles of heat treatment are next considered, again with the presentation of abundant material from technical practice.

The metallurgist will naturally turn with great interest to the remaining four sections, dealing respectively with special engineering steels, corrosion resisting and stainless steels, steels intended for use at high temperatures, and with tool and cutlery steels. On all these matters the author is in an exceptional position for the collection of full and accurate data, and his numerous tables form a most valuable compendium of information on such subjects. In deference to the audiences before which the lectures were delivered, temperatures are given on the Fahrenheit scale, but the Centigrade values are added in brackets. The author would render a service to metallurgy if he could persuade American workers to come into line with the rest of the world in this respect.

Dr. Hatfield has been very frank in including information which is often, for commercial reasons, difficult to obtain, and the volume, although small, will be frequently consulted, especially for the more complex alloy steels intended to resist creep at high temperatures, and other recent features of the industry. The references to the literature are abundant, but marred by numerous minor inaccuracies. The author is to be congratulated on a very useful piece of work.

Praktische Einführung in die Morphologie der Insekten: ein Hilfsbuch für Lehrer, Studierende, und Entomophile. Von Prof. Dr. Eduard Handschin. (Sammlung naturwissenschaftlicher Praktika, Band 16.) Pp. viii + 112. (Berlin: Gebrüder Borntraeger, 1928.) 11 gold marks.

This handbook is designed to meet the need for a practical manual for the laboratory training of entomology students in the elements of insect morphology. Its plan of arrangement is that each chapter is devoted to a separate region of the insect body, and is preceded by a short list of papers useful to the student for further reading. The author, it may be added, has borne in mind the importance of explaining structure in terms of function. By means of a series of judiciously selected types the student is led to understand the significance of the chief structural modifications found among representative insects. A considerable number of common and usually easily procurable species are used as types for dissection, and having mastered the course laid down, the beginner should have acquired a sound general acquaintance with the external structure of these animals. As a supplementary guide to practical work, a separate atlas of 23 plates is provided at the end of the book. Its figures illustrate practically all features discussed in the text; they are models of clarity and are for the most part original. The book can be recommended as a concise and thoroughly accurate laboratory manual.

A. D. Imms.

The Industrial Uses of Bauxite: with an Account of its Origin, Occurrence, Composition, and Properties. By Dr. N. V. S. Knibbs. Pp. 141. (London: Ernest Benn, Ltd., 1928.) 21*s.* net.

Dr. Knibbs's book is a valuable contribution to the literature relating to bauxite, and it is therefore very regrettable that the price is so high. Nine of the fifteen chapters are concerned with the uses of bauxite, a subject about which published information is rather scanty. After a brief account of its occurrence and properties, the uses of bauxite in the manufacture of aluminium and its compounds, alumina refractories, abrasives and aluminous cements, and in oil refining, are all fully described. In view of the great increase in the production of aluminium and the growth of a demand for aluminous cements, the possibility of a shortage of bauxite at some future date must be seriously considered, and in the concluding chapter Dr. Knibbs discusses the utilisation of clays as substitutes. Valuable lists of references are given at the ends of chapters.

Notions fondamentales de chimie organique. Par Prof. Charles Moureu. Neuvième édition entièrement revue et augmentée de nouveaux chapitres. Pp. ix + 657. (Paris: Gauthier-Villars et Cie, 1928.) 70 francs.

The new French edition of this well-known textbook has been revised and brought up-to-date. Several interesting chapters have also been added, dealing with the following aspects of applied organic chemistry: substances possessing odour (pp. 26) or taste (pp. 7), organic medicinals (pp. 47) and explosives (pp. 14). We may note that the first of the new chapters contains no mention of the striking osmophoric properties of organic sulphur and selenium, and that the revised account of the carbohydrates, which scarcely does justice to recent researches, could be expanded with advantage. The book may be criticised in these and other details; but the enlarged version, regarded as a whole, is characterised by the sense of proportion, logical presentation, and clarity of exposition which distinguished Prof. Moureu's original text.

J. R.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

An Isotope of Oxygen of Mass 17 in the Earth's Atmosphere.

SINCE we reported the presence of an isotope of oxygen with mass 18 in the earth's atmosphere (NATURE, **123**, 318; 1929) we have found further confirmation. Mr. Harold D. Babcock has sent us thirty-four lines which were withheld from publication by Dieke and Babcock (*Proc. N.A.S.*, **13**, 670; 1927) because it was not known that they were due to oxygen. Twenty-seven of these are due to the alternate rotation levels of the 18-16 oxygen molecule. Thus the 18-16 molecule has every rotation state where the 16-16 molecule has only alternate levels. Such an excellent confirmation of the predictions of wave mechanics in this regard has not heretofore been possible since the presence of nuclear spin usually permits all states to exist although not in equal amount. The more complete discussion of the data will appear elsewhere (*Jour. Am. Chem. Soc.*, May 1929). In the meantime Babcock, who obtained the data at Mount Wilson Observatory, has re-examined his plates and also obtained additional measurements. He has found a number of extremely weak lines in addition to extending the various 18-16 series, and has kindly permitted us to examine his manuscript in advance of publication (*Proc. N.A.S.*).

Babcock suggests that his new lines may be due to the forbidden 16-16 alternate rotation levels, although, as he points out, they fail to occupy the correct positions by several times his experimental error.

We have found that these lines originate from a molecule consisting of an atom of mass 17 in combination with one of mass 16. The normal state of this molecule has one-half unit of vibration, and both odd and even rotation levels exist. Each of these facts is in accord with the theory of wave mechanics.

The equations for the isotopic displacement are the same as previously given (NATURE, **123**, 318; 1929) except that 1·11 $cm.^{-1}$ and 0·0294 $cm.^{-1}$ should replace the values 2·12 $cm.^{-1}$ and 0·0556 $cm.^{-1}$ respectively. Out of 22 new weak lines we find that 19 belong to oxygen 16-17. The algebraic deviation of observed minus calculated lines is $-$ 0·03 $cm.^{-1}$ with a maximum deviation of 0·14 $cm.^{-1}$.

It is apparent from the comment of Aston (NATURE, **123**, 488; 1929) with regard to oxygen 18 that a mass spectrograph is unreliable in an initial or confirmatory investigation of isotopes present in very small amount. It appears that the various known isotopes of the elements, their several chemical combinations and multiple ionisations, are not eliminated by existing technique, and suffice to explain nearly any future observation that can be made on an isotope present in very small amount. This is, however, not the case in band spectroscopy, where the very characteristic fine structure having been found for an abundant isotope will lead to an equally characteristic counterpart. We may thus conclude with certainty that oxygen isotopes 17 and 18 do exist in the earth's atmosphere.

Babcock has carried out some very accurate intensity measurements to assist in the estimation of relative amount. As we have pointed out in our more detailed paper (to appear *Jour. Am. Chem. Soc.*, May 1929) 18-16 molecules may be slightly polar, due to zero point vibration. This would be expected, since the centre of mass does not coincide with the geometrical centre. Such polarity may increase the absorption coefficient of the 18-16 or 17-16 molecules. However, intensity measurements should lead to a maximum value. Babcock estimates oxygen 18 as present to one part in 2500. He has, however, overlooked a factor of two in his calculation, so that the estimate should be one part in 1250, as a maximum. This factor is due to the fact that the 18-16 molecules have twice as many states in which to exist as have the 16-16 molecules.

From Babcock's estimate of the relative intensity of the lines which are due to the 17-16 molecule we estimate its abundance as about one part in 10,000 as a maximum.

Oxygen mass 17 has been reported by Kirsch and Petterson (*Ark. f. Mat. Astron. och Physik*, Stockholm, 19, 15, 1-16; 1925: *Phys. Z.*, **26**, 457; 1925) and by Blackett (*Proc. Roy. Soc.*, A, **107**, 349; 1925) from data obtained on collisions between alpha particles and nitrogen nuclei. These collisions occasionally lead to combination with subsequent elimination of a proton leaving oxygen 17. These experiments did not indicate the stability of oxygen 17, except that Blackett was able to show a life of at least 0·001 sec.

A full account of our work will appear elsewhere.

W. F. GIAUQUE.
H. L. JOHNSTON.

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University of California,
Berkeley, California,
April 27.

The Heat Production of Crustacean Nerve.

IN my Ludwig Mond Lecture, published in NATURE of May 11, I referred to the experiments of Furusawa on the 'depolarisation' of crab's nerve by stimulation, and to the manner in which the 'polarisation' (as shown by the injury current) increases again to its original value in the presence, but not in the absence, of oxygen. In a paper by Furusawa, shortly to be published in the *Journal of Physiology*, it will appear that this recovery process occupies a time of the order of half an hour. I have recently succeeded in measuring the heat produced by crab's nerve, as the result of a 5 to 10 seconds' stimulus. Some 98 per cent of this heat occurs in the recovery phase, only 2 per cent during the actual stimulus: the recovery heat production lasts for 20 to 30 minutes at room temperature. There is no doubt, therefore, that the process in which the injury current, diminished by stimulation, returns to its original value is accompanied by a relatively large liberation of energy.

A striking fact is the small amount of heat set free in the initial phase, that is, during the passage of the impulse. If we regard the nerve wave as accompanied by a surface change in the fibre which momentarily allows electrical contact to occur between inside and outside (it is difficult to picture the 'action current' otherwise), then activity will allow an equalisation of concentration of ions to occur between the two sides, a process which must be reversed during subsequent recovery. The mixture of two salt solutions, say of potassium chloride and sodium chloride, involves very little change in total energy: considerable work, however, may be required to separate them again, and this work will require a provision of energy, and in any actual process the liberation of heat.

The crustacean nerve, as shown by Levin and by Furusawa, is highly fatigable, at any rate in respect of its electric change. Corresponding to this, Meyerhof and Schulz have shown in a recent paper in the *Biochemische Zeitschrift* that its oxygen consumption is high : reckoned per gram of *dry* nerve, when stimulated, twenty times as high as that of a frog's sciatic, at rest ten times as high. In a short stimulus I have found the total heat (initial plus recovery, spread over half an hour) to be about $2\cdot5 \times 10^{-3}$ calorie per gram of fresh nerve per second of stimulus, as compared with 7×10^{-5} calorie for the frog. The crab's nerve is non-medullated ; the fibres of the frog's sciatic consist mainly of medullary sheath : this may be one cause of the large difference between the two. The fact that the crab's nerve contains a far higher percentage of water would work in the opposite direction.

Whether the striking differences in fatigability, depolarisation, recovery, and energy exchanges between these crabs' nerves and the sciatic of the frog are simply to be attributed to the fact that the former are non-medullated and the latter medullated, only future work can show. The central nervous system, which consists largely of nerve cells and to an appreciable extent of non-medullated fibres, is far more fatigable and more dependent on an adequate supply of oxygen than is the peripheral medullated nerve. It may well be the case that in the limb nerves of the crustaceans we have in such respects a much better model on which to work out the elementary properties of the nervous system than we find in the ordinary medullated nerve, which hitherto has been chiefly used for the purpose.

A. V. HILL.

University College,
London, W.C.1, May 14.

The Inland Waters of South Africa.

IN view of the forthcoming visit of the British Association to South Africa, we should like to direct the attention of biologists to certain remarkable inland waters occurring in that country. Throughout the southern half of the Transvaal, as well as in many other parts of South and South-west Africa, are found shallow saucer-like depressions of various sizes which may be filled temporarily or permanently with water. These pans have been ably described by Rogers,[1] and are generally admitted to be the result of wind erosion at a time when the climate of the country was drier than it is at present, although Passarge [2] considers them to have been the result of 'zoogenous' erosion in the Kalahari.

We have examined a considerable number of these localities both on the Witwatersrand and in the Lake Chrissie region of the Ermelo district, an area of uncertain drainage from the edges of which arise the Vaal, Komati, and Usutu Rivers, and within which a surprisingly large number of pans occur.

From a hydrobiological point of view the Transvaal pans may be divided into temporary and permanent waters. The *temporary pans* dry up in the latter part of the winter season, often leaving a few small pools, and fill with the first heavy summer rains. They may be referred to the 'astatic' type of Gajl,[3] and normally support a rich phyllopod (s. str.) fauna. We have found it convenient to subdivide the temporary pans of the southern Transvaal into *grass-pans* and *mud-pans*. The *p*H of the former is below 8·0 when full, and the soil of the bottom does not become sufficiently 'brak' to inhibit the growth of a rich terrestrial vegetation on drying. When full, such localities support a large number of aquatic flowering plants, and a very abundant and varied tycho-plankton, characterised by the association of *Volvox* spp. with the rotifer *Conochilus hippocrepis*. The *mud-pans*, on the other hand, have a *p*H of more than 8·2 when full, and presumably their floor is too 'brak' when dry to allow the growth of abundant terrestrial vegetation. The plankton is far more restricted than is that of the *grass-pans*; phytoplankton is almost absent, and rotifers rare, the bulk of the organisms inhabiting such localities being crustacea.

In the Lake Chrissie area the majority of the pans are permanent. Chemical conditions are very variable and are reflected in corresponding differences in the fauna and flora. The most interesting condition was met with in a series of pans, all less than a mile in diameter and perhaps 10-20 feet deep. The water of these pans has a *p*H of about 9·0, is slightly salt (0·02-0·03 *N*.Cl), coloured from pale yellow to deep sepia by humic material, and may be very turbid. Such pans support practically no higher vegetation or phytoplankton and have a zooplankton composed almost exclusively of one or two species of Centropagid copepods and a large and remarkable Daphniid. The largest pans, for example, Lake Chrissie itself, which is about three miles long, may support a rich growth of *Potamogeton Livingstonii* (Moss: forthcoming publication). In striking contrast to these pans may be mentioned a pair of pans lying close together on the farm Weltevreden to the south of Lake Chrissie. One of these, which is slightly alkaline, supports an exceedingly rich growth of *Melosira* and a few other algæ and is slightly alkaline; the other, which is just on the acid side of neutrality, contained large numbers of desmids and a very rich rhizopod and rotifer fauna.

Naumann,[4] in his latest contribution to lake typology, characterises the *dystrophic* type of water as being on the acid side of neutrality, poor in electrolytes and containing considerable amounts of humic matter, while the *oligotrophic* type of Thienemann[5] is divided into *oligotrophic* (s. str.) on the acid side and *alkalitrophic* on the alkaline side of neutrality. The more extreme type of permanent pan containing large amounts of humic matter must be considered as *dystrophic*, but differs from Naumann's characterisation not merely in alkalinity, but also in containing large amounts of electrolytes (chiefly sodium bicarbonate and sodium chloride with some calcium, magnesium, and sulphates), including accumulated phosphates, up to 0·006 mgm. P_2O_5 per litre, which cannot be utilised owing to the lack of phytoplankton. The poverty of the planktonic flora must be attributed to the combined influences of alkalinity, turbidity, and colour of the water as well as to the direct toxic action of the humic matter. Since both acid and alkaline waters may be classified as *dystrophic*, it would seem better to abandon the term *alkalitrophic* type and to revert to Thienemann's earlier scheme, recognising, however, an alkaline as well as an acid phase in the *oligotrophic* and *dystrophic*, if not in the *eutrophic* type. Other cases of *alkaline dystrophic* waters are probably recorded in the literature without their true nature being recognised, for example, Turner's Lake, Isle-au-Haut, Maine.[6] Dr. S. C. Ball also kindly informed us that very salt humic waters may occur in the lagoons of coral atolls when completely shut off from the sea. In such a case a *salt dystrophic* lake may be formed supporting only a population of *Artemia*.

[1] *South Afr. Jour. Sci.*, **19**, p. 1 ; 1922.
[2] "Die Kalahari", Berlin, 1904.
[3] *Bull. Int. Ac. Pol. Sci. Math.* (B), p. 13; 1924.
[4] "Grundlinien der experimentellen Planktonforschung. Binnengewässer VI.", Stuttgart, p. 24; 1929.
[5] "Die Binnengewässer Mitteleuropas. Binnengewässer I.", Stuttgart, p. 199; 1926.
[6] Bishop and Clarke, "A Scientific Survey of Turner's Lake", N.Y. State Mus., 1923.

Normal acid *dystrophic* waters also occur in South Africa, but are chiefly of artificial origin, for example, the various reservoirs on Table Mt. from which the water supply of Cape Town is derived. The Transvaal pans by no means exhaust the hydrobiological wealth of the country; on the Witwatersrand are found very acid waters (*p*H 3·7) contaminated with nitre cake from gold extraction works, which support a restricted fauna. The alkaline vleis near Cape Town also deserve passing mention.

A detailed report on the chemical conditions and planktonic life of all these localities is in preparation and will be published as soon as our collections have been worked out by the various systematists who have kindly undertaken to examine them. Our very best thanks are due to Prof. L. T. Hogben, of the University of Cape Town, who first directed our attention to the remarkable field offered by South Africa for this type of research; to Dr. A. W. Rogers, director of the Geological Survey of South Africa, for bringing to our notice the Transvaal pans; to Prof. J. A. Wilkinson, of the University of the Witwatersrand, who generously placed his facilities for chemical analysis at our disposal; and to Prof. C. E. Moss and his staff, of the same University, and to Miss E. L. Stephens, of the University of Cape Town, for valuable botanical information.

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Vegetation Formulæ.

THE value of floral formulæ in indicating at a glance the systematic position and affinities of a phanerogam has so long been recognised that no apology is needed for suggesting that a comparable means of expressing the general character of vegetation types is both eminently desirable and likely to prove of great value to the ecologist and phytogeographer. At the present time the personal factor inevitably enters largely not only into the description of vegetation, but also into the interpretation of descriptions. After some years of residence in the drier parts of India and Burma the *Acacia* thorn forest and *Acacia* scrub, both with an undergrowth mainly of grass, had become two of the most familiar types of vegetation, yet I was unprepared for the extraordinarily close comparison which is possible with large areas of the Bush Veld of Southern Rhodesia or with certain types of mulga scrub and mallee scrub which I found on visiting South and Western Australia. Yet a vegetation formula, such as is now proposed, would have indicated the affinity at a glance. It is essential that the formulæ shall be kept as simple as possible, so that they may be used by travellers and explorers with only a slight knowledge of botany, but will at the same time impart a valuable precision to their observations.

The formula depends upon two separate considerations:

(*a*) The enumeration of plants over a definite standard area.

(*b*) The recognition of four or five main groups of plants for this purpose.

It has long been the custom of forest officers to study their forests by 'sample plots' and of ecologists to base detailed descriptions on similar plots. It is proposed that one hectare be taken as the standard area. Of course the enumeration may be carried out over any sized area and the results reduced to the standard area. Thus a hectare is equivalent to 2·47 (roughly $2\frac{1}{2}$) acres and is equal to 10,000 square metres, so that the enumeration of small plants may be made on the basis of a square metre. It is necessary to have a large standard area to cover adequately tropical vegetation where there may be but one or two individuals of a particular species even in a dense equatorial forest, or the widely scattered vegetation of a semi-desert.

It is suggested that, for practical purposes, the types of plants to be enumerated may be considered as divisible into five broad groups: trees (A from Lat. *arbor*), shrubs (F from Lat. *frutex*), herbaceous plants (H from Lat. *herba*), grass (G from Lat. *gramen*), and cryptogams (C). It is recognised that *herba* is not a very satisfactory word, but its use in the sense proposed (excluding grass) is already widespread in the adjective herbaceous. The basal vegetation formula is thus:

$$xA + yF + zH + x'G + y'C,$$

where x, y, z, x', and y' are the numbers of individuals per hectare. For broad descriptive purposes it will often be possible to ignore C entirely.

For trees and shrubs the presence of more than one story may be indicated by duplicating the symbol thus:

$$A + A' + F + F',$$

whilst the general character of the trees or shrub may be indicated by suffixes such as e (evergreen), d (deciduous), c (coniferous). The average height of the vegetation is important and should be expressed in metres. For all types of vegetation the letters a, b, c, d, etc., may be used to indicate dominants; x, y, z, etc., to indicate the absence of dominants or presence of numerous species. To take a very simple example:

$$150\ A^c a(30)$$

is the formula for a coniferous forest with one dominant (a), with an average height of 30 metres and averaging 150 trees to the hectare.

It is significant of the lack of precision in many of our existing descriptions of vegetation that I have not exact figures for any of the types of vegetation described in my "Vegetation of Burma" (1925) and in the *Journal of Ecology* (1923), but supplying estimates, four types of vegetation may be selected to indicate the use of the formulæ:

(1) *Indaing*
$$= 300A^d abx(20) + 50F^d y + 10^4(2Hz + 10Gmnz').$$
(2) *Diospyros* forest
$$= 200A^d bcdex(12) + 50F^d y + 10^4(Hz + 10Gmnoz').$$
(3) *Acacia* thorn forest
$$= 150A^d efx(7) + 100F^d y + 10^2(5Hz + 20Gmnz').$$
(4) *Acacia* scrub
$$= OA + 150F^d efy(2) + 10^2(2Hz + 5Gz').$$

TREES: a = *Dipterocarpus tuberculatus*, b = *Pentacme suavis*, c = *Terminalia tomentosa*, d = *Diospyros birmanica*, e = *Acacia catechu*, f = *Tectona hamiltonii*.

GRASSES: m = *Andropogum contortus*, n = *A. apicus*, o = *A. serratus*.

It is obvious that the four examples chosen form a continuous gradation (actually the result of decreasing moisture).

If the principle of vegetation formulæ is acceptable to ecologists, numerous refinements and extensions will be necessary, but the present outline scheme is put forward with the hope that it may induce a greater precision of description by travellers. It is to be noted that the formula is at least partially complete without the *naming* of the constituent species; it may also be noted that a formula can be drawn up from a study of scaled photographs, and even approximately in the case of forests from aerial photographs.

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Popa, Ashtead,
Surrey.

Distribution of Temperature in the First 25 Kilometres over the Earth.

Sir Napier Shaw, in his "Manual of Meteorology", gives on p. 100 of vol. 2 a very interesting diagram showing the distribution of temperatures in the upper air over the globe. As pointed out by Dr. C. W. B. Normand in his review of the book in the *Quarterly Journal of the Royal Meteorological Society* (vol. 54, p. 275; 1928), the diagram does not represent exactly the peculiarities of the distribution of temperature in the stratosphere over the tropical and subtropical regions. An attempt has therefore been made to prepare a modified diagram, using all the data now available. It shows (Fig. 1) the probable distribution of isotherms in the atmosphere up to 25 km. in summer and winter over the northern hemisphere. The dotted lines are based on very few observations and are therefore mainly conjectural. The principal features of the diagram may be briefly summarised.

(1) The stratosphere is not isothermal over any particular place, but above a certain level there is a tendency for the temperature to increase with height.

(2) The coldest air over the earth, of temperature about 185° A., lies at a height of some 17 gkm. over the equator in the form of a flat ring surrounded by rings of warmer air.

(3) The surface of the tropopause has a relatively steep slope towards the pole between latitudes 30° and 50° in summer and between 25° and 45° in winter.

(4) The ring of lowest temperature at the tropopause is displaced towards the summer hemisphere.

(5) There is a ridge of high temperature in the tropopause between latitudes 20° and 40° N. in summer corresponding to the ridge of high pressure at 8 km. over those latitudes (see Sir Napier Shaw's chart of 8 km. isobars in July, *loc. cit.* p. 262).

The evidence for (1) and (2) comes from the results of sounding balloon ascents at Batavia, Agra, and in the United States of America (Blair, *Bull. Mt. Weather Obs.*, vol. 4, part 4, pp. 183-304; 1912). The rise of temperature with height in the stratosphere over these places cannot be considered to be due to insolation, as most of the Agra ascents and many of the American ascents began late in the day when the sun was low. Bemmelen has given strong reasons for believing that the rise of temperature in the stratosphere which he observed over Batavia could not have been due to insolation. The Agra and Batavia results indicate a temperature of about 220° A. at a height of 24 km., and the American results show about 230° A. at 25 km.

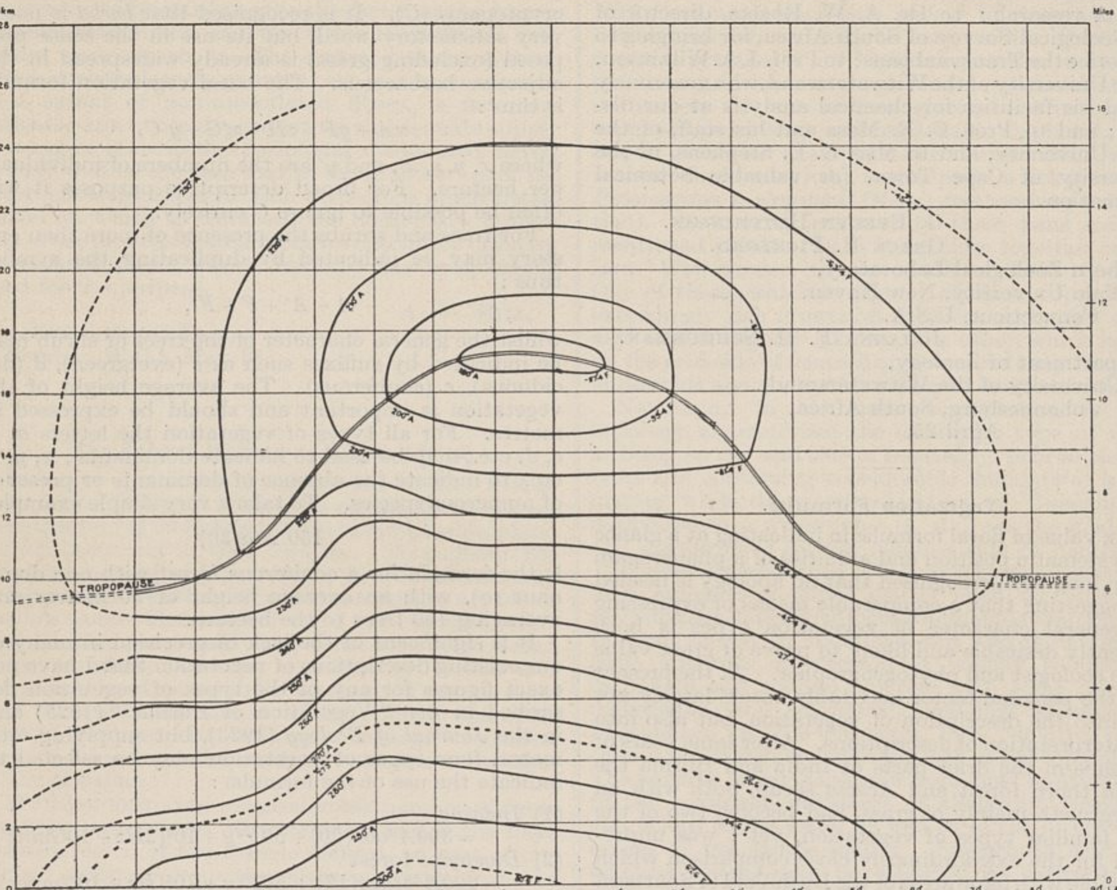


Fig. 1.

The seasonal variation of temperature of the tropopause at Batavia and Agra is illustrated in Fig. 2 and shows (4) clearly. The height of the tropopause over

Batavia does not show such well-marked variation as that of temperature, but the following figures taken from Bemmelen (*Proc. Roy. Acad.*, Amsterdam,

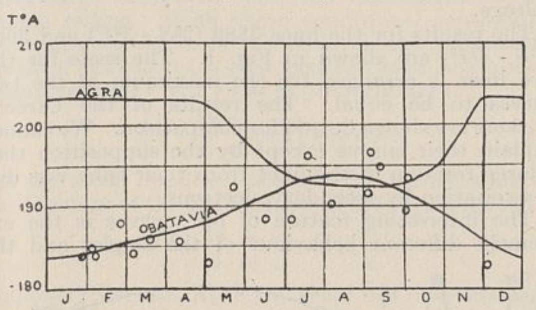


FIG. 2.—The points marked in the figure refer to Batavia temperatures.

vol. 20, p. 1313) show that the variation is similar to that which occurs over Agra but displaced by about six months.

HEIGHTS OF TROPOPAUSE OVER BATAVIA (KM.).

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
17·8	17·6	17·3	17·0	16·5	16·2	16·0	16·5	17·0	17·4	17·6	17·7

The lower temperatures and greater heights of the tropopause in summer are presumably due to the stronger convection in the troposphere in that season.

The persistent increase of temperature with height for at least 5 km. above the tropopause in the tropics finds a natural explanation if we assume that the tropopause marks the lower limit of the ozone layer in the atmosphere.

K. R. RAMANATHAN.
Meteorological Department,
Poona, India.

Significant Figures in Speed Records.

I HAD hoped that someone more competent than myself would have replied to Col. O'Gorman's letter, in which, in NATURE of Mar. 30, he offered an apologia for recording Sir Henry Segrave's speed to 8 significant figures, but probably most readers of this journal do not consider that motor speed records form a subject with which they are intimately concerned. It would, however, be regrettable if this silence led the general public to conclude that scientific workers are prepared to accept as valid a speed recorded to one hundred thousandth part of a mile per hour.

Col. O'Gorman commences his letter by admitting that the last figures are merely arithmetical residues, with which all will agree, but unfortunately in what follows he seems to attempt to justify the inclusion of these readings in the published value of the speed. and to this objection may fairly be taken. His first argument is based on the necessity for great precision in order that there may be no doubt whether a standing record has been beaten by a subsequent attempt or no. Let us examine this argument a little more closely. Sir Henry Segrave's mean time for the mile over his two runs was 15·56 sec., the automatic timing being carried to 1/100 sec., and the mile apparently assumed to be absolutely accurate. A subsequent claimant to the record may do one of the following five things :

1. He may beat the record by a substantial margin, in which case a statement to the nearest mile per hour would clearly be sufficient.

2. He may beat it by a narrow margin. We will take the nearest margin which can be recorded, one-half of one hundredth of a second (the time being the mean of two runs each of which is measured to 1/100 sec.). This will make his time 15·555 sec., and his speed 231·44 miles per hour (or if we give the arithmetical residues, 231·43683 . . . m.p.h.).

3. He may take precisely the same time to the half hundredth of a second as Sir Henry Segrave (15·56 sec.) with a speed of 231·36 miles per hour.

4. He may take one-half hundredth of a second longer, when his speed will be 231·29 miles per hour.

5. He may fail to obtain the record by a substantial margin.

Now in cases 2 and 4, to determine whether the claimant has obtained the record or not, it is amply sufficient to record the speed to 1/100th of a mile per hour. The difference from the standing record in each case amounts to 0·07 or 0·08 mile per hour. In case 3 no addition to the number of significant figures will serve to distinguish between the new record and the old. It is difficult to find any support for 8 significant figures from these facts.

Col. O'Gorman next points out that the speed published is not the true mean of the speeds obtained on the two runs over the measured distance, but the sum of the two distances divided by the sum of the two times. It is not clear how this fact affects the question of the permissible number of significant figures, which is governed solely by the accuracy with which the time and the distance can be measured. One may further ask why, if it is wrong to round off to two decimal figures, it is right to stop at five figures? Why not publish a whole page of decimals ?

It would perhaps be presumption on my part to suggest a line of defence which Col. O'Gorman might have adopted, which could not be assailed on the scientific side. He might have pointed out that these speeds to be accepted internationally must be worked out in the manner laid down by the international controlling body, and that any country which attempts a record and wishes its claim to be recognised must follow the prescribed rules. The Royal Automobile Club, therefore, would be under an obligation to give the prescribed number of figures whatever this number might be. It may publish a foolish statement, but no alternative is open except that of not claiming the record, and few people would wish to push the claim for scientific honesty to this length.

J. S. DINES.
78 Denbigh Street,
S.W.1.

The Spread of Scale Insects and their Parasites.

MANY years ago I was an industrious collector of scale insects and mealy-bugs, especially in Jamaica. I found them in great abundance on cultivated plants, and obtained many species. When recently travelling in the Oriental tropics, I was struck by the relative scarcity of these insects, and the occurrence of various well-known injurious forms only in small patches or isolated individuals. Perhaps the difference was partly due to the relative poorness of my eyesight, but I could not help speculating on the causes which might lead to a diminution of scale insects on cultivated plants, aside from the operations of economic entomologists. World-wide commerce has spread the injurious Coccidæ over the earth, as they are so easily carried with plants. In their native countries they are efficiently controlled by parasitic and predatory enemies. In several well-known cases a plague has been abated by going to these countries and obtaining the natural enemies, which had failed to arrive with the first (accidental) importation of the coccids. Thus, following the modern expansion of trade and rapid transit, there has been in many regions a great increase in the damage done by scale insects, at times reaching the magnitude of a calamity. But by the same process, gradually but surely, the natural enemies will also spread. In the course of time, almost imperceptibly, they will gain the ascendancy, and the coccid plague will cease, never to return unless through the importation of a new sort of coccid. Thus it may even happen in some cases that a rigid quarantine, after a pest has arrived, may be harmful, preventing natural enemies from following it. These latter may, however, be brought in by entomologists, through special permission, provided they have been found and recognised.

There is some proof that this is not mere speculation. I wrote to Dr. L. O. Howard, who has long paid special attention to the parasites of Coccidæ, and he directed my attention to a study he had made, comparing the scale-insect parasites of the United States (Chalcidoidea) with those he had studied and described in 1880. There was no doubt that in the years since that date the parasite fauna had changed owing to the introduction of many foreign species, which had in some cases supplanted native ones. Furthermore, the recent researches of Garcia y Mercet in Spain, and Silvestri, Masi, and Paoli in Italy, indicated the existence in great numbers, in the Mediterranean region, of Aphelinine parasites apparently unknown there seventy-five years ago. Last year, when I visited the Melbourne Botanic Garden (which has about 16,000 species of plants growing in the open), Mr. St. John informed me that there were not nearly so many coccids on the plants as formerly. This may partly be due to native enemies; thus the Red Wattle bird keeps the fluted scale (*Icerya purchasi*) in check; yet I suspect it may also be due largely to the spread of foreign parasites.

Similar-looking coccids may have quite different natural enemies. The citrophilus mealy-bug (*Pseudococcus gahani*), though an ordinary-looking species, was not controlled in California by the many enemies of the native American mealy-bugs. Now, after an extended search, *Pseudococcus gahani* has been found apparently native in Australia, and two species of Hymenopterous parasites, a Dipterous parasite, two kinds of Coccinellid beetles, and a Chrysopa have been observed to keep it within bounds in that country. These have now been taken to California, and there are already indications of favourable results. California's plant quarantine would have prevented them from coming over accidentally, and in any case the deliberate work of the entomologists is infinitely superior to the slow operations of chance.

T. D. A. COCKERELL.

University of Colorado,
Boulder, April 22.

Variation of the Intensities in the Helium Spectrum with the Velocity of the Exciting Electrons.

RECENTLY, Peteri and Elenbaas (*Zeits. f. Phys.*, **54**, p. 92; 1929) have published curves of the intensity variations of the helium lines when the velocity of the exciting electron steam is altered. We have been working on the same subject, and since our results do not agree with theirs, it seems worth while to give a preliminary account of them.

We also use a photographic method of measuring the intensities, but the apparatus for exciting the light is different. A narrow electron beam in helium at 0·024 mm. pressure passes into a field free box and produces a narrow streak of light. An image is thrown on to the spectrograph slit and runs perpendicular to it. We integrate the intensity over the length of the spectrum lines and subtract the background which is due to secondary excitation. In this way we completely avoid errors due (1) to secondary excitation, and (2) to the variation of the spatial distribution of the electron beam with the applied voltage.

The results for the lines 3889 ($2^3S - 3^3P$) and 3965 ($2^1S - 4^1P$) are shown in Fig. 1. The scale for the two lines is arranged for the maximum of the two curves to be equal. The results of the Utrecht workers are shown dotted for comparison. We cannot explain their curves except by the supposition that a large fraction of the light from their tube was due to excitation by secondary electrons.

The interesting feature of our curves is the extremely different behaviour of the singlet and the triplet lines. This is a general characteristic of all the lines, though individual cases show minor variations. The following conclusions may be stated.

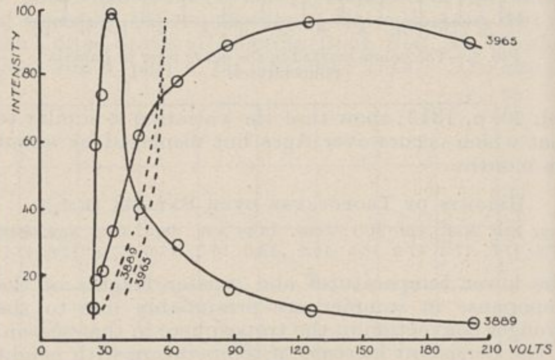


FIG. 1.—Intensities in the helium spectrum.

(1) For high exciting velocities, the triplets vanish in intensity compared with the singlets. This has been predicted theoretically by Oppenheimer, and had previously been found experimentally by Hughes and Lowe (*Proc. Roy. Soc.*, A, **104**, p. 489; 1923), with whose results ours agree very well in general.

(2) For low exciting velocities, the singlets are weak compared with the triplets. This is a new result. Since the normal state of He is a singlet state, this seems to indicate for low velocities a very close coupling of the spin of the exciting electron with the spins of the electrons in the atom.

There is another interesting point of dissimilarity between the singlets and triplets. We find that while the light of the triplets is confined closely to the electron beam, the light from the singlets tends to spread away from it. This makes the intensity determinations of the singlets somewhat arbitrary. We are not at the moment prepared to discuss the cause of this behaviour as the investigations are not yet complete.

J. H. LEES.
H. W. B. SKINNER.

H. H. Wills Physical Laboratory,
The University, Bristol,
May 7.

The Longitudinal Distribution of Photoelectrons.

THE new quantum mechanics has completely resolved the problem of the photoelectric effect. In fact, Wentzel (*Zeit. für Phys.*, **40**, 574; 1925: **41**, 828; 1927) and Beck (*Zeit. für Phys.*, **41**, 443; 1927) have succeeded in justifying theoretically the well-known Einstein equation; and the more complete treatment of Sommerfeld has permitted the calculation of the dissymmetry of the photoemission, that is, the experimental fact that the forward emitted electrons are in a greater number than the backward ones. Sommerfeld's theory is, however, a first approximation, valid only when the wave-length λ of the incident rays is fairly large compared with the dimensions of the atomic radius. With these conditions, considering electrons emitted from the K level, the probability $P(\theta)d\theta$ of emission of a photoelectron at an angle comprised between θ and $\theta + d\theta$ is proportional to

$$\left\{1 + \frac{18}{5}\frac{v}{c}\cos\theta\right\}\sin^3\theta d\theta \quad . \quad . \quad (1)$$

and the mean impulse σ acquired by the electrons in the direction of the propagation of the rays is given by

$$\sigma\frac{h\nu}{c} = \frac{18}{5}\frac{4}{10}\frac{h\nu}{c} = 1\cdot44\frac{h\nu}{c}.$$

Williams (NATURE, April 13, 1929) has demonstrated that this formula is in agreement with the experimental results, because recent experiments made in nitrogen and in oxygen lead to a value of σ ($\sigma = 1\cdot40$), nearly equal to the theoretical one.

Equation (1) is, however, only a first approximation, and it remains to be determined what is the formula of distribution valid when Sommerfeld's approximation is not enough. We have made the calculation for the K level without any limitations for the value of λ. We have obtained a very complicated formula, that in a first approximation, when

$$\lambda \gg \frac{h}{2mc},$$

gives the (1); and in a second approximation leads to the following expression:

$$\left\{1 + \frac{18}{5}\frac{v}{c}\left[1 - \frac{135}{56}\frac{RhZ^2}{mc^2} + \frac{45}{112}\frac{v^2}{c^2}\right]\cos\theta\right\}\sin^2\theta d\theta$$

where R, h, m, c, and Z are well-known constants.

Substituting for these their values, we have

$$\left\{1 + \frac{18}{5}\frac{v}{c}[1 - 6\cdot41 \times 10^{-5}Z^2 + 0\cdot40]\cos\theta\right\}\sin^3\theta d\theta. \quad (2)$$

According to (2), in the second approximation we have a variation from Sommerfeld's value, depending upon the atomic number Z, but of little entity, and a greater variation from the velocity of the photoelectron in the opposite sense. The agreement obtained in the case considered by Williams remains also in the second approximation. In fact, for nitrogen ($Z = 7$) irradiated with rays of $\lambda = 0\cdot6$, the ratio v/c is equal to 0·28, and formula (2) gives for σ quite the same value as formula (1) ($\sigma = 1\cdot41$).

The deviations from the value of σ calculated by (1) are sensible for the heavier elements. In fact, if one obtains with $v/c = 0\cdot1$, $\sigma = 1\cdot40$ for argon ($Z = 18$), which is a value a little different from that of Sommerfeld, for krypton ($Z = 36$) one obtains $\sigma = 1\cdot33$.

For very hard rays the effect of the second order, depending on the velocity, is more conspicuous. So if v/c is equal to 0·6, one obtains for argon $\sigma = 1\cdot61$, and for krypton $\sigma = 1\cdot53$. These values are not in agreement with those obtained by Augier for argon.

Further experiments may decide this question.

Details of the calculation will be published elsewhere.

ANTONIO CARRELLI.
Istituto Fisico, R. Università,
Napoli, May 3.

Dragonflies in Folk-lore.

IN recent years NATURE has adopted the very interesting departure of taking notice, by review or otherwise, of contemporary novels which hold some special interest for science, either (as in the case of H. G. Wells's "William Clissold") because of the recognised biological outlook of the author, or (as in the case of Aldous Huxley's "Point Counterpoint") because of some exceptionally expressed criticism of modern science, its aims or its outlook.

This attitude might well be adopted also towards novels which contain accounts or records of the popular outlook in times past towards natural objects, whether living or inanimate. Recently it has been my good fortune to read a novel which has already been acclaimed as a modern masterpiece, namely, the late Mary Webb's "Precious Bane". It is full of quaint, archaically expressed observations of Nature in the countryside. The time is about the end of the Napoleonic wars. The chapter on dragonflies (book 3, chap. v.) is well worth reading from this point of view alone, and I would like to ask readers of NATURE whether any of the expressions in the following passage are still in use in Great Britain:

"We called the dragonfly the ether's mon or ether's nild at Sarn, for it was supposed that where the adder, or ether, lay hid in the grass, there above hovered the ether's mon as a warning. One kind, all blue, we called the kingfisher; another one, with a very thin body, the darning-needle. Mother was used to tell Gideon that if he took dog's leave or did other mischief the devil would take needle to him and use the dragonflies to sew up his ears, so he couldna hear the comfortable word of God and would come to damnation. But I never could believe that the devil could have power over such a fair thing as a dragonfly."

I believe dragonflies are still quite commonly called "devil's darning-needles" in many parts of the United States of America, but whether the adder is still called the "ether", or the dragon-fly the "ether's mon" or "ether's nild" in any part of England or America I do not know. Perhaps some readers of NATURE could enlighten me.

The species called the "kingfisher" would evidently be *Calopteryx virgo* L., while the "darning-needle" must have been either *Agrion puella* L. or some other common damsel-fly, perhaps *Enallagma cyathigerum* Charp.

R. J. TILLYARD.
Canberra, F.C.T.,
Australia, Mar. 31.

Periodic and Spiral Forms of Crystallisation.

IN a recent letter to NATURE (April 20, p. 603), Hughes has suggested that the interesting spiral markings on carborundum reported by Menzies and Sloat (Mar. 9, p. 348) may be a special case of periodic crystallisation. Hughes refers to a remark in a paper by Miss Henley and myself (*J. C. S.*, 2725; 1928) concerning the formation of spirals in Liesegang rings as anomalies caused by accidental external conditions.

The periodic crystallisation of thin films of sulphur described by Hughes was previously investigated by Fischer-Treuenfeld (*Kolloid-Z.*, **16**, 109; 1915) and by Köhler (*ibid.*, **17**, 10; 1915), and an account of this and other examples of the same phenomenon is given in Hedges and Myers' "Physico-chemical Periodicity" (Arnold and Co., 1926) on pp. 34-37.

Some months ago I carried out some experiments on the crystallisation of thin films of molten organic substances and found that crystallisation in concentric rings readily takes place with benzil, benzoin, benzophenone, menthol, *m*-dinitrobenzene, and acetanilide. The experiments were discontinued, but I hope to return to them shortly: at present, the observations made are in the main in agreement with the views expressed by Hughes on the cause of the phenomenon.

I have examined the specimens to see whether there is any indication of the occasional formation of spirals in place of the usual concentric rings. The accompanying photograph (Fig. 1) clearly depicts the spiral growth of crystals. This specimen was made in Sir Henry Miers' laboratory at Manchester in 1924 by allowing a thin film of potassium dichromate solution to evaporate on a warm microscope slide. The structure differs from that of the specimen of sulphur in Hughes's illustration and from most of my specimens, in that crystallisation started from the periphery of the drop and travelled inwards, instead of beginning

FIG. 1.—Spiral crystal growth. ×25 diameters.

at a central nucleus and radiating outwards. The specimen of carborundum described by Menzies and Sloat may have crystallised in this way.

Where crystallisation starts from a central nucleus, I have not observed among the specimens an example of the immediate development of a spiral, but I have a specimen of camphorsulphonic acid, crystallised from ethyl acetate solution, in which a true spiral succeeds two concentric rings surrounding the nucleus of crystallisation. Moreover, examination shows that a disturbance has been caused at the point where the spiral begins by the presence of another nucleus in the vicinity.

There appears to be no doubt, therefore, that crystallisation does sometimes follow a spiral course to give a variety of periodic structure, and it seems probable that the markings on carborundum are to be explained in this way. ERNEST S. HEDGES.

Bedford College (University of London),
Regent's Park, N.W.1.

The Atomic Weight of Phosphorus.

IN a recent issue of NATURE (Mar. 9, p. 390) mention is made of the fact that the English Commission on Atomic Weights adopts for the atomic weight of phosphorus the value 30·98(2), this being based on Aston's results with the mass-spectrograph; whereas the German Commission adheres to the older and higher value 31·02, derived mainly from gravimetric analysis.

The following results, obtained by the physico-chemical method of density and compressibility as applied to phosphine gas, may therefore be of interest:

Density L_0^{760} at one atmosphere, 1·5317.

Density L_0^{760} at one-half atmosphere, 1·5243.

Assuming the compressibility factor to be a linear one, the value for $(1+\lambda)$ so obtained is 1·0097, which, in conjunction with the values for oxygen of 1·4290 for the normal density and 1·0009 for $(1+\lambda)$, leads to the molecular weight of 34·00(2) for phosphine and to 30·97(9) for the atomic weight of phosphorus.

Further experiments are being carried out at the pressures of three-quarters and one-quarter atmosphere, to ascertain whether the compressibility can be taken as a linear function of the pressure. Such results as have been obtained at one-quarter atmosphere give the value $L_0^{760} = 1·5208$ for which $(1+\lambda) = 1·0096$ and P = 30·98(2). MOWBRAY RITCHIE.

Department of Chemistry,
University of Edinburgh,
April 30.

The Atomic Weight of Copper.

WITH reference to the Research item in NATURE of April 27, p. 660, that Messrs. Richards and Phillips have recently found the atomic weight of copper to be 63·557 (Ag = 107·88), it may be interesting to note that the spectroscopic value given in my "Analysis of Spectra" (p. 127) is 63·5569 ± 0·060, the 0·06 referring to maximum possible errors. The probable error is much less. The value obtained on spectroscopic data depends on the doublet separation and the $p(1)$ term. These are known with very great accuracy in both silver and copper.

W. M. HICKS.

Quantum Geometry.

DIRAC's wave equation for the electron involves a Hamiltonian linear in the momenta p_k. This fact seems to be of geometrical nature and suggests the introduction of a linear fundamental differential form

$$ds = \sum_k \gamma_k dx_k$$

with matrix coefficients γ_k in geometrical considerations.

This linear ds is connected with Dirac's wave equation in the same way as the Riemannian ds^2 with the relativistic wave equation of the older theory.

The matrix vector γ_k may be interpreted as an operator corresponding to the fundamental velocity, namely, that of light, and is connected with the Einsteinian $h_{\nu a}$ by the relation $\gamma_\nu = \sum_a h_{\nu a} \gamma_a^0$ where γ_a^0 are Dirac's constant matrices.

Possibly other tensors of the second rank, like the energy tensor T_{ik}, or R_{ik} are to be replaced in the proposed 'linear geometry' by matrix vectors in the same way as g_{ik} is replaced by γ_k.

The linear geometry seems to furnish a basis on which a uniform theory of gravitation, radiation, and quantum phenomena is to be constructed. More detailed considerations on this subject will appear in the *Zeit. f. Physik*. V. FOCK.
D. IWANENKO.

Physical Institute of the University,
Leningrad, Mar. 21.

Early Use of Iron.

THE early history of iron outlined in the address by Prof. Louis (NATURE, May 18, p. 762) has been carried much further back by discoveries in South Palestine, published in *Gerar* last year. Furnaces were found dated to 1100 and 1175 B.C.; the earlier was 67 in. × 36 in. At the side of the furnace lay great hoes, 11 in. × 5 in., plough socks, and a pick of 6 pounds weight, showing that iron was as commonly used then as now. The earliest example was a knife of 1350 B.C., and this accords with the date of the polished steel dagger of Tutankhamen. This year another steel dagger, with cast bronze handle, has been found, of about 1300 B.C.; as it was snapped in two anciently without any bending, it could not be soft iron. FLINDERS PETRIE.

University College, W.C.1.

Einstein's and other Unitary Field Theories: An Explanation for the General Reader.

By Prof. H. T. H. PIAGGIO.

I.

THE announcement of the publication of Einstein's new theory has aroused great interest even among those who do not usually follow the advances of science. Unfortunately, this interest has been accompanied by a feeling that the new theory, like Einstein's earlier ones, is a mysterious mixture of metaphysics and mathematics, so obscure and paradoxical that the average man cannot possibly acquire any notion of what it is all about. Indeed, a French author declared that " when two German professors meet, and each can understand what he says himself, but cannot understand the other, they are said to be talking Metaphysics. If, however, the subject of discussion is so profound that they are unable to understand not only each other, but even themselves, it is called the Higher Metaphysics. Now Einstein's Theory belongs to the Higher Metaphysics."

The purpose of the present article is to dispel such views. By going back to the work of Newton and Maxwell we can trace the general nature of the ideas that have been uppermost in Einstein's mind. It will be shown how the desire for unification of apparently different physical phenomena was the guiding force in each case. Other attempts at unification of gravitation and electromagnetism will be explained and contrasted with Einstein's. It is hoped that, by simple considerations concerning the meridians and parallels of longitude on the earth's surface, readers without any mathematical knowledge may be able to grasp the general nature of the principles underlying the new geometries.

NEWTON AND GRAVITATION.

When Newton (1642–1727) started to consider the subject of planetary motions, he found in existence fairly accurate knowledge of the facts, but only the wildest speculations as to the underlying causes. Thus Kepler (1571–1630), by analysing the astronomical observations of Tycho Brahe (1546–1601), had found three laws of planetary motion. One of these was that the orbits were ellipses with the sun in the focus. Kepler even guessed that universal gravitation might have something to do with these laws, but he also considered them as partly due to a magnetic force set up by the sun's rotation. Descartes (1596–1650) thought that space was filled with vortices of ether, and the planets were dragged round by these vortices like sand particles in a whirlwind.

It was Newton's magnificent combination of physical intuition and mathematical power that enabled him to sweep aside these vague ideas, and to set up what we may call a unitary theory, which explained on a single basis effects hitherto believed to be due to more than one source. He showed that gravitation alone, acting between every two particles of the universe with a force proportional to the product of the masses divided by the square of the distance between them, was sufficient to account for all the phenomena of planetary motion. It is interesting to notice that at first Newton's theory of gravitation appeared to be disproved by the observed facts concerning the moon and the earth. This caused Newton to put aside his ideas for several years. When a more accurate set of observations was available the theory was vindicated. Its substantial correctness is conclusively proved every year by the truth, to a very close approximation, of the astronomical predictions of the *Nautical Almanac*.

MAXWELL AND ELECTROMAGNETISM.

We now come to the twin sciences of electricity and magnetism. The investigation of their mutual relationship was due to several investigators, among whom Faraday (1791–1867) takes a prominent place. Then came Maxwell (1831–1879), who, in what are now well known as " Maxwell's Electromagnetic Equations ", gave mathematical form to Faraday's ideas and extended them. Maxwell's theories, which united electromagnetism and light, were criticised at the time, and even Lord Kelvin was of opinion that " up to the present the so-called Electromagnetic Theory of Light does not seem to have accomplished much ". One term in Maxwell's equations (representing what is called a displacement current) seemed to owe its origin to an illegitimate union of mathematics and metaphysics. Worst of all, there seemed no experimental verification of the consequences of the equations. This was not forthcoming until after Maxwell's death, and was due to Hertz (1857–1894). The electric waves the existence of which was implied by Maxwell's equations were actually produced, and they may now be received every night by the millions who listen to radio concerts.

EINSTEIN'S SPECIAL THEORY (1905).

Long after Maxwell's equations had been firmly established for a fixed system, there was grave doubt as to how they should be extended to a moving one. In order to explain the results of the famous Michelson-Morley experiment, FitzGerald and Lorentz introduced the remarkable hypothesis of a contraction caused by motion. Einstein (1879–) showed that the phenomena could be accounted for on the basis of the hypothesis that the velocity of light and all other electromagnetic phenomena would be exactly the same for two observers who were moving with uniform velocity relative to each other. This was based on the measurement of time by light signals, an idea which seemed fantastic in those days, but an equivalent idea, the fixing of time by electromagnetic signals sent out by radio from Daventry or Paris, has now become a commonplace in many households.

Those who scoffed at the idea of time being anything but an absolute quantity must now see that it is at least possible that the clocks regulated by the radio signals from the Eiffel Tower, based upon observations at the Paris Observatory, might not agree exactly with those sent out from Daventry and based on observations at Greenwich. This discrepancy, conceivable in any case, would become more so if France and the Eiffel Tower were moving away from Daventry with enormous velocity. But the contraction of rods and the slowing down of clocks, to which so much attention has been directed, are (as pointed out by Eddington) only apparent. Nothing really happens, except that each observer is unable to get an accurate idea of what length and time really are in the other system. The only accurate way to take measurements in a system is to travel with it, and if this is impracticable, as in the case of an electron moving with a speed which is an appreciable fraction of that of light, our measurements of both space and time concerning the electron are slightly different from what they would have been if we could have travelled with it. These slight differences are related to each other. This is what we mean when we say that space and time form a four-dimensional continuum.

There is no need to try to imagine a fourth dimension, but calculations, to be accurate in the case of high velocities, must deal with time as well as with the three dimensions of space. In this sense the theory united space with time, and so was a unitary one. It also united electricity more closely with magnetism, for it showed that what appears to be a purely magnetic field in one system will appear to be a purely electric field in another system moving relative to the first. Moreover, it united mass (inertia) and energy, showing that one can be transformed into the other. This has since been confirmed in the case of the helium atom, the mass of which is slightly less than the sum of the masses of the nucleus and the electrons which compose it. The discrepancy is made up by the potential energy stored up when the electrons and nucleus are packed closely together.

In spite of this discussion of mass and energy, we can say broadly that Einstein's Special Theory was fundamentally an electromagnetic one, having no connexion with gravitation. Its experimental basis was a slender one, and even such as it is, it has been called in question by Miller, who claims to have obtained, at great distances above sea-level, evidence of the ether-drag of which Michelson and Morley, at about sea-level, found no trace. (In spite of the elaborate precautions against error that Miller took, there is a general disposition to reject his results.) Perhaps the chief service rendered to science by the Special Theory was the help it gave in arriving at the general one, with which we will now deal.

Physical Basis of Einstein's General Theory (1915).

In the dynamics of Newton, the same number, the *mass*, appears to measure three entirely different properties, namely, the quantity of matter, the inertia (or difficulty of setting it in motion), and the weight (the force exerted on it by the earth). Is this merely a marvellous coincidence? Einstein thought not, and inferred that inertia and weight are probably two aspects of the same phenomenon, due to something in the nature of space (or rather of space-time). Again, everyone knows the queer feeling of falling when a lift starts to descend, or of heaviness when a descending lift is coming to rest. Weight, in fact, seems to alter when in a system, like a lift, which can be accelerated.

This suggests a connexion with relative motion, which, for uniform velocity, was considered in the Special Theory. These considerations led Einstein to seek hypotheses concerning space and time which would incorporate the results of his former theory and at the same time account for inertia and gravitation. In other words, he was led to seek a new geometry.

Abstract and Physical Geometry.

How can there be a new geometry? Most of us had it fixed in our minds that geometry was a fixed and unalterable science. Did not Euclid, starting with axioms that were self-evident truths, reach conclusions which will stand for all time and, moreover, can be verified by sufficiently careful drawing? This is certainly what we gathered from Blank and Dash's "Geometry for Schools", but it rests upon a confusion of ideas.

First of all, there are two distinct kinds of geometry, abstract and physical. The first starts with certain *undefined* terms, such as point, straight line, and plane, and makes certain *unproved* statements, called axioms (or postulates), about them. Then we deduce consequences from these definitions and axioms, which constitute abstract geometry. The whole structure is purely a sort of building game, in which the definitions and axioms, taken more or less at random, furnish the bricks, and we see what we can build with them. There is no necessary connexion with the physical world, and so it is meaningless to inquire whether the axioms are true or self-evident. To vary the metaphor, they are the rules of the game, and may be changed at will if we want to construct a new game. Euclid's geometry in its ideal form, when it reasons entirely from the definitions and axioms (an ideal not realised in any school geometry), is one system of abstract geometry. But so long as the science is only an abstract one, we are at liberty to start with a set of axioms quite different from those of Euclid. We shall see later that by studying the properties of a sphere we can build up a system called Riemannian geometry, of which Einstein makes great use.

We now come to physical geometry, the science that deals with the results of the draughtsman, the surveyor, and the architect, and expresses the properties of rulers, set-squares, plumb-lines, and other physical objects. Of course, Poincaré was right when he asserted that we can assume any system of geometry we like (and no doubt most of us prefer the simplest, namely, Euclidean), and then explain any observed physical phenomenon, however strange, by attributing it to some physical force. However, Einstein preferred to proceed otherwise, and exercised his free choice of an abstract geometry in such a way as to sacrifice some of the simplicity in the geometry to gain as much as possible in the physics. For example, in his theory there is no need of a gravitational force to make a planet move in its orbit, for this orbit is as natural in his geometry as is a straight line in the geometry of Euclid and Newton. This is what is meant by 'the geometrisation of physics', and we may define physical geometry as that one of the many possible systems of abstract geometry which is most successful in giving a simple account of physical phenomena. The experience of draughtsmen and others shows that Euclidean geometry works very well indeed in ordinary terrestrial affairs, so physical geometry cannot differ very much from Euclidean.

The Origin of Adaptations.[1]

By Dr. E. J. ALLEN, F.R.S.

BY an adaptation is meant nothing more than a character of an organism, which has enabled a species to survive itself as such, or to survive until it is transformed into another species. It is survival that gives the measure of the value of the adaptation. Survival can only occur if the whole organism is adapted to the environment to an extent that suffices. Organism and environment must be thought of as a unity, as interlocked and fitted closely to form that harmony which is Nature and life. Organic evolution is a phase—the crowning phase, may be—of cosmic evolution. The biological environment determines survival no less than the physical, and adaptation to both must be sufficient. The environment is not fixed, but must be thought of as in a condition of perpetual flux and change. This is true especially of the biological environment, for species once common may practically disappear, and years later may reappear abundantly with devastating effect on other organisms.

The general physical conditions under which organisms live have been well discussed by L. J. Henderson in his book "The Fitness of the Environment" (1913). Henderson discusses the unique properties of water, carbonic acid, hydrogen, and oxygen, and shows how they are specially fitted for the purposes of organic life. "There are no other compounds which share more than a small part of the qualities of fitness of water and carbonic acid; no other elements which share those of carbon, hydrogen, and oxygen." "None of the characteristics of these substances is known to be unfit or seriously inferior to the same characteristics in any other substance." "The fitness of the environment is one part of a reciprocal relationship of which the fitness of the organism is the other."

Darwin's answer to the question, how does the adaptation of organism to environment come to be, was based on three factors—heredity, variation, selection. In ultimate analysis the fact of heredity depends on the cellular structure of organisms and the phenomenon of cell division. When a living cell divides, its most essential substance, the germ plasm, separates into two portions which are almost equal. But we cannot so easily obtain an insight into the problem of variation. For simplicity's sake, consider first the formation of a germ cell from its mother cell in an organism which is developing parthenogenetically. The researches of the colloid chemist have given us the picture. In imagination enlarge the germ mother-cell until you see the two phases; the liquid, the mass of molecular aggregates varied in size and shape; until you see the long, complex chains of atoms, building up the heavy molecules which form the aggregates; until you see the solar systems in miniature of protons and electrons which are the atoms—a seething, churning mass, active with the activity of cosmic forces, receiving matter and energy constantly from the surrounding medium, and giving them back. The preparations for cell-division begin; the molecular aggregates arrange themselves in new patterns; the separation of the cell into two parts ensues. Is it a matter for surprise that the partition of pattern and of substance is not always, perhaps is never, exact? We cannot wonder that germ cells thus produced differ in small respects among themselves. A few molecules more or less, a few atoms more or less, a few electrons even more or less, may mean large changes in the offspring into which the germ cell grows. We are, I think, safe in concluding that lack of equality in the partition of the hereditary material is one important cause of variation. If we think on similar lines of sexual development, where instead of one we have two germ cells uniting to form the zygote from which the offspring is developed, the probability of variation between parent and offspring, and between different offspring of the same parent, is obviously much increased.

Weismann was the first to draw a clear and sharp distinction between true hereditary characters and modifications of the body or soma, produced by the direct action of physical changes in the environment, and to develop the conception of the continuity of the germ-plasm. The germ-plasm is the transmitter, in unbroken continuity from generation to generation, of hereditary qualities. The body or soma is its temporary guardian, perishing when the work of transmission has been done. Blastogenic characters, as Weismann called the true hereditary characters, reappear in exactly the same form in the offspring as they show in the parent, provided both parent and offspring have grown up in the normal environment. Few now question that the nucleus is the essential organ of the germ cell which is engaged in the transmission of hereditary characters. Few

[1] Extracted from the Hooker Lecture, delivered before the Linnean Society of London on Mar. 14.

also question that the chromatin of the nucleus is the bearer of definite factors or genes, or that these factors are distributed in linear order in the chromosomes which appear at the time of cell-division. In ordinary normal development, hereditary characters are determined by the factors in the germ-plasm in response to stimuli furnished by the environment, for in the absence of a suitable environment no development at all takes place. If the environment is normal the characters are reproduced in normal form.

Hereditary *variations* are differences from the parental characters, which appear in the offspring, and are transmitted by the offspring to its descendants. We can only study them when the environmental conditions, in so far as they affect the characters concerned, remain unchanged throughout the growth of both parent and offspring, and this is the recognised basis of all breeding experiments. These hereditary or blastogenic variations we now call mutations, and mutations, according to the most recent usage of the word, may be either large or small, it being quite impossible to distinguish them from any other variations by the factor of size alone. In this respect the word mutation as now used does not convey exactly the same idea—it is not so limited—as Darwin's words 'sport' or 'monstrosity', and its meaning has been somewhat changed since it was first introduced by de Vries. The modern view is that mutations are heritable changes in the characters of organisms, which are due to definite alterations of the factors or genes, situated in the chromosomes of the germ cells. Contrasted with these mutations we have somatic modifications, the acquired characters of Weismann, the reaction of the organism to definite changes in the environment. De Vries's term 'fluctuations' is now generally employed in the same sense, and has, I think, ceased to be useful.

The variations or deviations revealed by the measurements of biometricians, which group themselves around a mean or modal value, according to the 'law of error', are probably in part small mutations which can be transmitted to descendants, and in part somatic modifications which are not so transmitted. With adequate measurements for a series of consecutive generations, the statistical tests which the biometrician applies enable him to say whether or not any of these deviations are inherited, and to give a measure of that inheritance. To take an example, it is frequently maintained that Johannsen's experiments with garden beans (*Phaseolus vulgaris nana*), which multiply by self-fertilisation and from which he obtained what he regards as pure lines, have proved that individual differences as shown by these lines are not inherited, and that therefore they cannot provide material upon which natural selection can act. Pearson, however, maintained, so long ago as 1910, that the pure line theory demands that the offspring shall be as highly correlated with the grandparent as it is with the parent, whereas Johannsen's own figures show that the coefficient of correlation between offspring and parent is higher than that between offspring and grandparent. These experiments should be repeated with larger numbers of measurements.

Mutations may be classified into 'combination mutations', those due to rearrangement of factors or genes already present, and 'alteration mutations' due to changes in the factors themselves. Evidence is now forthcoming that the germ-plasm itself can be acted on by physical and chemical forces in the environment in such a way that mutations are produced. Heslop Harrison's work on the production of melanic forms in Geometrid moths was described (see NATURE, Jan. 22, 1927, p. 127). This work is of outstanding interest, not only on account of the fundamental importance of the results attained, but also for its perfect combination of acute and penetrating observations in the field with critical and long-sustained experimentation. Harrison has shown quite clearly that the germ-plasm can be changed by chemical substances contained in the food of an animal, or in more general terms that the germ-plasm can be altered by the environment. Another important advance in the same direction has come in H. J. Muller's account (*Science*, July 1927) of his production of mutations in *Drosophila* by irradiating spermatozoa or oöcytes with X-rays. When the correct dosage had been found, many mutations were produced, which on the whole were similar to those previously reported in *Drosophila*, such as 'white eye', 'miniature wing', and 'forked-bristles'. Most were recessive, but a number were dominant.

One further point with regard to variations must be noted. The possibilities of variation of an organism are strictly limited and circumscribed by the general physical and chemical properties of protoplasm. The essential physiological processes, upon which the life and activity of organisms depend, are comparatively few. Digestion, growth, sexual activity follow the same general lines throughout the whole animal kingdom. It is probable that the physico-chemical mechanisms alike of all muscular movement, of the movement of amœba by pseudopodia and of the movement of cilia, will fall into one general scheme. Similarly, the transmission of the nervous impulse is being shown to proceed on essentially the same lines in animals of widely separated groups. The essential physiological processes already function in the protista. If the physiological processes are few and circumscribed, variations in structure and form will be limited also, recognising that form is "a product of an inner physiological activity" (Kusnetzov. D'Arcy Thompson, "Growth and Form", 1917).

The last of the three principal factors on which Darwin based his theory of evolution was natural selection, or in Herbert Spencer's phrase, which Darwin adopted, "the Survival of the Fittest". Later, Ray Lankester suggested another formula, "the elimination of the unfit", which describes more correctly the meaning of the conception. That natural selection, acting on heritable variations, is *a* factor in fixing adaptations is almost a truism. But whether it is the only factor, whether it is sufficient by itself to account for the living things we know, each fitting so perfectly its own little niche in its world, is a more difficult question. The process is of necessity so slow. But the time available is enormous, and geologists and physicists seem satisfied that it is to be reckoned in tens, if not in hundreds of millions of years. We must consider also whether the mutations that occur are sufficiently diverse, for if adaptations are to be selected, mutations in the direction of those adaptations must occur. The known mutations of *Drosophila* amount to some 400, but the mutations so far studied are, for practical reasons, those which are large and obvious. There is increasing reason to think that they are outnumbered by small mutations which only long practice can detect. Many mutations studied are slight colour changes, because they can be distinguished with remarkable precision by the practised human eye. Correspondingly minute changes in size or shape would be very hard to detect, and to study them by breeding experiments and the methods of Mendelian analysis is not yet possible. We can only form judgments about them by analogy with results from larger mutations. There remains the statistical method of attack, by the study of mass-populations of successive generations. The method is efficient, active, and advancing, and it can only be lightly disregarded by those who have failed to grasp its meaning.

Alternative or additional theories to account for evolution are favoured by many naturalists. Darwin himself attached much importance to characters being inherited which had been produced by constant use or disuse in the parent. This is a particular case of Lamarck's conception of "the inheritance of acquired characters", or, better expressed, of somatic modifications. Some authorities consider that experimental proof of such inheritance is already available: for example, MacBride cites the work of Kammerer and of Durkhen and Brecher, the latter work being supported also by Heslop Harrison. On the other hand, Graham Kerr ("Evolution." London: Macmillan and Co., 1926) advances strong arguments on the other side, and Goodrich ("Living Organisms", 1924) takes the same view: "The real question Biology has to answer in future, as O. Hertwig has pointed out, is not 'Are modifications inherited?' but 'How are new factors acquired?'"

Even if it could be proved experimentally, without possibility of question, that somatic modifications were inherited, we should only have advanced a little way towards an understanding of our problem. The question *how* the soma influenced the factors in the germ cell would remain. In this connexion Cunningham's suggestion that hormones provided a capable instrument is of interest, and might be followed up experimentally.

The more elusive notions, which introduce the idea of some psychic or psychoid influence, controlling and regulating the processes of metabolism and organic growth, it is hard to distinguish from the animisms of primitive man, who finds a spirit on every mountain, a devil in every bush. All these ideas contain a suggestion of purpose, some of them an idea of almost conscious purpose such as we know only in ourselves, or by analogy assume in higher animals, in each case associated with an elaborately differentiated nervous system. They are brought into the story at the point where knowledge based on observation and experiment ceases, at the point where it seems to many of us more satisfactory to say frankly, I do not know.

The idea of orthogenesis or nomogenesis (Berg, 1926), the idea that development takes place in a predetermined direction, is certainly unsatisfying in its elementary form. An explanation of adaptations on these lines offers special difficulty, for the theory fails to provide the flexibility necessary to produce that constant adjustment of the organism to its ever-changing environment which is imperatively demanded. If, to reach the required adjustment, a predetermined direction of variations and of evolution is postulated in the organism, a predetermined evolution of the environment on parallel lines would surely be necessary. That evolution proceeds according to laws of the same character as other laws of Nature, is the common basis of all modern evolutionary theory, and was held perhaps more strongly by Darwin, Huxley, and Weismann than it is by some writers of to-day. The physical laws in accordance with which the processes of growth are controlled, with results that we see in so many curious patterns, from the simple branching of a tree or of a nerve fibre to the elaborate spirals of a shell or of a growing plant; or again, the laws which lie behind the varied shapes, so curious and wonderful, of organisms and of their different parts,—these laws, and many others like them, still call for serious consideration and research. This is the valuable feature of the theory of orthogenesis, and in directing renewed attention to it, its followers make a valued contribution to biological thought.

There are many other aspects of the problem of the origin of adaptations that might be considered, but it has seemed better to confine ourselves to the larger questions, even at the risk of saying nothing but what was already well known. The outlook for biology to-day is as alluring and as full of hope as it was in those years of joyful enthusiasm which followed the historic paper by Darwin and Wallace, communicated to the Linnean Society by Hooker in 1858. In whatever direction we look problems bristle, problems open to successful attack; and the old qualities, insight, patience, and determination, will get them solved. But we must not limit the outlook, and all aspects of biological research must proceed hand in hand. Botany, zoology, palæontology, the work of the systematist and of the field naturalist, the study of structure and the study of function, the work of the embryologist and of the experimental physiologist, of the geneticist and of the statistician, all are necessary, and none can succeed without the others.

News and Views.

The President of the Board of Trade has appointed a committee to report whether any, and if so what, amendments in the Patents and Designs Acts, or changes in the practice of the Patent Office, are desirable. This committee may be regarded as the result of the suggestive report on the Reform of the British Patent System, issued by the British Science Guild in October last and reviewed in detail in Nature of Nov. 17, 1928 (vol. 122, p. 757). This report was the work of an expert committee of which Dr. W. H. Eccles was chairman and Capt. C. W. Hume, honorary secretary. It immediately aroused the keenest interest throughout the country and even abroad, and was generally considered to be a very valuable document. Nearly thirty professional institutions and organisations representing the industrial and business world appointed committees to consider the report, and a number of these are understood to have endorsed its findings in general terms, with reservations in matters of detail in some cases.

As no particular interest, to say the least, was taken in the British Science Guild report by the Board of Trade when it appeared, it is probably not too much to assume that the public attention since given to the report has now, after a lapse of seven months, led the President of the Board to appoint an official committee to consider the same subject. The chairman is Sir Charles Sargant, a former Lord Justice of Appeal, and the members are Mr. Horatio Ballantyne, a chartered patent agent and a director of Messrs. Lever Brothers; Mr. H. A. Gill, a chartered patent agent and member of several previous committees on patent matters, including the international conference of 1925 and the British Science Guild committee; Mr. E. H. Hodgson, of the Board of Trade; Sir Herbert Jackson; Mr. W. S. Jarratt, Comptroller-General of the Patent Office; Mr. Fearnley Owen, a solicitor; Mr. J. G. Weir, a member of the Glasgow firm of engineers; and Mr. James Whitehead, of the patent bar, who was chairman of the Dating of Patents Committee, 1927. The secretary is Mr. R. W. Luce, a member of the non-technical staff of the Patent Office. We suggest that the absence of any representative of the electrical industry is to be regretted, since British industry is likely to be profoundly affected by electrical developments during the next decade; but perhaps the officials of the Board of Trade consider that the electrical aspects of the subject are sufficiently represented in the British Science Guild report.

By means of the Government grant of £100,000, and more than £180,000 collected by the *Times*, a very large sum is now available for the purchase of radium for Great Britain. Prof. F. A. Lindemann, in the *Daily Telegraph* of May 15, raised the question of justification for the present price of radium. The ordinary expectation is that when a chemical product is made the subject of large-scale operations, the price of the product will diminish. With radium the reverse has happened, for when it was produced on a very small scale, the bromide of radium in a high state of purity could be sold, presumably at a profit, for about 32*s*. per milligram of radium element content. Large-scale production was first attempted in America with the low-grade ore carnotite, but the price was always a high one by comparison with that quoted above, and rose during the War to more than £30 per milligram of element. Belgian production has brought the price down to £12, but the interests concerned have sold it for £10 per milligram where large quantities have been in question, and, on the other hand, they may charge £14, as stated by an official in a communiqué to the *Daily Telegraph* of May 25. Prof. Lindemann's question remains a pertinent one, for whether it would pay to explore British territory for radium obviously depends on whether, with a find so rich as that in the Belgian Congo, production on a big scale would make a really big difference in the present selling price.

The retirement on May 20 of Mr. W. J. Bean from the position of curator marks another milestone passed in the history of the Royal Botanic Gardens, Kew. His loss to the establishment will be very great, for, in addition to his extensive knowledge of plants, he possessed considerable administrative ability and had the faculty of inspiring confidence and respect. Mr. Bean comes of Yorkshire stock and entered Kew as a student gardener in April 1883. His personality soon marked him out for advancement, and in 1888 he was given charge of the Temperate House Department. His great opportunity came, however, in 1892, for in that year the late Sir William Thiselton-Dyer began the reorganisation of the arboretum, and Mr. Bean was transferred from the Temperate House to take charge of the work. At that time the collections of trees and shrubs were weak in number of species, the general standard of cultivation was low, and really decorative subjects were not shown to advantage. The work over a number of years was very arduous, but all who know the Kew arboretum of the present day will agree that Mr. Bean is well repaid for his many years of hard work. During the greater part of his career at Kew, Mr. Bean has contributed to periodical horticultural literature. He is also the author of "The History of the Royal Botanic Gardens, Kew" (Cassell, 1908), but is probably better known for his book "Trees and Shrubs Hardy in the British Isles" (John Murray, 1915), which has already been reprinted four times. Mr. Bean has for many years been a member of the Floral Committee of the Royal Horticultural Society, and the Society has awarded him the Veitch Memorial Medal and the Victoria Medal of Honour. His services have on many occasions been requisitioned by public bodies at home and abroad, and in 1924 he was appointed a companion of the Imperial Service Order.

The Davy centenary celebrations at Penzance will take place on June 8, the arrangements having been made by the Royal Geological Society of Cornwall, the Royal Institution of Cornwall, and the Royal

Cornwall Polytechnic Society; the headquarters of which are respectively at Penzance, Truro, and Falmouth. At noon on that day the Mayor of Penzance, accompanied by members of the Town Council and of the three Cornish societies, will proceed to the Davy statue, upon which a wreath will be placed; luncheon will be served at the Pavilion at one o'clock, and at three o'clock a public meeting will be held in the same building, over which the Mayor will preside. Addresses will be given by Dr. J. Symons, president of the Royal Geological Society of Cornwall, Mr. J. C. Tregarthen, Sir Humphry Davy Rolleston, and Sir Ambrose Fleming, the last of whom will represent the Royal Institution of Great Britain, where for eleven years Davy worked and lectured so successfully. An exhibition of Davy relics will be on view. The Societies will be pleased to welcome anyone interested in the proceedings.

The seventh Annual Conference of the South-Western Naturalists' Union was held at Torquay during Whitsuntide under the presidency of Dr. F. A. Bather. The Union covers the counties of Cornwall, Devon, Dorset, Somerset, Gloucestershire, and Wilts. The meetings were held in the Pengelly Hall at the Museum of the Torquay Natural History Society, the president of which, Sir Francis Layland-Barratt, received the guests. The fine weather favoured excursions to Kent's Cavern, with Mr. H. G. Dowie as guide, round Dartmoor, and to the chief points of geological interest in the neighbourhood of Torquay under the vigorous leadership of Mr. G. C. Spence. Sir John Russell delighted the members with an address on "The Conquest of the Waste Places", showing, chiefly by illustrations from the wheat belt of Canada and the irrigation of Australia and Egypt, how science has countered the pessimistic predictions of Sir William Crookes. Mr. F. R. Horne, of Seale Hayne Agricultural College, lectured on the succession of various woodland associations by grass land, and Mr. J. Walker read a paper on the moths and butterflies of the Torquay district. The president's address, "Imagination and Fossils", showed how the controlled imagination can reconstruct the living form, habitat, and mode of life of vanished creatures quite unlike any now existing.

On May 15 a disastrous explosion, followed by fire, at the Cleveland Clinic, Ohio, was the cause of more than a hundred deaths among patients and staff. The heavy mortality was due to gas poisoning; rescue work was much hampered by the dense brown choking fumes in the building, which, it was suggested, were bromine. The first explosion appears to have occurred in the X-ray department, and was probably due to the ignition of cellulose nitrate photographic film stored there. In a statement made to Science Service, of Washington, D.C., Dr. Charles E. Munroe, the chief explosives chemist of the U.S. Bureau of Mines, stated that, within less than a half-minute after the explosion of such film, the resulting gases would be about one-third carbon monoxide and one-tenth oxides of nitrogen. These gases, produced in large quantities, spread through the building, and the brown fumes of the oxides of nitrogen were thought to be bromine. The secondary explosion was probably due to the ignition of an explosive mixture of the carbon monoxide with air. In investigations upon the effects of the fumes from smokeless powder explosions made by H. C. Knight and D. C. Walton at the Chemical Warfare Service's Edgewood Arsenal in 1925, it was found that experimental animals brought out of the explosion fumes, apparently unharmed, succumbed later to pulmonary œdema. Since the fumes from smokeless powder are practically identical with those from cellulose nitrate film, this would account for the delayed poisoning effect shown by many of the victims.

The Linnean Society of London held its anniversary meeting at Burlington House on May 24, under the presidency of Sir Sidney F. Harmer. The following were elected officers of the Society for 1929–30:—*President:* Sir Sidney F. Harmer; *Treasurer:* Mr. H. W. Monckton; *Zoological Secretary:* Dr. G. P. Bidder; *Botanical Secretary:* Mr. J. Ramsbottom. The Linnean Gold Medal for 1928–29 was handed to Dr. J. B. Hubrecht, Counsellor of the Netherland Legation, and son of the famous zoologist, for conveyance to Prof. Hugo de Vries, to whom the medal had been awarded in recognition of his great contributions to the advancement of botanical science. In presenting the medal, the president, Sir Sidney Harmer, paid tribute to the influence de Vries has had on biological thought since his thesis in 1870, particularly by his work on osmotic pressure, his theory of intracellular pangenesis, and his long series of studies on experimental evolution.

Lieut.-Col. A. T. Gage, having informed the Council of the Linnean Society of London that he wishes to resign his position as Librarian and Assistant Secretary at the end of October, Mr. Spencer Savage has been appointed to succeed him. Col. Gage was formerly the Director of the Botanical Survey of India and Superintendent of the Royal Botanic Garden, Calcutta. He entered the services of the Linnean Society as assistant to the late Dr. B. Daydon Jackson in 1924, succeeding him in office (though not with the special title of General Secretary) in 1926. Mr. Savage has been clerk to the Society since 1911, with a break while on active War service. He is well known to botanists by his bibliographical studies and to members of the Society as an authority on the Linnean collections and manuscripts.

The Hanbury Memorial Medal of the Pharmaceutical Society of Great Britain for "high excellence in the prosecution or promotion of original research in the Natural History and Chemistry of Drugs" has been awarded for the year 1929 to Prof. Henry Hurd Rusby, professor of materia medica in the College of Pharmacy, Columbia University, New York. The medal is purchased from a fund raised in 1876 to perpetuate the memory of Daniel Hanbury, F.R.S., who died in the previous year. His family name is perpetuated by the house of Allen and Hanbury, in which his father, Daniel Bell Hanbury, who survived him, was a partner. His principal investigations were upon the drugs of commerce of his time. In 1927 the recipient of the medal was Dr. T. A. Henry, of the Wellcome Chemical Research Laboratories, an authority upon the chemistry of the drugs, and it is fitting that his successor to the award should be one who has specialised upon their botany and natural history. So long ago as 1880, Prof. Rusby accompanied an expedition organised by the Smithsonian Institution to New Mexico and Arizona, where many new species of plants were discovered, and in 1885 he was in Bolivia, when some four thousand previously unknown species were found and described. It was while exploring Para and Brazil that he discovered the plant *Cocillana*, and first made known the medicinal properties for which it is now largely employed. In addition to his explorations in Venezuela, the rubber forests of the Madeira River, and the forests of the lower Orinoco, during the War he went on an expedition to Columbia in search of quinine-yielding barks. Nor did the passage of years blunt his zest for exploration, for in 1922 he was in charge of the Mulford expedition which undertook a biological investigation of tracts of the Amazon basin. In addition to the chair of materia medica, he has the post of pharmacognosist to the Port of New York, and with it the responsibility for the inspection of drug imports, a task calling for ceaseless vigilance in the detection of ingenious adulterations. He is at the moment engaged in a typically vigorous campaign to prevent the importation and use of decaying ergot from Russia. Only twice before has the award gone to America—to J. M. Maisch in 1893, and to F. B. Power in 1913.

AT the present time there is a great demand for underground cables suitable for carrying electric currents at very high voltages in towns and their neighbourhood. A very large amount of experimental work in this direction has been carried out by cable manufacturers during recent years. We learn from a paper by G. Martinez which appears in the *Electrical Review* for May 24, that success is now almost assured by the invention of an 'oil-filled' cable. In this cable there is inside the conductor a longitudinal duct carrying oil which is connected with reservoirs at the junctions at each end of a section. When the conductors get hot the oil is forced by their thermal expansion into the reservoirs, and when they get cool it is sucked back. The conductor is insulated in the usual way, but owing to the diminished mechanical stresses on it the thickness of the insulation necessary is appreciably diminished. The cable is armoured with hard brass strip over the lead sheath and is finally protected with waterproof cloth tape. The working temperature of this oil-filled cable can be much higher than that of the ordinary high voltage cable, and so it can carry a heavier load, while it can be safely laid directly in the ground. There are no hollows inside these cables. In ordinary cables the brush discharges that take place in a hollow are a frequent cause of breakdown. It is claimed that it is possible to install underground cables of this new type up to pressures of 220 kilovolts. We understand that two 132 kilovolt lines having a total length of 52 miles will be installed in London very shortly. The installation is partly experimental, but the makers have so much faith in the performance of their cables that they are taking the greater part of the financial risk.

IT is expected that in a few weeks' time the Brookmans Park Station, the first high power station of the regional scheme of broadcasting in Great Britain, will begin operation. At first it will radiate only one programme, but later on it is intended to radiate two simultaneously, using different wave-lengths. It is probable that at first difficulties will be experienced by listeners, especially those who are in the neighbourhood of Brookmans Park. The foreign station listener in this district will have great difficulty in tuning out the local station. The ordinary listener also may be unable to hear the programme from 5GB to which he has been accustomed. The *Wireless World* for May 15 questions the wisdom of the policy of providing satisfactory crystal reception throughout Great Britain. It suggests that this is probably being done at the expense of those who have invested in expensive valve sets. These listeners have begun to think that they have a right to regard the continental stations as a source of entertainment, however superior the quality of the home reception may be. In the same paper there is an article on "Getting ready for Brookmans Park", describing methods of improving selectivity. It is known theoretically that the selectivity of a receiving set can be improved either by diminishing the resistance of its tuned circuits or by increasing their number. In the latter case a filtering effect is imposed on the incoming signals. It is found in practice that the limit to which the resistance can be diminished is quickly reached. We may increase the number of tuned circuits so as to filter out undesired signals, but this would be expensive. The most promising device is to use a tuned and variably-coupled aerial transformer. It is stated that in no other way can the selectivity of a set be so radically improved.

EXTENSIONS of the building of the Royal Scottish Museum, Edinburgh, have permitted considerable expansion and rearrangement of the collections, while the Interim Report of the Royal Commission on National Museums, by allaying the fear of fire, permitted the progress of equipment and schemes previously held up. Thus we read in the Director's type-written Report for 1928 of the opening of a gallery of comparative ethnography, two new halls for natural history, a civil engineering gallery, and added exhibition space for minerals. A beasts of prey hall and an architectural hall will be opened before long. Still there are complaints of lack of space: a printing press bought for exhibition has to be kept in store, while the consultation of reserve collections is hampered for want of storage accommodation. For all that, the collections grow: the larger accessions include the Logan collection of British Lepidoptera; the late Robert Dunlop's fossils on loan from Dunfermline will be more accessible to students; a most useful collection of ceramics is lent by Lady Binning. Among the numerous individual additions one notes the first specimen of the desert wheatear to be found in the British Isles, the nest of a garganey duck—the first proof of its nesting in Scotland—and a self-rescue apparatus presented by the Mine Safety Appliances Co. of Pittsburg. One learns without surprise that the museum grows in popularity. Apart from the school classes and the lantern lectures to school children, the annual number of visitors has increased by 130,000 within the last eight years. It is believed that visitors to the city are responsible for the numbers on week-days, but that local people make up the large Sunday crowds. Evening opening, so often clamoured for, appears here, as elsewhere, scarcely to warrant the additional cost of lighting and attendance.

The floating of globules of mercury on a water surface was described recently in letters to the Editor (Mar. 16 and May 18). A correspondent reminds us that this effect was dealt with by Prof. C. V. Boys in the second edition of his well-known book on "Soap-Bubbles and the Forces which Mould them". The description is as follows: "One of the most beautiful bubbles of one liquid in another which can be produced is occasionally formed by accident. If a basin of water containing a few pounds of mercury is placed under a violently running water-tap the water and air carried down into the mercury cause mercury bubbles to form and float to the surface. I have been able to float these into a second basin, where sometimes for a few seconds they look like shining balls of pure silver, perfect in form and polish. When they break, a tiny globule of mercury alone remains, far more, however, than the liquid of a soap-bubble of the same size. I have obtained mercury bubbles up to about ¾ inch in diameter. M. Melsens, who first described these in 1845, found the upper part to be so thin as to be transparent and of a slaty-blue colour, a phenomenon which I have not noticed."

The code devised at Strasbourg and adopted by international agreement for the telegraphic transmission of seismological information provides only for the data derived from the seismograms of individual stations (Nature, Dec. 22, 1928, p. 968). There are occasions, however, when the sender of a report has already determined the epicentre of an earthquake and wishes to give its position. For this purpose, a simple method has been adopted by the Meteorological Office and by the U.S. Coast and Geodetic Survey. At the close of the report there will be added the word 'epicentre' and a group of five figures. The first two figures give the latitude and the last three the longitude. If the latitude is north and the longitude east, the number 2 is added to the middle figure; if south and east the number 4, if south and west the number 6, and if north and west the number 8. Thus, the figures 01779 would indicate that the epicentre is in lat. 1° S., long. 179° W.

In the January issue of the *Bulletin de la Société d'Encouragement pour l'Industrie nationale*, the Agricultural Committee of the society gives an account of the steps which have been taken during the past twenty years by the railway companies of France to encourage agriculture and the remarkable results obtained. The Paris-Orleans company in 1903 began to distribute pamphlets, to organise lectures, discussions, and demonstrations, with the view of improving and intensifying production and increasing the possible markets for fruit, cereals, potatoes, wines, cattle, milk, butter, cheese, fowls, eggs, and honey. Special officials were appointed to deal with the rapid transport of this produce to market. The result of these efforts was remarkable: in 1905 the company carried 250,000 tons of agricultural produce, and in 1907, 639,000 tons. Other French lines have taken similar action with like noteworthy results.

Dr. J. H. Quastel, of Trinity College, Cambridge, who is known for his work on reduction-oxidation systems and for his studies of the activation of molecules by living organisms, has been appointed biochemist at the Cardiff City Mental Hospital.

A violent earthquake was recorded at Kew Observatory, commencing at 22 hr. 51 min. 19 sec. G.M.T., on May 26. The epicentre is estimated to have been 4800 miles away, but the initial impulse was not sharp enough to give any indication of the bearing.

At the annual general meeting of the Institute of Physics, held on May 28, the following were elected to take office on Oct. 1 next:—*President:* Dr. W. H. Eccles; *Honorary Treasurer:* Major C. E. S. Phillips; *Honorary Secretary:* Prof. A. O. Rankine. Sir Ambrose Fleming, Sir James Jeans, and Sir Oliver Lodge were elected honorary fellows of the Institute.

It is announced in *Science* that the Agassiz medal for oceanography of the National Academy of Sciences of the United States has been awarded to Prof. J. Stanley Gardiner, professor of zoology and comparative anatomy in the University of Cambridge, and the Watson medal to Dr. Willem de Sitter, director of the Observatory at Leyden and professor of theoretical astronomy in the University.

The fourteenth Annual Conference of the Museums Association will be held at Worthing on July 1–5, under the presidency of Sir Henry Miers. The presidential address, on "Co-operation—the Association's Task", will be delivered on July 2, and will be open to discussion. In connexion with the Conference there will be an exhibition of museum furniture and requirements. The local secretary for the meeting is Miss Marian Frost, The Museum, Worthing.

The Rochdale Literary and Scientific Society has celebrated the jubilee of its formation by the publication of a volume of *Transactions* covering the years 1926–28, and by the presentation of his portrait to Dr. J. R. Ashworth, in recognition of his services as honorary secretary since 1885. Dr. Ashworth contributes a short article on "The Influence of Rain on Atmospheric Deposits", and an unusual and well-illustrated account of the very varied structure of the old pack-horse tracks about Rochdale is given by Jas. L. Maxim.

The Council of the Association of British Chemical Manufacturers has decided to prepare and issue to its members a set of model safety rules for use in chemical works. The Works Technical Committee has been actively engaged for some months on the preparation of these rules, and a small booklet of provisional rules has now been presented to members of the Association. A set of explanations of these rules is in preparation by the Association, the address of which is 166 Piccadilly, London, W.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A lecturer in the Electrical Engineering Department of the Sunderland Technical College—The Chief Education Officer, 15 John Street, Sunderland (June 5). Assistant Examiners in the Patent Office—The Secretary, Civil Service Commission, Burlington Gardens, W.1 (June 6). A principal engineering inspector under the Engineering Inspectorate of the Electricity Commission—The Secretary, Electricity Commission, Savoy Court, Strand, W.C.2 (June 8). Lecturers in, respectively, engineering, chemistry, and physics, and a mechanical workshop instructor and an electrical instructor, each at the Constantine Technical College, Middlesbrough—The Director of Education, Education Offices, Middlesbrough (June 10). An assistant lecturer in Nature study and horticulture at Stranmills Training College, Belfast—The Principal, Stranmills Training College, Queen's University, Belfast (June 10). A principal of the Government Commercial Institute, Calcutta—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (June 12). An assistant lecturer in the Mathematical Department of the Derby Technical College—The Secretary, Education Committee, Becket Street, Derby (June 14). A director for the Harcourt Butler Institute of Public Health, Rangoon—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (June 15). A scientific assistant under the Imperial Bureau of Soil Science—The Director, Imperial Bureau of Soil Science, Rothamsted Experimental Station, Harpenden (June 19). An assistant lecturer in mathematics in the University of Sheffield—The Registrar, The University, Sheffield (June 19). A bacteriologist at the Antitoxin Establishment of the Metropolitan Asylums Board, Sutton—The Clerk, Metropolitan Asylums Board, Victoria Embankment, E.C.4 (June 19). A senior plant introduction officer, an assistant plant introduction officer, an assistant plant pathologist, a weeds officer, an assistant mycologist, an assistant plant geneticist, and two assistant agrostologists under the Commonwealth of Australia Council for Scientific and Industrial Research —F. L. McDougal, Australia House, Strand, W.C.2 (June 20). An assistant Government analyst, Hong Kong—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1 (June 30). A research assistant in dyeing in the University of Leeds—The Registrar, The University, Leeds (July 1). A zoologist on the scientific staff of the *Discovery* Committee—The Secretary, *Discovery* Committee, Colonial Office, S.W.1 (July 15). A senior secretary on the central administrative staff of London University—The Principal, University of London, South Kensington, S.W.7. A lecturer in library routine and practical cataloguing in the School of Librarianship, London University—The Secretary, University College, Gower Street, W.C.1. A laboratory steward in the physics department of the University College of Hull—The Secretary, University College, Hull.

Our Astronomical Column.

THE TOTAL SOLAR ECLIPSE OF MAY 9.—*Harvard Announcement Card*, No. 87, announces that Prof. H. T. Stetson, who was stationed at Alor Star, Kedah, experienced some interference from high cirrus clouds, but succeeded in measuring the illumination of the corona. He found it equal to 0·15 candle at 1 foot, or to 1 candle at 2·58 feet. As the brightness of the sun has been given as equal to 5000 candles at 1 foot, it is about 33,000 times as bright as the corona.

A DOUBLE STAR OF THE TYPE OF GAMMA VIRGINIS.—Mr. C. Luplau Janssen discusses the orbit of the star Burnham 12304 in *Mon. Not. Roy. Ast. Soc.* for March. He shows that the distance, which increased from the discovery of the duplicity in 1832 up to 1910, is now decreasing, and that an approximate orbit can now be deduced. That which he gives is of the type of Gamma Virginis with very large eccentricity (0·95) and very close approach at periastron, which he calculates will take place in 1976. The period is 177·2 years, and the semi-major axis 2·81″. The hypothetical parallax is 0·089″. It is important to follow the star carefully during the approach to periastron.

HISTORICAL RECORDS OF METEORIC SHOWERS.—Prof. W. J. Fisher, of Harvard College Observatory, Cambridge, Mass., has issued a circular, and distributed it amongst astronomical and other scientific institutions, asking for old accounts of abundant meteoric displays. He intimates that though many descriptions were found by Newton, Quetelet, Herrick, and others, there must be numbers of additional records which have never yet been brought into the light and suitably investigated. That this may be accomplished, and that a thorough discussion of all the available results, ancient and modern, may be submitted to examination and deductions made, seem desirable. It is therefore hoped that persons having access to ancient works containing accounts of long past meteoric exhibitions will search them out and send copies of them to the Harvard Observatory so that they may receive due consideration.

With new data gleaned from old catalogues and chronicles, and the whole comprehensively treated, there is no doubt that our knowledge might receive important additions of interesting kind. From Russian and Japanese sources some useful details have already been received, and the research promises good results if the subject is amply worked up and supported as it undoubtedly deserves.

Of the display of Leonids in November 1766 nothing is apparently known more than mere rumours can convey. Dr. Dick says the meteors of 1799 were seen by all the inhabitants of Cumana, the oldest of whom asserted that the great earthquakes of 1766 were preceded by similar phenomena. Further careful inquiry might elicit important details.

Research Items.

FOOD OF THE GREAT HORNED OWL.—A short account of the more striking habits of this owl (*Bubo virginianus*) appears in the *Canadian Field-Naturalist* for April. In the poplar savanna of Manitoba, where the author, Ralph D. Bird, studied the owl, he estimated that one nesting pair was present in every square mile of suitably wooded country, the presence of good hunting grounds being apparently a decisive factor in the selection of the site. The birds when disturbed have been known to attack man, and the author describes a concerted attack upon himself which had serious enough consequences. An examination of 112 food pellets showed that as a staple diet rabbits headed the list, then followed voles, pocket gophers, ground squirrels, and occasional birds, taken especially after the spring migration. The association of prairie and woodland mammals in the diet suggests a wide hunting range on the part of the owl. Although the nests were not far from farmyards, only one domestic fowl was found to have been taken, and game birds did not average as many as two per nest. The conclusion is that the bird is a decided benefactor to humanity, through its enormous destruction of rodents, which injure crops and are second only to fire as a factor in checking the spread of the forests.

THE GENUS *PHELLIA*.—Dr. T. A. Stephenson's account (*Trans. R. Soc. Edin.*, vol. 56, 1929) of the British species of *Phellia* fills a lacuna in our knowledge of British sea-anemones. In 1858 P. H. Gosse collected from a "rock called Proudfoot, at the entrance to Wick Bay in Caithness", the original specimens of *Phellia gausapata*. The author visited this rock in 1926, and collected thirteen examples of the species, and has given an account of their external characters and internal anatomy. He has examined three other species which have been regarded as belonging to the genus *Phellia*, and shows that two of them —*P. murocincta* and *P. picta*—are Sagartias, and that the other—*P. brodricii*—should be placed in a new genus, *Cataphellia*. The genus *Phellia* is defined for the first time on a valid basis and its relationships determined ; it is removed from the Sagartiidæ and placed in a separate family, the Phelliidæ—with *P. gausapata* as the type species. The patterns developed on the disc and tentacles in the Phellias and other sea-anemones are analysed, and their value as an indication of relationship discussed, especially in respect of species the relationships of which are difficult to determine. The paper is illustrated by text figures and by finely executed drawings in colour which have been admirably reproduced.

GENETICS OF *PRIMULA KEWENSIS*.—In 1899, *Primula Kewensis* appeared at Kew as a natural hybrid between *P. floribunda* and *P. verticillata*. The cross was then successfully made, but has never been repeated, the few plants obtained in later attempts being either like the mother (*floribunda*) or tetraploid *Kewensis*. The original diploid hybrid plants first bore seeds in 1905, producing the tetraploid form. Owing to errors in the early work on this form, it has long been a cytological and genetical misfit. In a paper by the late W. C. F. Newton and Miss C. Pellew (*Jour. of Genetics*, vol. 20, No. 3), which will become a classic, the various problems regarding its origin and genetical nature are solved, and it is brought into line with other cases in recent genetical literature. The fertile *P. Kewensis* is shown to be a tetraploid mutation arising in somatic tissue of the sterile diploid hybrid, and not due to a transverse fragmentation of the chromosomes as formerly supposed. Usually the diploid hybrid is highly sterile, but on the three occasions in which it is known to have set seeds, these gave rise to fertile tetraploid plants. The third lot of such plants, grown at Merton, was the largest, numbering 287 plants, of which 261 were of the ordinary tetraploid type, while the remaining 26 showed much variation, which was generally associated with the presence of 35 or 37 instead of 36 chromosomes. There is also variation in mealiness and shape of the leaves. Several other cases are now known in which a tetraploid form is produced in the crossing of two diploid species, but *P. Kewensis* differs from these in that the tetraploid condition first arises in somatic tissues. By crossing it with the diploid parents, various triploid or near-triploid forms have been obtained and studied. This paper is an excellent example of the necessity for cytological studies in the investigation of any complicated genetical situation, but various problems regarding the descendants of *P. Kewensis* remain to be attacked.

SODIUM ACCUMULATION AND THE EARTH'S AGE.—In the *Am. Jour. Sci.* for April 1929, Prof. A. C. Lane directs attention to yet another source of error in this much-discussed method of estimating geological time. It has been customary, in estimating solvent denudation, to take several analyses of the river water and average them to get the average composition, and then multiply this by the total run-off. This neglects the fact that, generally speaking, the greater part of the run-off of a river is in floods, and that in time of flood the amount of sediment is greater, and of dissolved matter much less, than when the river is normal or low. From work by W. D. Collins on the Colorado River, and by L. Nys on the Meuse and the Ourthe, Lane deduces that it would not be safe to take the solvent denudation of the lands by river waters at more than five-eighths of that usually adopted (for example, by F. W. Clarke in his well-known "Data of Geochemistry"), and he thinks there is a fair possibility that it may be no more than two-fifths. Making allowance for other factors, and for the slow denudation of small continents in times of peneplanation and marine transgression, it is not difficult to bring the figures for the age of the earth by solvent denudation into agreement with the longer periods obtained from the lead-ratios of radioactive minerals.

LIMESTONES AND LIMESTONE SOILS OF THE EAST INDIAN ARCHIPELAGO.—In *Communication* No. 14 of the Geological Institute of the Agricultural University of Wageningen, Holland, Prof. J. van Baren has presented in English the results of his investigations during the last thirteen years on the weathering of limestones and the formation of limestone soils in Java and other islands of the Dutch East Indies. Detailed qualitative mineralogical analyses are given for 21 rocks and for two mechanical fractions of 46 soils derived from them. Other soil data include colour by Lovibond's tintometer, mechanical analysis, hygroscopic coefficient, maximum water capacity, and reaction measurements by several methods. Full chemical analyses are given for a dozen soils and their underlying rocks. It is concluded that the properties of the soils are determined primarily by the composition of the limestone rock. Although the rainfall is important the present knowledge of agricultural climatology is totally inadequate as a basis for the classification of soils and soil-forming processes. The analogies that have been drawn between the red limestone soils of the tropics and other red soils, such as the Mediterranean *terra rossa*, are strongly criticised. The red colour shows nothing beyond the presence of some colloidal iron oxide of unknown origin and gives no evidence that the soil has been formed in a humid tropical climate. It is claimed that the careful collection of facts must proceed for many decades before generalisations on the relation of soil to climate can have any value. Prof. van Baren appeals especially for detailed and systematic mineralogical research on the relation of the soil to the parent rock. He has been able to distinguish minerals formed within the soil from those derived from the parent rock or introduced by the action of volcanoes, water, or wind. The fuller study of such newly formed minerals should reveal some of the chemical processes within the soil. Again, it is shown that apatite is rarely present in either soils or rocks, and cannot be the source of the phosphoric acid in these soils. Prof. van Baren's detailed notes, photomicrographs, and bibliographies on the minerals and organic remains identified will prove of great value in extending this type of work.

Refrigeration Constants.—Supplement No. 65 to *Communications* from the Physical Laboratory of the University of Leyden contains reprints of the papers communicated by Drs. Keesom and De Haas to the Institut International du Froid on the entropy-temperature and total heat-entropy diagrams of methane, ethylene, nitrogen, hydrogen, and helium. The whole of the experimental facts available have been used in constructing the diagrams and have been supplemented where necessary by thermodynamic relations and the law of corresponding states. Copies of these diagrams may be obtained by those interested in refrigeration through the Institut International du Froid.

Diffraction of Light.—The April number of the *Physical Review* contains a paper by Profs. M. E. Hufford and H. T. Davis which is illustrated by a very beautiful pair of photographs of diffraction patterns. These were produced by passing monochromatic light from a small source through two circular holes, and the one from the smaller aperture shows some seventy clear concentric rings in the original. The radii of these have been measured up carefully, and have been compared with the radii computed by an extension of the classical wave theory of diffraction by a circular aperture which was given by Lommel; calculated and observed values are in good agreement. As the authors point out, an investigation of this nature would have been considered to be of purely academic interest a few years ago, whereas at the present time it is of considerable value in defining the regions in which wave theory and quantum theory are individually applicable. It is to be regretted that the detail of the photographs, exceptionally good as it is, is insufficient to show the presence of some secondary fringes that should theoretically be present.

Bridge Stresses.—The issue of the *Journal of the Royal Society of Arts* for May 3 contains the Trueman Wood lecture delivered by Sir J. Alfred Ewing on the results of the work done during the past six years by the Bridge Stress Committee of the Department of Scientific and Industrial Research. It has been found that the passage of a locomotive over a bridge produces a deflection at the centre which oscillates between limits determined by the weight of the locomotive and the intensity of the hammer blow it strikes on the rails due to the movement of unbalanced parts of its mechanism. Some of the lighter engines still in use weighing 15 tons per axle deliver a blow equivalent to a further 15 tons, when some of the more modern ones weighing 20 tons per axle only deliver a blow equivalent to a further 5 tons. The subject is too complex to allow simple rules for the calculation of the stresses produced to be formulated.

Artificial versus Natural Illumination.—In a paper on the cost of lighting industrial buildings which appears in the *Journal of the Franklin Institute* for February, L. L. Holladay discusses some of the problems which arise when the electric light can be purchased at a price not exceeding about 0·7 of a penny. In several cases he proves that artificial light is more desirable than daylight from the economical point of view. It is pointed out that natural light, whilst costing nothing out of doors, can only be delivered at a certain definite cost indoors. The cost and maintenance of the windows and the lighting shafts has to be taken into account. In the winter time the thermal losses through the windows are appreciable and increase the heating costs. In making the comparison between the running and overhead costs of a building built for artificial lighting and one built for utilising the daylight also when possible, it is assumed that both buildings have similar ventilating and heating apparatus. It is assumed that for seven months of the year the inside of the building is maintained at 65° F. and that the air is completely changed twice every hour. The costs of washing the windows at least twice every year and cleaning the lamps at least six times are taken into account. The heat loss due to the windows is generally offset by the saving they effect on the cost of the electric light. The author recommends, therefore, that industrial buildings should be built with simple side windows. A windowless building requires a shaft about two feet wide for ventilation. It is not economical to incur heavy expenses for lighting shafts or windows in the roof. For dwelling houses we must have windows to enable us to see outside, but in factories the glass of the windows is often obscured. The conclusion is that when artificial illumination can be obtained very cheaply, it would be well for the architect to take this into account when designing the building.

The Testing of Porcelain Insulators.—The initial and maintenance costs of the large number of porcelain insulators required for high-tension overhead distributing systems have made it necessary to apply rigorous tests to them before they leave the factory. They are usually tested in accordance with the standard specification or with one which follows it very closely in essential details. Specifications based on the individual opinions of consulting engineers are now very rare. In a paper read to the Institution of Electrical Engineers on April 11, B. L. Goodlet discussed the technique of porcelain insulator testing. The three basic electrical tests are the dry and the wet spark-over voltage and the puncture voltage. The fundamental mechanical and physical tests are for mechanical strength, ability to withstand a temperature cycle, and the test for porosity. In addition, seven other tests, including corona tests, fog tests, and tests to determine 'fatigue' under vibration, are sometimes specified. The six fundamental tests are generally considered to be sufficient. If the physical laws which govern the effects produced were better known, it is highly probable that the required tests could be much simplified and appreciable economies effected. The influence of the atmospheric humidity on the spark-over tests is known to few physicists. Curiously enough, an increase in the humidity of the atmosphere up to about 75 per cent, at 40° C., increases the voltage at which a flash occurs. The wet spark-over voltage test is made with artificial rain. As the rate of precipitation is increased, the spark-over voltage falls rapidly until a rainfall of about 3 mm. per minute is reached, after which a further increase in the intensity of the rainfall has little effect on the voltage at which spark-over occurs. The angle of the rainfall has a considerable effect on the result, and so also has the resistivity of the rain, which is a very variable quantity. It is found that fog troubles only occur in districts where a considerable amount of solid matter in a finely divided state is suspended in the atmosphere.

RADIO RECEPTION IN A TUNNEL.—Some interesting experiments were recently made by Dr. A. S. Eve, of McGill University, and several well-known radio engineers, on reception in a tunnel on the Canadian Pacific Railway. The results are printed in the *Proceedings of the Institute of Radio Engineers* for February. The tunnel is 3½ miles long and passes through Mount Royal near Montreal. Preliminary experiments made in 1926 indicated that the penetration of radio waves into the tunnel was a function of their frequency. If the wave-length was less than 100 metres, the radio waves died away within a few hundred feet of the mouth of the tunnel. More exact experiments made in 1928 bring out the fact that the wires, cables, and rails leading into the tunnel play an important part in the reception by the receiving set. The mouths of the tunnel were blocked and the cables were earthed. The results showed that the effect of the cables and rails was also a function of the frequency. The experiments show that more energy enters through the tunnel mouth than was at first suspected. The effects of the rails and cables were due to a variety of causes which involve wave-antenna effects and re-radiation. Curves are given showing graphically the results obtained and details are given of the geology of the region. Amongst the conclusions arrived at are that short waves do not penetrate rock or soil to any appreciable extent, that cables and rails conduct long waves better than short waves, that insulated wires and cables act as wave antennæ, and that a very appreciable amount of energy enters through the tunnel mouth. Further work is required in a tunnel with no wires or rails leading into it.

PULVERISED FUEL IN POWER STATIONS.—In a paper read to the Institution of Electrical Engineers on April 18, Mr. R. A. Chattock discussed the use of pulverised fuel in electric power stations. He claims that, as the result of the experimental work carried out during the last few years at the Birmingham electrical power station, it has been proved that the use of pulverised fuel gives a higher combustion heat efficiency in the boilers than is obtained by mechanical stokers. He points out that for pulverised fuel equipment the capital cost is greater than for mechanical stokers, but, as boilers can be used of far greater capacity than those equipped at present with mechanical stokers, there is a considerable economy effected in the cost of boilers and boiler house. In the second series of tests made at Birmingham, the equipment consisted of four large coal driers of the rotary type which were fired by small furnaces. These driers reduce the total moisture in the coal from 20 per cent to 6 per cent without driving off any material part of the volatiles contained in the coal. The dry coal was conveyed by elevators and conveyors to bunkers in the boiler house. From thence it was fed to four large motor-driven mills each capable of pulverising 12 tons per hour. The mills are air-swept and the fuel is caught in cyclone collectors and stored in bins over the boiler. From these bins it is delivered by special feeders to the six burners installed in each boiler furnace. Two of these boilers have been in operation for a year with a combustion heat efficiency of about 85 per cent. These experiments have led the Birmingham Corporation to adopt boiler units having an evaporative efficiency of 200,000 lb. of water per hour for the new Hams Hall Station. Unit pulverisers will be used for the boilers, each of which will have five mills, four to run and one to be kept in reserve. New developments are in progress, but satisfactory results extending over several years have been obtained both in America and on the Continent.

PREPARATION OF SUBSTITUTED DIPHENYLAMINES.—The preparation of substituted diphenylamines is often a matter of some difficulty, and it is therefore interesting to note that a new method is given by A. W. Chapman in the *Journal of the Chemical Society* for March. As previously shown, *N*-arylaryliminoaryl ethers [R.C.(OR″): NR′] are converted quantitatively by the action of heat into acyl derivatives of the corresponding diphenylamines [R.CO.NR′R″], and on treatment with alcoholic potash these acyl compounds are readily hydrolysed to the corresponding diphenylamines in yields of about 80 per cent.

SOLUBILITY OF IODINE IN SOLUTIONS OF HALIDES.—The *Journal of the Chemical Society* for March contains an account of experiments carried out by Carter and Hoskins which appear to show that the solubility of iodine in solutions of halides is the result of a tendency to form polyhalides and the opposing salting-out effect. The latter effect is considerable with bromides and chlorides, but negligible with iodides and with the halogen acids. Attention is directed to the fact that in their investigation of the tri-iodide equilibrium Brönsted and Pedersen used potassium chloride solution as solvent and assumed that all the dissolved iodine was present in the free state. No allowance was made for the effect of polyhalide formation, and hence the mass-law expression deduced by Brönsted and Pedersen is incorrect. The corrected value for the equilibrium constant in this case is approximately the same as when the solvent is water.

BENZENE RING.—The April number of the *Proceedings of the Royal Society* contains a full account of Dr. Kathleen Lonsdale's investigation of the crystal structure of hexamethylbenzene, $C_6(CH_3)_6$, which, as was indicated in a letter from her to NATURE on the same subject (Nov. 24, 1928, p. 810), is of great interest from the way in which it confirms current ideas of the structure of the benzene ring. This particular molecule, unlike many other aromatic compounds, exists as a separate entity in the crystal, which is triclinic and easily deformed. The X-ray evidence is definite that the molecule is in the form of a ring, and that its nucleus is similar, both in size and shape, to the six-carbon ring of graphite. The X-ray measurements also show that the carbon atom of the methyl group lies in the plane of the benzene ring, so that at least three of the valencies of the aromatic carbon atom must be coplanar. There is unfortunately no new information to be had concerning the elusive fourth bond, except that it must be disposed so as to give the ring as a whole a centre of symmetry, which seems to rule out Kekulé's static model, with its three double bonds. The carbon atoms in the methyl groups, as would be expected from their aliphatic nature, resemble the carbon atoms in diamond rather than those in graphite; the methyl group itself, to use Dr. Lonsdale's analogy, acts towards X-rays very like an electron shuttlecock, if we picture a single atom as a tennis ball.

In the Yellowstone with Princeton.[1]

By Prof. O. T. JONES, University of Manchester.

IN the issue of NATURE of Nov. 5, 1927, Mr. E. B. Bailey gave a brief account of the 'Summer School of Geology and Natural Resources', which has been organised by Prof. R. M. Field, of the University of Princeton, N.J. I was privileged last summer to be the guest of the Summer School in a tour through some of the characteristic regions of the United States, my fellow guests being Mr. W. J. Johnston, of the Canadian Geological Survey, and Prof. W. A. Parks, of Toronto.

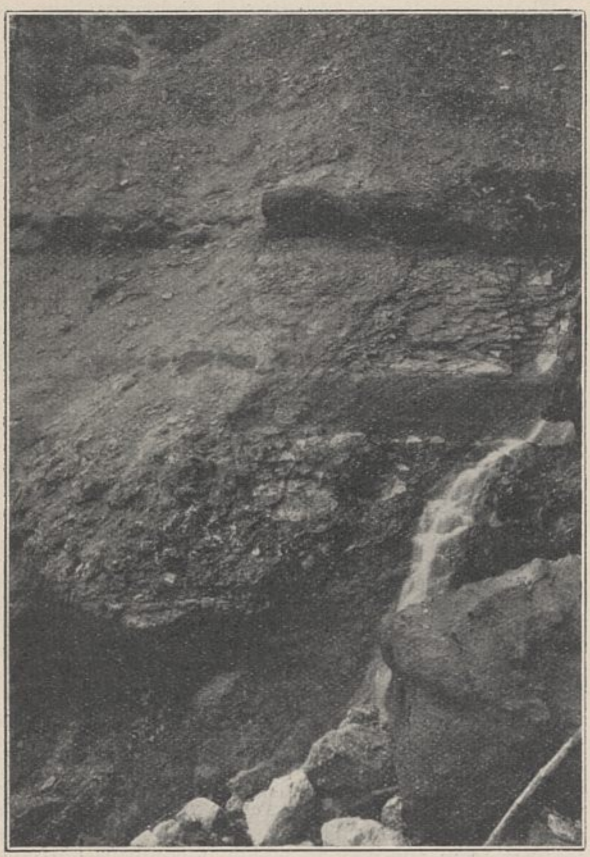


FIG. 1.—Section of lower part of sediments near Red Rock. Photograph by Prof. O. T. Jones.

We started from Princeton on June 21, and returned on Aug. 2, and in the course of the tour we visited the Yellowstone National Park.

Within its area of 3344 square miles, this Park numbers many remarkable features, and among them the great canyon which has been carved by the Yellowstone River on its way to join the Missouri is one of the most interesting. After leaving Yellowstone Lake the river winds through a flat-floored valley before plunging in succession over the Upper Fall (108 ft.) and the Lower Fall (309 ft.), where the canyon commences. About 20 miles lower down, the Yellowstone is joined by the Lamar, an important tributary flowing in a wide, flat-floored valley.

In the course of the 1926 excursion, Prof. Field observed from near Artist's Point some sediments in the opposite wall of the canyon about half a mile below the Great Fall, and with a kinematograph camera and telephoto lens obtained a clear record of these deposits. In August 1928 we visited the locality and examined the sections in detail. Our examination led to the discoveries in regard to the remarkable history of the canyon which are briefly summarised below.[2]

The sediments which Prof. Field had previously observed lie in a narrow 'in and out' channel which passes behind a prominent pinnacle on the canyon wall known as the Red Rock, and consist of more than 187 feet of alternations of blue muddy silt, yellow sand, and conglomerate, the coarser deposits having a calcareous or tufaceous cement (Fig. 1). The base of the channel lies about half-way down the canyon wall, which at this point is about 800 feet high. Dr. Elwyn Perry and other members of the Summer School observed also a small thickness of sediments within 50 ft. of the bottom of the canyon and within about 100 yards from the foot of the Great Fall, and one of us noticed on the west side of the canyon, where it is drenched by the spray of the fall, a patch of blue stratified material which appeared to be similar to the silt near the Red Rock. On our return to the east we discovered that this exposure had been visited nearly sixty years ago by Dr. A. C. Peale, during the preliminary survey of the Park by F. V. Hayden and his assistants. Dr. Peale described this material as a blue mud, and there is little doubt that this and the sediments low down on the opposite side of the canyon are relics of the same series as that more fully preserved near the Red Rock. We found, too, that the east wall of the canyon, between the Upper and the Lower Fall, is composed in large part of cross-bedded sands capped by a tough conglomerate with tufaceous cement.

According to the prevalent opinion, the canyon was eroded in postglacial times, and it has been regarded as evidence of the enormous amount of denudation that has taken place since the Glacial Epoch. Colour was lent to this view by the distribution of the terraces which surround the Yellowstone Lake and extend down into the Hayden Valley towards the Yellowstone Falls. These terraces are composed in part of resorted glacial deposits which occur around the Yellowstone Lake and in the Hayden Valley, and are therefore clearly of postglacial date. It appears also that the conglomerate between the Upper and Lower Falls has been interpreted as an extension of these terrace deposits, and it was so regarded by E. De Martonne, who figured the section in the *Annales de Geographie* (vol. 22, 1913, Pl. II. B, facing p. 136). This was also the interpretation adopted by Mr. W. H. Holmes in his report on the geology of the Park attached to Hayden's 12th Annual Report on the Territories, 1878. As this conglomerate occurs on both sides of the present canyon, it was argued that the canyon must be of later date than the Yellowstone Lake terraces, and therefore postglacial. Our examination disclosed, however, that a pre-existing canyon had been at some period filled to the brim with sediments, and the relation of these to the glacial deposits seemed to indicate that not only the erosion of the canyon but also its subsequent filling had taken place before the advent of the glacial period, and that the canyon was a much older feature than had been previously supposed.

The fine muddy silts which form a considerable proportion of the sedimentary succession in the canyon recall lake deposits, and the occurrence of several

[1] Based on a lecture entitled "The History of the Yellowstone Cañon (Yellowstone National Park), U.S.A.", delivered before the Geological Society of London on Jan. 9.

[2] A more detailed account appears in the *Amer. Jour. of Science*, March 1929.

layers of silt following immediately upon conglomerate inevitably suggests the establishment of lakes in the canyon at successively higher levels, and their subsequent filling with deposits, beginning with fine sediments and ending up with coarse sands and gravels. Such lakes could only come into existence if the canyon had been dammed below this point subsequent to its erosion. What then was the agent which impounded these lakes in the canyon? The study of the geological maps in the United States Folio (1896) suggested the possibility that great flows of lava had entered the Yellowstone Valley from the north from the direction of Gardiner, and had flowed against the direction of the drainage into the Lamar Valley and the canyon. On the geological map of the Canyon and Gallatin Sheets several small masses of basalt and trachytic rhyolites have been mapped, the relation of which to the flanks of the valley suggests that they are relics of flows which must originally have been of wide extent and filled the lower Yellowstone Valley to a depth of more than 1500 ft.

FIG. 2.—Section near Tower Falls showing two basalts with intervening conglomerate resting on andesitic breccias. Photograph by Dr. M. B. Hodge.

The suggestion that arises naturally from the study of the geological map is, however, contrary to the interpretation of certain of these flows which is embodied in the description of the Folio which was published in 1896. The summary in the Folio of the geological and volcanic history of the region is due to Arnold Hague. The igneous rocks were described by Iddings in Monograph 32, Part II, and in this monograph reference is made to the account of the physiography of the Park by Hague in Monograph 32, Part I. It appears, however, that this part of the monograph has never been published, and we are dependent upon the brief summary of the geology of the Park which accompanies the folio.

Hague's view of the volcanic history of the Park is embodied in the following table:

Pleistocene	Glacial drifts, etc.
Neocene	Basalt. Rhyolite. Basalt. Canyon Conglomerate. Basalt. Andesitic flows and breccias. Trachytic rhyolites. Basic breccias.
Eocene	Acid breccias. Pinyon Conglomerate
	Unconformity.
Cretaceous	Laramie formation

The rocks to which special attention is directed are the trachytic rhyolite, which was assigned to a period during the accumulation of the Neocene volcanic breccias, and the two basalt flows with the intervening canyon conglomerate which were believed to underlie the rhyolite. Since the canyon conglomerate yielded fragments of bones which were identified by Prof. O. C. Marsh as belonging to the skeleton of a fossil horse of Pliocene time, the rhyolites must, according to this view, have been erupted at a late stage in the Pliocene period, and the erosion of the canyon through the rhyolites must have occurred at a still later period. As this interpretation of the relation of the basalts, canyon conglomerate, and trachytic rhyolite to the main rhyolite seemed to be at variance with the distribution of these rocks as shown on the geological map, Prof. Field and I decided to investigate this problem further.

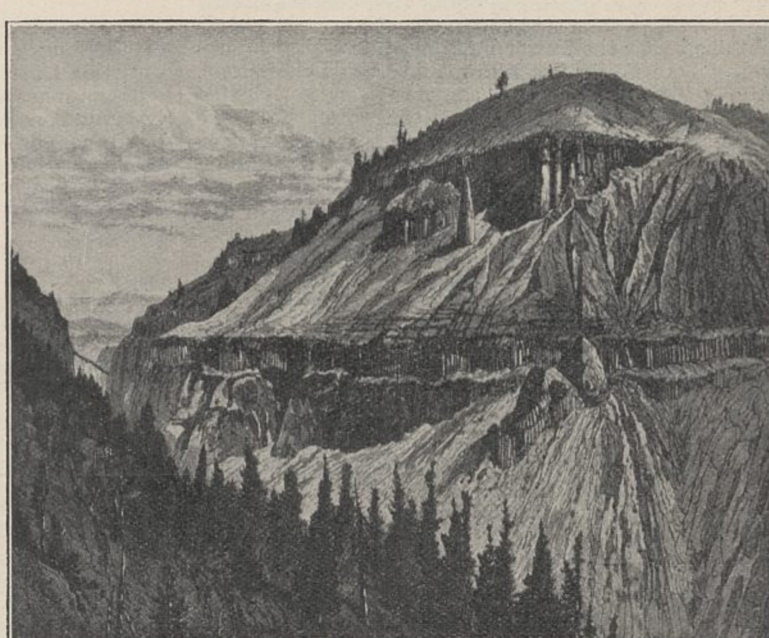


FIG. 3.—Drawing of section near Tower Falls by W. H. Holmes. From Hayden's 12th Annual Report of the Territories, 1878.

In various places on the route between Gardiner and Camp Roosevelt, which lies near the junction of the Yellowstone and Lamar Valleys, there are masses of basalt and trachytic rhyolite which are obviously perched on narrow shelves on the valley sides and their situation is such that these lavas must have been poured out on to the floor of a pre-existing valley.

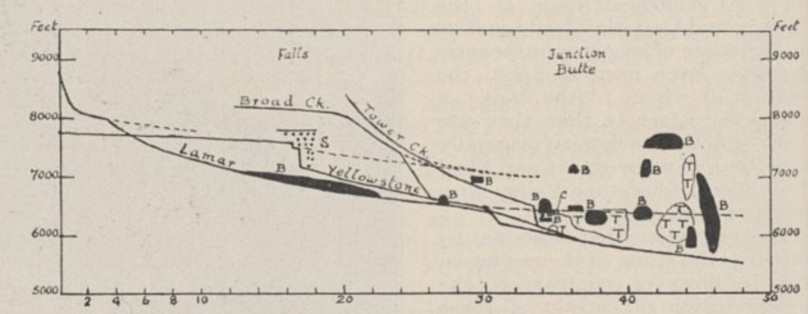
The most convincing evidence of the relation of the basalts to other rocks in the canyon is, however, obtained near the Tower Falls south of Camp Roosevelt, where Tower Creek drops into the Yellowstone. Above Tower Falls the 'canyon' is a fairly wide valley with terraced slopes. Near Tower Falls the river swerves to the west and enters a very narrow canyon with almost precipitous walls of andesitic breccia which has been eroded into a striking series of pinnacles or 'needles'. This is the 'second canyon' of earlier observers, and is probably of postglacial origin. Its rim is formed by a sheet of basalt with remarkably regular columnar jointing; this sheet is easily accessible on the road on the west side, where it rests on a conglomerate. On the east side the basalt overlies a conglomerate about 100 feet thick, underneath which is another band of columnar basalt (Fig. 2). This striking section is among those drawn by W. H. Holmes, and a comparison of recent photographs with the sketch made more than fifty years ago demonstrates the remarkable accuracy of that artist (Fig. 3).

FIG. 4.—Section in canyon below Tower Falls showing upper basalt and upper part of conglomerate resting on andesitic breccias. Photograph by Prof. O. T. Jones.

If the east side of the second canyon be examined for about a mile below Tower Falls the upper basalt can be traced as a continuous band, but the lower basalt is only present at the north end and the south end, and is not visible in the intervening space, where also the conglomerate is reduced to about one-quarter of its thickness (Fig. 4). This behaviour of the lower basalt and the conglomerate as seen from the west side of the canyon is due to the fact that the lower basalt and the lower part of the conglomerate pass behind a screen of the andesitic breccias which form the lower wall of the canyon. In other words, the basalt and conglomerate series occupy an old valley, and the existing canyon has been eroded on the flank of that valley through the basalts and conglomerate into the underlying andesitic breccia. On the roadside south of Tower Falls the flank of the old valley stands at a still higher level, so that only a few feet of conglomerate separate the upper basalt from the andesitic breccias; ultimately it cuts out from below the upper part of the conglomerate, and the upper basalt then comes to rest on the andesitic breccias that formed the flank of the old valley. There is here convincing evidence that the basalts and conglomerate have filled in a valley which formerly continued in the line of the wide part of the canyon above Tower Falls.

In the same line about two miles farther north stands the striking feature known as Junction Butte. The capping of the butte is basalt, while the lower part of it is composed of trachytic rhyolite. Both here and in other places farther down the canyon, the relation of the basalts to the trachytic rhyolites appears to indicate that these two rocks belong to the same general period of eruption. A narrow outcrop of trachytic rhyolite is in fact represented on the geological map directly on the course of the buried canyon more than a mile south of Junction Butte.

Holmes has also given a drawing of a sheet of basalt lying on conglomerate about half-way down the wall of the canyon, four miles above Tower Falls. Again, basalt overlying in places the canyon conglomerate is mapped on the floor of the wide Lamar Valley for a distance of 20 miles above Junction Butte.



Approximate scale in miles.

FIG. 5.—Longitudinal profiles of Yellowstone and its principal tributaries, showing also the lava flow relics in relation to the profiles. The black masses labelled B are basalts; the areas marked T are trachytes; C indicates the canyon conglomerate near Tower Falls; and S the sediments near the Yellowstone Falls.

There is no doubt, therefore, that lava flows entered the Lamar Valley and penetrated for several miles into the canyon, and that near Tower Falls this filling of the older canyon is by a fortunate circumstance still preserved, and it confirms the suggestion made above that the damming of the canyon may have been due to lava flows.

If we inquire further into the distribution of the basalt relics that now lie in the flanks of the lower Yellowstone canyon—the 'third canyon' of previous authors—we find that they rise in places to a level of between 7800 ft. and 8000 ft., whereas the highest level attained by the sediments near the Yellowstone Falls is a little above 7800 ft. The lava surface stood, therefore, at a height sufficient to cause the filling of the upper end of the canyon to its very brim.

We turn now to a consideration of the longitudinal profile of the Yellowstone River and its principal tributaries. The Lamar Valley profile shows clearly three cycles of erosion—the earliest cycle is only represented by a portion near the head of the valley, the second cycle extends down to within about five miles of Junction Butte, where the valley of the third cycle begins. In the Yellowstone there are three or perhaps even four cycles represented (Fig. 5).

There is some doubt whether the part of the valley above the falls or the portion between the two falls should be assigned to the first cycle, but it is immaterial in this connexion. The main canyon belongs clearly to the second cycle and the third canyon to the third cycle, the second canyon being probably due to a later and postglacial cycle. The greater part of Tower Creek pertains to the second cycle, and at present hangs conspicuously above the second canyon. The profile of Broad Creek, which enters higher up the main canyon on the east side, is related as to its middle portion to the first cycle and as to its lower portion to the second cycle. Evidences of these cycles can also be traced in the transverse profiles of the various canyons. If now we project on to these profiles the outcrops of the basalt and trachytic rhyolite relics, we find that these descend at their lower ends to within about 100 feet of the river level in the third canyon and at their upper ends attain increasingly greater heights downstream.

It follows that these lava flows entered the canyon when the third cycle of erosion was far advanced.

Since the main canyon which pertains to the second cycle was eroded through the rhyolitic rocks it is obvious that a great interval of time separates the eruption of the rhyolites and that of the valley basalts which occupied the valleys of the third cycle. These considerations render it unthinkable that the basalts and conglomerates near Tower Falls were in existence prior to the eruption of the rhyolites. Moreover, there is reason to believe that the surface of the rhyolites had been reduced by prolonged erosion to a peneplain before the initiation of the first cycle of erosion. The canyon cycle of erosion thus commenced a very long time after the eruption of the rhyolites, and as a result, it is assumed, of successive uplifts, rejuvenation brought about the erosion of the main canyon and later of the third canyon. While the latter cycle was far advanced, eruptions of basalt and trachytic rhyolites dammed the canyon, and near the falls it was filled to the brim with sediments. Erosion was thus arrested and the canyon became a fossil canyon.

Since the lava eruptions of the Upper Pliocene the greater part of the lava dam has been removed, leaving only relics here and there as witnesses to the former extent of the lava floods. The erosion of the dam allowed of the removal of the sediments and the resurrection of the canyon. The original canyon is therefore an extremely ancient feature, dating probably from the Middle or Lower Pliocene.

In conclusion, it gives me great pleasure to put on record the remarkable accuracy of Mr. Holmes's observations and his deductions made during the short period when he was examining the geology and physical features of the Park more than fifty years ago.

Mineral Industry of New South Wales.

The Department of Mines of New South Wales has issued a very useful volume entitled "The Mineral Industry of New South Wales", written by E. C. Andrews and the staff of the Geological Survey, and edited by F. S. Mance, Under Secretary for Mines, who contributes two introductory sections. Such a work was long overdue; in 1901 a similar work, entitled "The Mineral Resources of New South Wales", was produced by Mr. Edward F. Pittman, at that time Government Geologist of New South Wales. This book contained a mass of useful information, and was in such demand that it has been out of print for many years. When Mr. Pittman's book was written, the most important mineral products of New South Wales were gold, copper, and tin, whereas to-day lead, zinc, and coal are of far greater importance.

The general trend of mineral production in the State has been markedly upwards, and the value of these productions has risen tremendously. The total value of the metals and minerals produced in the State of New South Wales to the end of 1927 is given as close upon 445 million pounds sterling, out of which the decade 1918–1927 has contributed no less than 155½ million pounds sterling, and there is every evidence that the upward trend is likely to continue.

The present work covers satisfactorily the whole field of mineral production; it commences with a few brief sections of a general character, followed by a description of the occurrences of metals and metallic ores, ranged in alphabetical order; the only serious exception to this statement may be found in the fact that the four metals, silver, lead, zinc, and cadmium, are all lumped together mainly for the reason that the ores of these metals are generally found intimately associated. Of course by far the most important deposit of these minerals in the State of New South Wales is in the Great Broken Hill deposit, one of the most important in the world, not only on account of its magnitude, but also because the intimate admixture of ores occurring there has stimulated the ingenuity of inventors to devise processes which have since been applied successfully to deposits in all parts of the world.

The third part of the book consists of a description of the occurrences of non-metallic minerals, also arranged in alphabetical order. The term 'non-metallic' minerals is used in its ordinary acceptance, compounds of the elements which the chemist would speak of as metals of the alkalis, and the alkaline earths being, in accordance with ordinary everyday usage, spoken of as non-metallic substances. The work is a very complete one, and will no doubt satisfactorily fulfil its object of presenting to the reader a brief but accurate and authoritative description of the mineral wealth of New South Wales.

University and Educational Intelligence.

Cambridge.—The Director of the Observatory has, with the consent of the Vice-Chancellor, reappointed Dr. W. M. Smart, of Trinity, as chief assistant at the Observatory for five years.

The Sudbury Hardyman Prize at Emmanuel College, offered to a graduate of less than M.A. standing, has been awarded to A. H. Wilson for a dissertation on "Quantum Mechanics". Special dissertation prizes have been awarded to C. B. Allsopp (physical chemistry) and J. G. A. Griffiths (chemistry).

Sixty-nine 'land-grant' colleges and universities have been established in the United States under a series of Acts, beginning in the year 1862, for the granting of land for financing education in agriculture and the mechanic arts. The sixtieth annual report of the Bureau of Education on these institutions (*Bulletin* No. 14; 1928) shows that from small beginnings they have by degrees become leading factors in higher education, enrolling, as they do, more than two-fifths of all the university and college students in the United States. Land-grants now provide only a small fraction of their total revenues. In 1926-27 the land-grants and other federal aid amounted to only four million dollars out of receipts amounting in the aggregate to 137 million dollars. Twenty-six of them with receipts amounting to 78 million dollars are now combined land-grant colleges and State universities. Agriculture attracts only a small and diminishing number of students. In 1927 only seven and a half per cent of the resident students in the 52 institutions attended by white students were pursuing agricultural courses, while twenty per cent and five per cent were students of engineering and home economics respectively. In the 17 negro colleges, out of 7018 students enrolled in regular courses, 965 were studying agriculture, 1672 trades and mechanic arts, and 1630 home economics. A comprehensive national survey by the Bureau of Education of the land-grant colleges is now in progress.

The annual conference of the Association of Teachers in Technical Institutions was held in Liverpool during the Whitsuntide holiday. In his presidential address, the new president, Mr. A. E. Evans, of the Battersea Polytechnic, pursued two main arguments which deserve special and serious attention, particularly in view of the educational re-organisation which is now proceeding. The first was that local and regional inquiries into the question of education and industry, and the setting up of occasional committees such as those for engineering and salesmanship, are not, in themselves, sufficient to solve the problems which have already received the attention of such national inquiries as those made by the Malcolm and Emmott Committees. Both these bodies saw the necessity of establishing a small national committee the duty of which would be to co-ordinate local and regional effort and to act as a clearing house for suggestions made towards the solution of the many problems now being presented. No concerted national action is possible without such a body, and, until it is set up, only piecemeal attempts at advance can be made. While welcoming the recently appointed committee on salesmanship, Mr. Evans insisted that production is the first necessity if our industrial problems are to be solved; new methods and new processes must be developed and devised, and new links made between the operations underlying production and the creation of power. Mr. Evans's second argument was one with which readers of Nature are already familiar. In spite of the lip-service paid to the new conception of education with which our scientific and industrial civilisation is concerned, there is still a great tendency for educationists to regard with distrust schemes and curricula which deal with the application of science to industry, and to preserve, therefore, an attitude of remoteness from the everyday world. They forget, in their adoration of poets and artists and philosophers, the scientific workers, engineers, builders, and architects from whom technical institutions are handing down the means of lightening the burdens of mankind. Among resolutions dealt with by the Conference was one on the position of the junior technical school in the educational system. It was the result of a lengthy inquiry made by the Association which included special attention to the way in which these schools have been able to satisfy the demands of industrialists for employees able to adapt themselves to the changing needs of industry.

Calendar of Patent Records.

June 1, 1818.—The first French aeronautical patent was that granted to P. C. Verger on June 1, 1818, for a dirigible airship. The ship, in the shape of a fish, was propelled by manually operated fans and was caused to rise or descend by a weight which could be moved along the length of the ship. According to the patent specification, successful flights had been made in which the airship had been driven and manœuvred with ease, but there is no other record of these flights. The ship bears a close resemblance to that proposed by Pauly and Egg, which had been patented in Great Britain three years earlier.

June 4, 1872.—Vaseline was patented in the United States by R. A. Chesebrough, of New York, on June 4, 1872, the word being used for the first time in the specification of this patent. It was decided in the British courts that the word became one descriptive of the substance on the lapse of the patent rights in Great Britain, and could not be registered as a trade-mark.

June 5, 1787.—William Symington's steam engine, which was patented on June 5, 1787, was originally intended for a road carriage, but its chief claim to importance lies in the fact that it was used by Patrick Miller in the first practical attempts at steam navigation in Great Britain, a small double-hulled paddle boat, with the paddle wheels placed between the two hulls and originally driven by man power, being successfully propelled by it on Dalswinton Lake in 1788. In the following year a larger vessel of the same type was propelled on the Forth and Clyde Canal at a speed of 5 miles an hour, but after a few trials the experiments were abandoned, and were not resumed until the *Charlotte Dundas*, with a new engine, was launched in 1803.

June 5, 1854.—James Bowman Lindsay was the first to propose a definite scheme for connecting Britain and America by wireless telegraphy. His invention for a method of transmitting telegraphic messages by electricity through and across water without submerged wires, the water being made available as the conducting medium, was patented on June 5, 1854. Signals were successfully transmitted across the River Tay (a distance of about ½ mile), and Lindsay calculated that with two stations, one situated in Cornwall and one in Scotland, and two correspondingly disposed stations in America, communication could be obtained across the Atlantic.

June 7, 1821.—The use of the rocket for the killing and capturing of whales was patented by Sir William Congreve and J. N. Colquhoun on June 7, 1821. The specification includes a description of the rocket-bomb, which was afterwards re-invented in America and became one of the most deadly weapons used in whale-fishing.

June 9, 1840.—It was Thomas Edmondson who first thought of issuing railway tickets in their present form. His patent, dated June 9, 1840, had for its object the printing of "cardboard tickets in such a manner that each ticket should bear a progressive number or figure and thus, by being delivered in successive rotation to the passengers, the way bills would be readily made out, a most perfect check could be kept upon all clerks or other officers engaged in receiving money, and a daily or weekly return could be readily made merely by noting the opening and closing numbers of the tickets delivered". The invention comprised a printing machine for printing the cardboard blanks with the proper letterpress and successive numbers, and a dating machine which was put into operation by pushing the end of the ticket into the apparatus.

Societies and Academies.

LONDON.

Linnean Society, May 2.—H. H. Haines: Some aspects of the New Forest, with special reference to the changes wrought by direct or indirect human agency. The poverty of the reproduction of trees and the poor aspect of the young growth is due chiefly to the grazing, browsing, and trampling of domestic animals, as also is the entire composition of parts of the vegetation. The first evident results of excessive browsing is the gradual reduction of the underwood to thorny, prickly, or otherwise distasteful species. The herbaceous flora and fauna are affected by grazing, but also very largely by collectors and the direct action of man in clearing and draining. The impoverishment of the fauna and flora of the open heaths is partly accounted for by too much and too severe burning.—F. S. Russell: The Great Barrier Reef Expedition and its aims. The expedition is based on Low Island, forty miles north of Cairns, North Queensland, and situated eight miles from the mainland and midway between the coast and the great barrier itself. The shore party is undertaking an ecological survey of the island and adjacent barrier reef, studies in the growth of coral, and life-histories of economic products, and experimental work on the feeding habits of corals are being carried out in the laboratory. The sea work entails a complete seasonal survey of the chemical constituents of the sea water and of the plant and animal plankton, together with physical observations such as temperature and transparency (see NATURE, Jan. 19 and May 18).—G. Tandy: The vegetation of the Great Barrier Reef. There is a mangrove swamp to windward (with *Rhizophora mucronata* the dominant) and a more or less vegetated cay of coral sand to leeward as is found on many islands north of Low Island. The formation depends on the South-East Trade Wind, which is fairly constant here from April to November. In early morning it will be at S.S.E. and light, but as the day goes on it will shift to E.S.E. or even E. and freshen. The heaviest seas are thus on the north side of the mangrove island, and the drift of the coral shingle is driving the mangrove back. On the lee side of the swamp, however, they are extending in a westerly direction.—H. W. Pugsley: A revision of the British *Euphrasiæ*. The British species of *Euphrasia* were first studied by the late F. Townsend, who published a monograph in 1897, adapted from the larger work of Prof. E. von Wettstein of the preceding year. The relationship of the generic subdivisions, as given by Wettstein, is open to criticism.

PARIS.

Academy of Sciences, April 22.—Jean Baptiste Senderens: The preparation of the ether-oxides of the aromatic alcohols by the catalytic action of the alkaline bisulphates. Benzyl alcohol and phenylethyl alcohol are readily converted into the corresponding ethers by the action of sodium bisulphate. Mixed ethers, such as $C_4H_9-O-CH_2(C_6H_5)$, can be prepared in a similar way.—J. Herbrand: Some properties of true propositions and their applications.—Bertrand Gambier: Moutard equations with quadratic integrals.—Ragnar Frisch: A general formula of the mean.—Arnaud Denjoy: A class of analytical functions.—H. Mineur: The rotation of the local (star) cluster.—P. Lejay: A chronograph recording the ten-thousandth of a second and its application to the measurement of the irregularities of astronomical pendulums. A development of the method described in an earlier communication for recording the passage of a pendulum through the vertical without using contacts.—J. Barthoux: Badakchan. An outline of the physical and geological features of this Afghan province.—L. Décombe: Electrified spherical pellicles and the Stark effect.—Henri Chaumat: The calculation of electrostatic machines.—J. Vuillermoz: The reversible electromotive force of electrolysis.—H. Weiss and E. Vellinger: The measurement of the interfacial tension between mineral oils and aqueous solutions. The influence of the degree of refining and of the degree of alteration of the oils.—S. Piña de Rubies: The arc spectrum of samarium. Measurements made at the normal pressure between 2750 A. and 2200 A.—R. Soulillou: The separation of the various spark spectra of antimony. The spark lines of antimony can be split up into three groups, probably Sb II., Sb III., and Sb IV.; the last two named are perfectly homogeneous, but the first, which is rich in lines, appears to consist of two sub-groups.—D. Chalonge and M. Lambrey: The continuous spectrum of the hydrogen tube. The influence of the following variables on the intensity of the continuous spectrum of hydrogen has been studied: the pressure of the hydrogen, the intensity of the discharge current, the dimensions of the tubes. The results suggest that it should be possible to use these tubes as standards of intensity in the ultra-violet.—F. Joliot: A new method of studying the electro-chemical behaviour of substances in very dilute solution. The velocity of deposition of the substance under examination is determined by measuring the increase in the optical density of a gold or platinum electrode transparent to light, a photo-electric cell being used for the light measurement. Details are given of the determination of the potential of the deposit of bismuth on a gold electrode, the quantities deposited being less than 10^{-5} gm.—E. Rinck: The equilibrium in the liquid state between potassium, sodium, and their bromides. The law of mass action, (Na) (KBr)/(K) (NaBr) $= c$, has been verified, and for temperatures from 900° C. to 1000° C. the constant c does not vary appreciably with the temperature. From this it follows that thermal effect of the reaction $Na + KBr \rightleftharpoons K + NaBr$, which at the ordinary temperature is $-9{\cdot}5$ cal., is nearly zero at 800°-1000° C.—F. Bourion and Ch. Tuttle: The cryoscopic determination of the molecular equilibria of resorcinol in aqueous solutions of potassium chloride.—Jean Calvet: The corrosion of aluminium. Three specimens of aluminium were used in these experiments, one purified by Hoopes method (99·94 per cent Al), and two commercial metals (99·75 and 99·18 per cent Al). The extra pure aluminium (Hoopes) showed a marked increase of resistance to attack by solutions of hydrochloric, nitric, sulphuric, and phosphoric acids.—Jean Lugeon: A method of investigating the atmosphere by means of the disturbances of the electromagnetic field at the time of the passage of a crepuscular band.—A. P. Dutertre: The discovery of fossil bones of fishes in the Devonian of the Boulonnais. An account of a new species of *Ganorhynchus* (*G. Rigauxi*) found in the limestone of Ferques at Beaulieu (Pas-de-Calais). This is comparable with that which has been described and figured by R. H. Traquair under the name of *G. Woodwardi*, and appears to be the only representative of the genus *Ganorhynchus* in Europe.—A. Paillot: Bacterial symbiosis and humoral immunity in the Aphides.—Armand de Gramont: The application of binocular vision to fixing direction.—Jean Timon-David: The action of bromine on insect oils. Figures are given for the hexabromide figure (Hehner and Mitchell method) of several insect oils, and a rough classification is attempted.—H. Wünschendorff and Ch. Killian: New observations on the metabolism of *Ustulina vulgaris*.—Mme. **Phisalix**: Some comparative properties of antirabic sera from vaccinated animals and natural antirabic sera.

Geneva.

Society of Physics and Natural History, Mar. 7.—**P. Balavoine**: Observations on ice. The water from melted ice is always slightly turbid; this is not a sign of impure water, but is due to the calcium salts crystallised during the solidification failing to redissolve. Ice, moreover, absorbs ammonia from the surrounding air, and water from melting ice may contain ammonia without the original water having been contaminated. —**Ed. Parejas**: Geological observations in Corsica (3). The red deposits of Caporalino. This formation occurs at the base of the Neojurassic limestones of Caporalino. The latter are mixed with thin layers at their base. In the absence of any characteristic fauna, there are as good grounds for correlating the red deposits of Caporalino with the red Oxfordian-Argovian of the median Prealps as with the Upper Cretaceous, all the more that they appear to lack the Foraminifera usual in the Upper Cretaceous.—**A. Liengme**: The effect of intracardiac injections of adsorbent carbon in the guinea-pig and white rat. Intracardiac injections of carbon in the form of Indian ink in suspension in physiological serum are innocuous. Intracardiac injections in doses of 4 milligrams or more per kilogram of live weight of Merck adsorbent carbon, in suspension of 1 per cent in physiological water, cause immediate death. Smaller doses produce total loss of muscular tone with clonic shocks in the posterior limbs. After several hours of severe discomfort, the animal returns to its normal condition. Doses of Merck carbon eight times the lethal dose are innocuous if first mixed with a sufficient quantity of fresh human or guinea-pig serum.—**L. W. Collet** and **Ed. Paréjas**: The geology of the Hockenhorn. The unfolding of the Morcles-Doldenhorn nappe has produced a crystalline wedge which has broken its sedimentary covering, has scraped it in part, and has even penetrated the opposite side of the layer.—**L. W. Collet** and **G. Rosier**: A new crystalline wedge in the Inner Faflertal (Lötschental). By the discovery of a new crystalline wedge in the Inner Faflertal, the authors point out a correction required in the geological map of the Jungfrau of L. W. Collet and Ed. Paréjas.—**G. Rosier**: A granitic mylonite of the Baltschiederlücke, the Bietschhorn massif. There is at the Baltschiederlücke a zone of granitic mylonite connected with a plane of overlapping. The mylonite contains lenses of crystalline schist of unknown origin; it is composed of albite and microcline cemented by a fine material, consisting for the most part of crushed quartz. The microcline, not twinned, can only be identified by Fedorof's method.—**A. Falconnier**: The stratigraphy of the Sequanian in the anticlinal chain of Noirmont, Creux du Cruaz, near Saint-Cergues. The Sequanian there comprises three divisions: (1) The lower, with marls and limestones containing *Astarte vocetica*, *Perisphinctes Streichensis*, *P. Fontannesi*, 35 metres; (2) middle reef facies, 60 metres; (3) upper, limestone-marl with *Perisphinctes inconditus*, and *P. Lothari*, 20 to 30 metres. It corresponds with the horizons of the Geissberg, Wangen, and of Baden below the Argovian of the Jura. It is defined by zones with *Peltoceras bimammatum* and *Perisphinctes Achilles* of Haug.—**J. Pilloud**: The presence of the upper Lias, the Gault and the Barremian at Voirons (Préalpes externes, Haute-Savoie). The discovery of fossils has enabled the author to determine the presence at Voirons of the Gault (zone with *Leymeriella tardefurcata*), of the Barrémian (limestones with Desmoceras), and of the upper Lias (zone with *Lioceras opalinum*).—**R. Wavre**: The moments of inertia of the terrestrial ellipsoid. The author gives a new formula for the constant of precession of the equinoxes, and he extends that of Poincaré to the whole of the equipotential surface exterior to the planet.

Rome.

Royal National Academy of the Lincei, Feb. 17.—**G. Scorza**: Riemannian matrices. With the help of the theory of algebra, together with the results already obtained by the author concerning Riemannian matrices, Rosati's fundamental theorem of matrices may be deduced readily from his observations on the pseudo-axes of such a matrix. Rosati's statement with regard to the indices of what he calls minimum invariant varieties is contained in propositions already established in the author's earlier publications.—**R. Marcolongo**: The geometrico-mechanical investigations of Leonardo da Vinci. These investigations are classified into the following groups: on lunes and on the quadrature of plane figures limited by circular arcs; on the transformations of solids into equivalent solids under given conditions; on the problem of incidence or Alhazen's problem; on the centres of gravity of plane and solid figures; on the construction of mathematical instruments. Leonardo discovered and demonstrated the theorem of the meeting point of the axes of a tetrahedron, but it does not appear that he showed this to be the baricentre of the tetrahedron. For the centre of gravity of a semicircle he not only gave an approximate calculation, but he also used the method of decomposition into elementary sectors, thus reducing the problem to that of the graphic composition of a system of parallel forces. With slight variations, his precision compasses are still sold, and he designed also a parabolic compass.—**A. Amerio**: New method for measuring the velocity of sound in liquids. In this method, use is made of the very sensitive property of the ear which allows it to determine the direction of origin of a sound when this lies in the horizontal plane passing through the ears.—**S. Franchi**: The importance of the San Remo and Imperia sheets of the 1 : 100,000 geological map of Italy for the solution of questions of Alpine and Apennine geology.—**A. Comessatti**: The curves of Galois (1).—**T. Boggio**: Riemann's homograph for the hyper-surfaces of a curved space.—**S. Cherubino**: Decompositions in sums of squares of definite and semi-definite polynomes.—**E. Bompiani**: The elements of the second order of curves of a surface. In previous notes the convenience of associating, with an element of the second order of a curve traced on a surface of ordinary space, two quadrics termed asymptotic osculatory quadrics of the element, was indicated. Considerations analogous to those evolved in these notes point to the possibility of associating with such an element two new quadrics, of which the equations are now given.—**N. Mouskhelichvili**: The problem of the torsion of isotropic elastic cylinders.—**A. Masotti**: The dynamic actions in a system of rectilinear vortices.—**G. B. Lacchini**: The limits of visibility with refractors of small dimensions.—**A. Carrelli**: Broadening of lines by resonance (2). Experimental results are given which, in conjunction with those of the author's previous communication on this subject, show that the widening of a spectral line in emission varies as the square root of the concentration of the vapour, and that the distribution of the intensities follows an exponential law. These conclusions were derived by Holtzmark on the basis of the theory of absorption founded on the mutual action of similar resonators.—**Angelina Cabras**: Functional operations of mathematical physics represented as rational functions of the symbol of derivation.—**B. Rossi**: The Raman effect and negative absorption. The Raman effect is usually regarded as an experimental proof of the induced emission or negative absorption postulated by Einstein in his deduction of Planck's formula. Closer examination of this interpretation reveals difficulties. Thus, if Einstein's induced emission resembles a Raman effect of the second species, it should possess a frequency double that absorbed or emitted spontaneously by the atom. Exact analysis shows that the corpuscular theory of light renders it possible to unite the Raman effect and the phenomena of absorption and emission (spontaneous and induced) in a coherent scheme, according to which the Raman effect of the second kind is considered as a super-elastic impact of a light quantum with an excited atom, and induced emission as a modification of the probability that an atom will emit a radiation of given frequency as a result of the presence of other quanta of the same frequency.—**G. Malquori**: The system, $Fe(NO_3)_3 - HNO_3 - H_2O$ at 25°. Study of this system gives results which exclude the existence of the acid salt Fe_2O_3, $4N_2O_5$, $18H_2O$ and indicate the presence, in solutions highly concentrated as regards nitric acid, of the solid phase $Fe(NO_3)_3$, $6H_2O$.—**D. Bigiavi** and **S. Stefanic**: Action of diazotates on azoxyphenols. When treated with bromophenyldiazonium hydroxide, α-benzeneazoxyphenol yields directly the corresponding hydroxyazo-compound, whereas its β-isomeride gives a diazo-ether, which is able to undergo coupling with β-napthol and also rapid transformation into the isomeric hydroxyazo-compound.—**V. Montoro**: The supposed sesquioxide of molybdenum. According to Guichard (1901), molybdenite is converted into the compound Mo_2S_3 when heated in a carbon crucible in the Moissan furnace for four minutes by an arc carrying 900 amperes at 50 volts. X-ray examination of a number of specimens of molybdenite partially desulphurised in this way shows, however, that these consist of mixtures of the disulphide with solid solutions of carbon in molybdenum. This result confirms Parravano and Malquori's conclusion, drawn from an investigation of the equilibrium of the reduction of molybdenite by hydrogen, that no molybdenum sulphide exists which is less rich in sulphur than the disulphide.—**L. Passerini**: Investigations on spinels. The compound $MgCr_2O_4$, obtained by calcining a mixture of the nitrates of the two metals at about 800°, and $NiFe_2O_4$, similarly obtained from the corresponding hydroxides, crystallise in the cubic system with a lattice structure of the spinel type. For $MgCr_2O_4$ the side of the unit cell is $a = 8{\cdot}290 \pm 0{\cdot}005$ A., the volume of the cell $v = 569{\cdot}72 \times 10^{-24}$ c.c., and the calculated density 4·49; for $NiFe_2O_4$ the corresponding magnitudes are $8{\cdot}340 \pm 0{\cdot}005$ A., $580{\cdot}09 \times 10^{-24}$ c.c., and 5·268 respectively.—**C. Antoniani** and **G. Fonio**: Investigations on the interchange of the phosphoric acid of the soil with arsenic acid. When soil which has been treated with sodium phosphate is afterwards treated with dilute arsenic acid solution, the phosphate anion is replaced to some extent by the arsenic anion.—**G. Mezzadroli** and **E. Vareton**: Action exerted by an oscillating metallic circuit on the germination of seeds. Experiments with beans, wheat, barley, and beet show that the presence of an oscillating circuit with a single coil, 30 cm. in diameter, capable of catching natural cosmic waves of wave-length about 2 metres, exerts a favourable influence on the germinating power of seeds, the time of germination being reduced, in some cases, by one-half.—**M. Cassinis** and **L. Bracaloni**: Hydremic curves.—**B. Alosi**: Hæmolytic poisons and alterations of the liver.

Official Publications Received.

BRITISH.

Sugar Beet Problems: Report of Second Conference held at the College on Wednesday, January 23rd, 1929. Pp. 44. (Newport, Salop: Harper Adams Agricultural College.)

The Cultivation and Manuring of Sugar Beet. Pp. 23. (Newport, Salop: Harper Adams Agricultural College.)

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1928. Pp. iv+416+103. (London: H.M. Stationery Office.) 12s. 6d. net.

The Journal of the Royal Agricultural Society of England. Vol. 89. Pp. 8+322+clxxiv+xii. (London: John Murray.) 15s.

Manchester Municipal College of Technology. Summer Evening Classes: Prospectus of Short Courses of Lectures and Laboratory Work to be given during the Summer 1929. Pp. 26. (Manchester.)

Survey of India. Geodetic Report, Vol. 2: From 1st October 1925 to 30th September 1926. Pp. xi+73+3 plates+6 charts. 3 rupees; 5s. 3d. Records of the Survey of India. Vol. 22: Exploration of the Shaksgam Valley and Aghil Ranges, 1926. By Major Kenneth Mason. Pp. xi+182+16 plates. 3 rupees; 5s. 3d. (Dehra Dun.)

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, 1927–1928. Pp. 24. (London: H.M. Stationery Office.) 3s. net.

The Journal of the East Africa and Uganda Natural History Society. Nos. 33 and 34, May and September 1928. Pp. 73+26 plates. (Nairobi.) To Members, 7s. 6d.; to non-Members, 15s.

The National Institute for Research in Dairying: its Work and Needs. Second edition. Pp. 60. (Reading.)

Proceedings of the Cambridge Philosophical Society. Vol. 25, Part 2, April. Pp. 121-254. (Cambridge: At the University Press.) 7s. 6d. net.

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 20: A Study of Lactose-fermenting Yeasts isolated from Milk, Cream and Butter. By M. Grimes and J. Doherty. Pp. 261-264. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6d.

British Science Guild. The Annual Report of the Executive Committee, 1928-9, presented at the General Meeting of Members, held at the Hotel Cecil, Strand, London, 8th May 1929. Pp. 28. (London.) 1s.

Memoirs of the Asiatic Society of Bengal. Vol. 11, No. 2: The Language of the Mahā-Naya-Prakāsa; an Examination of Kāshmīrī as written in the Fifteenth Century. By Sir George A. Grierson. Pp. ii+73-130. (Calcutta.) 2.4 rupees.

Indian Journal of Physics, Vol. 3, Part 3, and Proceedings of the Indian Association for the Cultivation of Science, Vol. 12, Part 3. Conducted by Prof. C. V. Raman. Pp. 307-450. (Calcutta.) 3 rupees; 4s.

Papers and Proceedings of the Royal Society of Tasmania for the Year 1928. Pp. v+191+32 plates. (Hobart.) 10s.

Dominion of Canada. Report of the Department of Mines for the Fiscal Year ending March 31, 1928. (No. 2182.) Pp. vi+65. (Ottawa: F. A. Acland.) 15 cents.

Canada. Department of Mines: Geological Survey. Summary Report, 1927, Part A. (No. 2162.) Pp. 65A. Summary Report, 1927, Part B. (No. 2172.) Pp. 94B. (Ottawa: F. A. Acland.)

Transactions and Proceedings of the Royal Society of South Australia (Incorporated). Vol. 52. Edited by Prof. Walter Howchin, assisted by Arthur M. Lea. Pp. iii+275+22 plates. (Adelaide.) 17s.

Southern Rhodesia. Report of the Director, Geological Survey, for the Year 1928. Pp. 18. (Salisbury, S.R.)

Modern Safety Rules for use in Chemical Works. Part 1: Model Rules. Pp. 39. (London: Association of British Chemical Manufacturers.)

Proceedings of the Society for Psychical Research. Part 110, Vol. 38, May. Pp. 281-408. (London: Francis Edwards, Ltd.) 5s.

The Scottish Forestry Journal: being the Transactions of the Royal Scottish Arboricultural Society. Vol. 43, Part 1, March. Pp. iii+80+36. (Edinburgh.) 7s. 6d.

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 67, No. 389, May. Pp. 557-684+xxxviii. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

The Linen Industry Research Association. Report of the Council, 1928. Pp. 24. (Lambeg, Co. Antrim.)

Agricultural Progress: the Journal of the Agricultural Education Association. Vol. 6, 1929. Pp. 157. (London: Ernest Benn, Ltd.) 5s. net.

Tanganyika Territory: its Geology and Mineral Resources. Pp. 23. (Dodoma: Geological Survey.)

Proceedings of the Royal Society of Edinburgh, Session 1928-1929. Vol. 49, Part 2: The Thermal Equilibrium between Ethylene, Iodine and Ethylene Di-iodide. By R. B. Mooney and Dr. E. B. Ludlam. Pp. 160-169. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 1s.

FOREIGN.

Carnegie Endowment for International Peace: Division of Intercourse and Education. Annual Report of the Director for the Year 1928. By Nicholas Murray Butler. Pp. 93+7 plates. (New York City.)

The Science Reports of the Tohoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 13, No. 1. Pp. 15+8 plates. (Tôkyô and Sendai: Maruzen Co., Ltd.)

Proceedings of the Third Pan-Pacific Science Congress, Tokyo, October 30th-November 11th, 1926, held under the Auspices of the National Research Council of Japan and through the Generosity of the Imperial Japanese Government. Vol. 1. Pp. x+1220. Vol. 2. Pp. xvi+1221-2678. (Tokyo: National Research Council of Japan.)

Territory of Papua. Native Education: the Language of Instruction and Intellectual Education. By F. E. Williams. (Anthropology, Report No. 9.) Pp. 25. (Port Moresby: Government Printer.)

Scientific Papers of the Institute of Physical and Chemical Research. Nos. 186-187: A Rosy Muscovite from Suizawa and a Dark-grey Muscovite from Doi, by Satoyasu Iimori and Jun Yoshimura; A Pink Kaolin, and Ruthenium as a Minor Constituent of the Tanokami Kaolins, by Satoyasu Iimori and Jun Yoshimura. Pp. 221-228. (Tôkyô: Iwanami Shoten.) 20 sen.

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 22, Part 2: Über den Einfluss meteorologischer Faktoren auf den Baumzuwachs. ii. Untersuchungen über das Längenwachstum einer Schwarzkiefer unter Verwendung eines neuen Höhenzuwachsautographs. Von Hirokichi Nakashima. Pp. 301-327+Tafel 10-15. Vol. 20, Supplementary No.: A Monograph of the Dibranchiate Cephalopods of the Japanese and adjacent Waters. By Madoka Sasaki. Pp. v+357+30 plates. (Tokyo: Maruzen Co., Ltd.)

Proceedings of the United States National Museum. Vol. 75, Art. 2: Beetle Larvae of the Subfamily Galerucinae. By Adam G. Böving. (No. 2773.) Pp. 48+5 plates. Vol. 75, Art. 4: A Review of the Birds of the Islands of Siberut and Sipora, Mentawi Group (Spolia Mentawiensia). By J. H. Riley. (No. 2775.) Pp. 45+1 plate. Vol. 75, Art. 8: Notes on some North American Moths of the Subfamily Eucosminae. By Carl Heinrich. (No. 2779.) Pp. 23+5 plates. Vol. 75, Art. 6: Some New Genera and Species of Nematode Worms, Filarioidea, from Animals dying in the Calcutta Zoological Garden. By Asa C. Chandler. (No. 2777.) Pp. 10+3 plates. (Washington, D.C.: Government Printing Office.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1588: Frost and the Prevention of Frost Damage. By Floyd D. Young. Pp. 62. (Washington, D.C.: Government Printing Office.) 10 cents.

Department of Commerce: Bureau of Standards. United States Government Master Specification, No. 23c: Lamps, Electric, Incandescent, Large, Tungsten Filament. Pp. ii+3. 5 cents. United States Government Master Specification, No. 618: Lamps, Electric, Incandescent, Miniature, Tungsten Filament. Pp. ii+3. 5 cents. (Washington, D.C.: Government Printing Office.)

Sudan Notes and Records. Vol. 11, 1928. Pp. iv+242. (Khartoum: Sudan Notes and Records; London: Sudan Government Office.) 30 P.T.; 6s.

University of Illinois Engineering Experiment Station. Bulletin No. 189: Investigation of Warm-Air Furnaces and Heating Systems. The Research Residence, Part 4. By Prof. Arthur C. Willard, Prof. Alonzo P. Kratz and Prof. Vincent S. Day. Pp. 114. 60 cents. Bulletin No. 190: The Failure of Plain and Spirally Reinforced Concrete in Compression. By Prof. Frank E. Richart, Anton Brandtzaeg and Rex L. Brown. Pp. 72. 40 cents. (Urbana, Ill.)

Suomen Geodeettisen Laitoksen Julkaisuja. No. 11: Die Beobachtungsergebnisse der Triangulation in den Jahren 1926–1928. Pp. ii+139. (Helsinki.)

A Series of Fourteen Radio Talks on Science for the Home Manager. By Dr. George D. Beal, H. S. Coleman, E. R. Harding, Dr. O. F. Hedenburg, R. H. Heilman, L. E. Jackson, Dr. H. M. Johnson, H. M. Marc, H. K. Salzberg, Dr. Erich W. Schwartze, Dr. T. H. Swan, Dr. R. B. Trusler, Dr. O. E. Jennings. (Radio Publication No. 48, University of Pittsburgh.) Sponsored by Mellon Institute of Industrial Research, and Broadcast from the University of Pittsburgh Studio of KDKA, Westinghouse Electric and Manufacturing Co., Pittsburgh, Pennsylvania, 1929. Pp. 138. (Pittsburgh, Pa.: University of Pittsburgh.) 75 cents.

Proceedings of the Imperial Academy. Vol. 5, No. 3, March. Pp. v-vi+103-160. (Tokyo.)

Preussische Staatsbibliothek. Handbibliothek des grossen Lesesaals, Abteilung 7: Mathematik und Naturwissenschaften. Pp. viii + 75. (Berlin: Staatsbibliothek.)

Japanese Journal of Mathematics: Transactions and Abstracts. Vol. 5, No. 4, March. Pp. iv+269-367+13-39+vi+iv. Vol. 6, No. 1, March. Pp. 171. (Tokyo: National Research Council of Japan.)

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 18, No. 12: The Faunal Areas of Southern Arizona; a Study in Animal Distribution. By Harry S. Swarth. Pp. 267-383. (San Francisco.)

Bulletin of the American Museum of Natural History. Vol. 59, Art. 1: Pelmatozoan Root-Forms (Fixation). By Kurt Ehrenberg. Pp. 76. (New York City.)

The University of Colorado Studies. Vol. 17, No. 1. Pp. ii+44. (Boulder, Colo.) 1 dollar.

Koninklijk Nederlandsch Meteorologisch Instituut. No. 102: Mededeelingen en Verhandelingen, 29b: Klimatologie van den Indischen Oceaan. Door P. H. Gallé. (With English Summaries.) Pp. 34. 0.75 fl. No. 102: Mededeelingen en Verhandelingen, 30: The Influence of Sea Disturbance on Surface Temperature. By P. M. van Riel. Pp. 17. 0.30 fl. No. 106a: Ergebnisse aerologischer Beobachtungen. 16, 1927. Pp. iv+44. 2.50 fl. No. 108: Seismische Registrierungen in De Bilt. 14, 1926. Pp. ix+63. 1.00 fl. (Amsterdam: Seyffardt's Boekhandel.)

CATALOGUES.

Watson's Microscope Record. No. 17, May. Pp. 32. (London: W. Watson and Sons, Ltd.)

Preliminary Summer List, 1929. Pp. 4. (London: W. Heffer and Sons, Ltd.)

Liver Therapy: some Clinical Evidence of its Value in Pernicious Anæmia. Pp. 8. (London: The British Drug Houses, Ltd.)

Diary of Societies.

FRIDAY, MAY 31.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. E. N. da C. Andrade: The Air Pump: Past and Present.

MONDAY, JUNE 3.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 4.—Special General Meeting.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Sir Ambrose Fleming: Nature and the Supernatural (Presidential Annual Address).

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. W. C. M'Intosh: On Abnormal Teeth in certain Mammals, especially in the Rabbit.—Dr. I. Sandeman: Bands in Hydrogen related to the Fulcher System.—J. A. V. Butler and W. O. Kermack: The Action of Salts of Polynuclear Bases on Colloidal Suspensions and on the Electro-capillary Curve.—Sir Thomas Muir: The Theory of Skew Determinants and Pfaffians from 1891 to 1919.

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

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Miss E. M. Terry: Individual 'Difficult' Children.

TUESDAY, JUNE 4.

INSTITUTION OF GAS ENGINEERS (at Institution of Civil Engineers), at 10 A.M.—Annual General Meeting (continued on June 5, 6, and 7).

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. H. H. Dale: Some Chemical Factors in the Control of the Circulation (Croonian Lectures) (I.).

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—H. J. Burkill: The Yorkshire Derwent.

ILLUMINATING ENGINEERING SOCIETY (Annual General Meeting) (at Royal Society of Arts), at 7.—Dr. J. F. Crowley: Some Further Applications of Synchronously Intermittent Light for Revealing Moving Machinery.

WEDNESDAY, JUNE 5.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.—Dr. H. Scott: An Entomoogical Excursion into Basuto Land.

THURSDAY, JUNE 6.

ROYAL SOCIETY, at 4.30.—Prof. E. A. Milne: The Structure and Opacity of a Stellar Atmosphere (Bakerian Lecture).

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital), at 5.—Prof. W. Bulloch: The History of Bacteriology.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. H. H. Dale: Some Chemical Factors in the Control of the Circulation (Croonian Lectures) (II.).

CHEMICAL SOCIETY, at 8.—F. Challenger, L. Klein, and T. K. Walker: The Production of Kojic Acid from Pentoses by *Aspergillus Oryzæ*.—Prof. T. M. Lowry and G. Jessop: The Properties of the Chlorides of Sulphur. Part II. Molecular Extinction-coefficients.—M. S. Lesslie and E. E. Turner: The Isomerism of Derivatives of 2-phenylnaphthylene-1:3-diamine.—Prof. T. M. Lowry and F. L. Gilbert: Studies of Valency. Part XIII. Further Experiments on the Molecular Structure and Configuration of the Quadrivalent Derivatives of Tellurium.

FRIDAY, JUNE 7.

GENETICAL SOCIETY (at Linnean Society) (Annual General Meeting), at 3.—Prof. D. E. Lancefield: The Genetics of *Drosophila obscura*.—Dr. C. Stern: Some Recent Work on *Drosophila*.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—Dr. C. T. Onions: The Supplement.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Dr. A. K. Wells, Dr. A. Brammall, and others: Discussion on The Value of Petrographic Character as a Criterion of Age.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—C. Leonard Woolley: Excavations at Ur, 1928–29.

CONFERENCES.

JUNE 5 TO 8.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (at Brighton).

Wednesday, June 5, at 2.45.—W. C. Wallis: Brighthelmstone of Early Times.—Sir Arthur Smith Woodward: The Willett Collection of Chalk Fossils.

At 8.—Sir Arthur Keith: Southern Englishmen of the Pre-Roman and Roman Period (Presidential Address).

Thursday, June 6, at 11 A.M.—A. H. Allcroft: Archæological Address.—A. D. Cotton: The Importance of the Study of Systematic Botany.

At 12.—J. H. Pull: The Blackpatch Excavations.—G. Morgan: The Etiology of Sphæroblasts, or Wood-nodules.

Friday, June 7, at 11 A.M.—H. Dewey: The Denudation of the Weald.—Dr. G. P. Bidder: Death (Address).

At 12.—E. A. Martin: The Brighton Rubble Drift, and Cliff Formation.—A. Griffith: Some Sussex Birds and Insects.

At 8.—Reginald A. Smith: Early British Art (Public Lecture).

Saturday, June 8, at 10.30 A.M.—Prof. H. J. Fleure: Regional Survey Address.

At 11.30 A.M.—D. Edwards: Town and Regional Planning.

JUNE 6 TO 15.

INTERNATIONAL HIGH TENSION CONFERENCE (at Paris).

JUNE 11 TO 22.

INSTITUTION OF ELECTRICAL ENGINEERS.—Summer Meeting in France.

PUBLIC LECTURES.

FRIDAY, MAY 31.

CHELSEA PHYSIC GARDEN, at 5.—H. V. Taylor: Supplies from the Vegetable Kingdom and the Public Health (Chadwick Lecture).

MONDAY, JUNE 3.

KING'S COLLEGE, at 5.30.—Prof. P. Karrer: Organic Chemistry. (Succeeding Lectures on June 5 and 6.)

FRIDAY, JUNE 7.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Philosophy of Leibniz. (Succeeding Lectures on June 10, 12, 14, 17, and 19.)