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Science and Administration in East Africa.[1]

THE special geographical difficulties of tropical East Africa due to climate, remoteness, and the scantiness of the native population, have led to an awkward dilemma as to the labour and land policies. In consequence, serious friction arose between the European and Asiatic settlers and the Government, and widespread unrest among the natives. Accordingly, the late Government appointed a Commission consisting of the Hon. W. G. A. Ormsby-Gore (the present Under-Secretary for the Colonies), Major A. G. Church, then a Labour M.P. and secretary of the National Union of Scientific Workers, and Mr. F. C. Linfield, then a Liberal M.P., to collect information and report on the development of the British East African Dependencies, and on the social and economic conditions of the natives. The Commission, after a long tour of inspection, has prepared a valuable report on the countries and their administration. One of its most gratifying features is its recognition of the economic value to such countries of scientific guidance; and this welcome innovation enhances regret at the deplorable contrast described between the former attitudes of the British and German Colonial Governments towards scientific research.

Before the War, German East Africa was described in monumental scientific works which have taken their place amongst the standard contributions to the literature of tropical Africa; and several well-equipped scientific laboratories had been established. Mr. Ormsby-Gore and Major Church visited the Amani Institute, which was founded by the German Government in 1902. Its extensive grounds range from 1300 to 3600 ft. above sea level, with a branch establishment at sea level. The Commissioners report that the German Government spent 120,000*l.* on the station; they consider that it was superior to any corresponding institution in any British Colony, and compare it with Buitenzorg in Java. In its extensive grounds vast plantations of tropical shrubs and trees of economic importance were established; the laboratories investigated plant diseases and breeding, and analysed the soils; and the lectures of the expert staff and the publications explained its results to the colonists.

The War stopped all this useful work. The British Government in 1920 placed the Institute under the Agricultural Department of Tanganyika Territory. Sir David Prain, who reported on it in the same year,

[1] (*a*) Report of the East African Commission. (Cmd. 2387.) Pp. 195. (London: H.M. Stationery Office, 1925.) 3*s.* 6*d.* net.
(*b*) Education in East Africa: a Study of East, Central, and South Africa by the Second African Education Commission under the Auspices of the Phelp-Stokes Fund, in co-operation with the International Education Board. Report prepared by Dr. Thomas Jesse Jones. Pp. xxviii+416+44 plates. (New York: Phelp-Stokes Fund; London: Edinburgh House Press, n.d.) 7*s.* 6*d.* net.

urged that the Director should be independent of any Department and responsible directly to the Governor, and urged its development as a central research institute for the British East African Dependencies. Their Governors were asked by the Colonial Secretary for financial support. Two of the five Dependencies were unable to contribute at the time, and the Institute remained under the Agricultural Department—with the results foreseen by Sir David Prain. Last year the Governor of Tanganyika recommended that the Institute should be closed; the Director resigned, and several thousand acres of adjacent land were announced for sale. The intervention of Mr. Thomas saved the Institute from this fate, and has given it another chance. The Commission strongly urges that a fresh attempt be made to maintain it by securing financial support from the five Dependencies, a substantial grant from the Imperial Government, and a suitable constitution. If these recommendations be carried out and Amani developed on the lines recommended by Sir David Prain, it should do for East Africa what Pusa is doing for India. It should be supplemented by local laboratories. Not only, however, was Kenya Colony unable to contribute to Amani, but its own institutes, the Naviasha Stock Farm, the experimental farm at Kabete, and the station at Mazeras were closed in 1922–23 on financial grounds—a "most unfortunate" step, say the Commissioners.

Amani should serve the main purposes of East Africa for forestry and economic botany. The Mpapwa Research Laboratory, also a German foundation, may similarly serve as the central institute for work on stock and their diseases, and the manufacture of serum; but so little is known in one East African colony of the progress in the next that the Commissioners were assured in Northern Rhodesia that the Mpapwa Institute was derelict, and they state that its results are unknown in Kenya Colony.

The Commission strongly recommends the extension of the geological surveys, and directs attention to the valuable results obtained by Dr. Dixey in Nyasaland and Mr. Wayland in Uganda. Tanganyika and Kenya Colony have neither of them at present a geological survey; in one case owing to action by the local government, and in the other by the Colonial Office. The Commission regrets the decision that the Nyasa Survey is to be suspended unless some profitable mineral be soon discovered. This policy seems particularly deplorable in regard to Nyasaland, which, in spite of its many advantages, remains the poorest of the East African colonies owing to the difficulty of communication with its port. As the Commission points out, a geological survey is not merely of value in discovering ores: its main service is in the preparation of a geological map which will help many departments of work as a guide to the distribution of the various types of soil, of underground water, and of such materials as clays, building stones, cements, limestones, and road metals, and in reference to public health. Local supplies of these heavy low-priced minerals are of high value in a remote country, and are indispensable to many industries. A new country has not the benefit of the experience of centuries of local observation to indicate where these materials can be found. They must be discovered by a scientifically conducted search. The maps of a geological survey in a newly settled country may repay their cost by avoiding waste in industrial and agricultural development. The Commission, it may be remarked, quotes Dr. Dixey, Government Geologist of Nyasaland, that water diviners, faith in whom is widespread in East Africa, and water-finding machines, are completely valueless.

The Commission strongly recommends the development of the Nairobi Museum, which was founded by the Uganda and East Africa Natural History Society. It has been suggested that this Museum should be extended as a memorial to the late Sir Robert Coryndon, and it is to be hoped that this scheme will be adopted.

Mr. Ormsby-Gore and his colleagues recognise that more funds should be provided for scientific work, and they urge the extension of the power and activities of the Colonial Research Committee. It was intended to have at its disposal 20,000*l.* per annum for five years; but its grant was cut down by the Geddes Committee to 2000*l.*, which, as the Commission remarks, is quite inadequate. "There can be no doubt," says the Commission, "that increased provision under this head is one of the chief methods whereby Great Britain can assist her tropical possessions and her own trade. But, above all, it is essential that greater encouragement and better pay should be given to scientific officers in order that a supply of trained men shall be forthcoming from the Universities."

The East African Commission has directed attention to the urgent need for Government co-operation in education. On this subject its proposals are endorsed by the recommendation of the Phelp-Stokes Commission, the chairman of which, Dr. Jesse Jones, is an expert on Negro education in America. This Commission was accompanied by Dr. Shantz, of the United States Bureau of Agriculture, who has prepared an instructive report on his observations. The Phelp-Stokes and Ormsby-Gore Commissions coincide in their chief educational views. They both express high appreciation of the missionaries' educational work, but recommend that it should be subject to Government inspection. The Ormsby-Gore Commission states

that if the missionaries knew what was being taught by some of the native teachers at the "so-called mission schools" they would stand aghast.

Mr. Ormsby-Gore's report includes several educational proposals which will be received with warm approval. In reference to one much-debated problem the Commission approves of elementary teaching in the language of the locality, and that where a second language can be taught it should be English. It also shows its practical insight by the recommendation, "We attach great importance to making natural science, as far as possible, the basis of higher education in African native schools." A knowledge of the three R's is, of course, essential, but they should be used for teaching the elements of natural science as illustrated by the life, agriculture, sanitation, and physical geography of the country in which the pupils live.

Mr. Ormsby-Gore's position as Under-Secretary of State for the Colonies should secure the adoption of his Commission's proposals. They would lead to a great advance in scientific research in East Africa, and help to remedy the various ills he and his colleagues were sent to investigate. J. W. GREGORY.

The Herring.

(1) *Meddelelser fra Kommissionen for Havundersogelser.* Serie: Fiskeri. Bind VII.: On the Summer- and Autumn-Spawning Herrings of the North Sea. By Dr. A. C. Johansen. Pp. 118. (Kobenhavn: C. A. Reitzel Boghandel, 1924.)

(2) *Ministry of Agriculture and Fisheries. Fishery Investigations.* Series 2, vol. 7, No. 4, 1924. First Report on Young Herring in the Southern North Sea and English Channel. Part I.: Distribution and Growth of Larval and Post-larval Stages, by Dr. William Wallace; with Appendix: The Water Movements of the North Sea in relation to the Geographical Distribution of Post-larval Herring, by J. N. Carruthers. Pp. 84. (London: H.M. Stationery Office, 1924.) 13*s.* net.

(3) *Ministry of Agriculture and Fisheries. Fishery Investigations.* Series 2, vol. 7, No. 3, 1924: The Herring in Relation to its Animate Environment. Part I.: The Food and Feeding Habits of the Herring with Special Reference to the East Coast of England. By A. C. Hardy. Pp. 53. (London: H.M. Stationery Office, 1924.) 8*s.* 6*d.* net.

THE herring is our most important food fish. Workers in different countries are approaching the problems connected with it from different points of view. The accumulation of data tends towards both simplification and complication. It is possible that increased hydrographic knowledge may assist us to foretell, to some extent, the nature of the fishery and that applied science may score a success, but the understanding of the subject is in the realms of pure science. The three papers specified above all help, in varying extent, to increase our knowledge.

(1) Dr. Johansen's work is a contribution to our knowledge of the racial characters of herring, and deals with, chiefly, the summer and autumn spawners of the North Sea. The numbers of vertebræ, keeled scales between the pelvic fins and anus, and rays in the pelvic, dorsal, and anal fins are treated statistically. Use is made of the results obtained by other workers. We have a comprehensive work which enables us to take a broad view of the subject of herring races.

The summer herrings of the east coast of Scotland, the Dogger Bank, the Jutland Bank herrings, and part of the Shetland summer herrings are all referred to one race, the Bank herrings of the North Sea. The main spawning-grounds of the race are near the British coast, from the Shetlands to Norfolk, and in the vicinity of the Dogger Bank. Spawning occurs also on the Little Fisher Bank and the Jutland Bank, including the adjacent waters of the Skager-Rack. It is indicated, however, that the Jutland Bank herrings have not been investigated sufficiently and that there are differences between the Scottish and Dogger Bank herrings.

In the attempt in Chap. x. to connect the racial characters of the Bank herring with temperature and salinity at the spawning-places, and compare the spawning of this race with that of the North Sea Deep-water herring and the Autumn herring of the German Bight, a great deal is assumed. The differences between the Bank herring and those from the deep water and German Bight are small. Comparison is made with herrings caught in the Kattegat, the Channel, northern waters, and the spring spawners of Scottish waters.

Following the general survey of shoals from waters adjacent to those yielding the Bank herring, an examination of the herrings of the Skager-Rack and Kattegat is given. The catches made from these waters show considerable fluctuations which have conveyed the impression that the fishery from about the entrance of the Baltic was one due to migrations. Johansen's work supports this idea and shows that, whilst Kattegat and Norwegian herrings are caught, the most important herring in these waters is the same as is found in the North Sea. This naturally leads to a consideration of Pettersson's work on periodicity in the fishery and, to a less extent, on the effect of currents, temperature, and salinity on migrations. As is pointed out by Johansen, there are two extreme views held with regard to migrations. One is that the herring is always a wanderer and has no fixed spawning-ground, and the

other is that herrings when they become mature return to where they were hatched.

It is highly possible that some herrings do return to the place of their origin, and there is much evidence which can be taken as indicating that spawning shoals return to the same spawning-grounds year after year, but there are indications that herrings spawn independently of when and where they were hatched. New spawning-grounds are formed; fisheries have been known to disappear; a change in the number of spawning fish on the grounds may appear, as has been the case recently in the East Anglian fishery; changes in extent and direction of migrations have been indicated; and whilst it is possible, for convenience, to think of spring and autumn spawners, it is also possible to have spawning taking place, in eleven months in the year, in the North Sea or waters adjacent. Further, the young are carried by the prevailing currents; they grow at different rates; there is evidence which points to shoaling being governed by size in immature shoals and by development in spawning shoals, and we have the fact that variations in development are great—young fish with two winter rings may be taken spawning, whilst virgins have been taken with as many as six winter rings.

It is a combination of all these which makes it difficult to think that the differences shown by Johansen are correctly defined by being named racial. There is a difference between herrings from different waters. It is one which can be expressed generally in terms of size for age, and the rate of growth decreases as oceanic conditions give place to those of narrow waters. There is evidence that a migration from narrow waters to oceanic conditions is followed by a great increase in the rate of growth.

If we arrange the data given by Johansen according to oceanic and narrow-water conditions, we find a gradual decrease in the number of vertebræ and an increase in the number of keeled scales. We have therefore much the same change as has been found for rate of growth. It is possible that the "racial" differences are such as could be produced in a generation by environment. The work of Schmidt, a short account of which is given, pp. 89-90, can be taken as supporting this view.

It is of interest that the high number of vertebræ found in spring spawners of the Firth of Forth supports the conclusion, arrived at from a consideration of the rate of growth, that some of these fish migrate south for spawning.

Whilst it is impossible to agree with the conclusions of Johansen as to the different races of herring, it is equally impossible not to have a high appreciation of the work he has produced. It is a very welcome work and one which must be considered seriously by every one connected with herring investigations.

(2) This paper deals with the larval and post-larval stages, collected by the Ministry of Agriculture's research vessel, and those of Plymouth and Belgium, in 1921–1923. The material has been analysed by Dr. Wallace and helpers, and Mr. Carruthers has furnished hydrographic data which add considerably to the value of the work. Detailed accounts of the various cruises, the catches made, as well as a consideration of the hydrographic conditions, yield information which increases our knowledge of the drift of the young and also of the rate of growth. The work is well illustrated with charts and diagrams.

The area investigated was of considerable extent, and stretched from the Northumberland to the Cornish coast. It is to be regretted that, as the Dogger Bank area was not surveyed for spawning-grounds, records for comparative purposes in future years are not available. The high numbers of recently hatched fish found in the Southern Bight and the eastern end of the Channel make it desirable that the investigations do not come to an end before it is established, whether or no, spawning to such an extent as indicated can be considered a general condition.

The drift of the young brings about, in the Southern Bight, and to some extent in the German Bight, a mixing of autumn-spawned young of the North Sea with the winter-spawned young from the Channel. From the data supplied by Carruthers it is evident that the drift of the larvæ varies; and Wallace directs attention to the difficulty of assigning fry caught in the Southern Bight to either the Dogger Bank or the Channel race of herring.

This work should be read in conjunction with that of Dr. Johansen. No other paper, to the present writer's knowledge, has shown so well to what an extent the young from different spawning-grounds can be mixed, and, from the supporters of herring races, it calls for an explanation as to how and when the races sort themselves again.

(3) Most of the data in Mr. Hardy's paper are for southern North Sea fish, though young stages from the eastern portion of the Channel have been examined. The results of previous workers are given.

The food of the young consisted chiefly of diatoms and peridinians. With increased size there is a change in the food; larger plankton forms are taken and the smaller of the common copepods become of importance. After metamorphosis the range of food is increased, and it varies from the largest plankton forms to the eggs of shrimps and crabs. It is difficult to imagine how the latter can be of much importance. Their presence and the other foods found in the stomach point to the

herring taking practically anything which is floating in its vicinity. This makes doubtful Hardy's suggestion that varying numbers of Pseudocalanus in the southern part of the North Sea may be the cause of fluctuations in later years.

The food consists of plankton, and there is evidence that in spring the larger forms are selected. The presence of recovered spents may have influenced the curve given by Hardy, on p. 17, representing the feeding of the herring, which shows an interesting agreement with Lea's curve representing the growth of Norwegian herring.

A portion of the paper is devoted to various opinions as to how the herring takes its food. From the stomach contents and observations at Cullercoats, Hardy is of the opinion that feeding is selective and carried out by a definite act of capture.

Such diagrams as Fig. 11, or models in three dimensions as Hardy suggests, have their value and call for some ingenuity in their making, but it is doubtful if they are necessary. The price of the Ministry's reports is so great that only those interested in the subject are likely to buy. The majority of workers on fishery problems should be able to picture the results without such aids.

It may be that *Limacina retroversa* is a regular constituent of the plankton off the Northumberland coast in late summer, but we must have other reasons than a statement of belief before this can be accepted.

B. STORROW.

Chemistry and Technology of Cotton-Cellulose.

Cotton-Cellulose: its Chemistry and Technology. By A. J. Hall. Pp. 228. (London: Ernest Benn, Ltd., 1924.) 30*s.* net.

WITH the establishment of the Linen and Cotton Industries Research Associations in England, and such institutes as the Kaiser-Wilhelm Institut für Faserstoffchemie in Germany, the number of "cellulose chemists" has increased considerably during the past few years, and many questions which have for too long been in doubt are beginning to show some prospect of solution. Indeed, so rapid are the advances in knowledge, that to workers actually engaged in this field a text-book has but little interest. There are, however, many reasons why a book should be written on cotton for the non-specialist scientific worker; first, to remove an impression that cellulose is a dull, inactive material only interesting in its technical applications, and secondly, to explain why those who do decide to experiment with it should supply precise information as to the origin of their material and the conditions of their tests when recording results.

Mr. Hall has written such a book, but unfortunately he has begun too soon. The novel sections of his book are those in which he summarises, with little attempt at criticism, the newest results published in Great Britain, but we venture to suggest that as most of the work reviewed is mainly exploratory, a much more interesting story will be told in a few years' time. It should then be possible to write of discovered broad principles, rather than merely to record copious details of miscellaneous experiments. Furthermore, the author has not quite succeeded in quickening the imagination; true, he does show that cellulose is abundantly reactive, but not in such a way as to attract new workers with its possibilities for research. Nor does he succeed, except to those who already know, in emphasising the variability of cotton, and the difficulty of obtaining "cellulose" from it, free from mineral and other impurities but unaltered in physical and chemical properties. The method of the Cellulose Division of the American Chemical Society (p. 40) is probably too precise in specifying "Wannamaker's Cleveland cotton" as the source of "standard cellulose," but some explanation of the intentions behind this exactitude, on one hand, and, on the other, of the danger of regarding any promiscuous sample of surgical cotton-wool as "cellulose," should have been given.

The first chapter deals with the development, morphology, and physical properties of the cotton hair. Unimportant details are recorded about the convolutions which so strikingly distinguish cotton, but the most absorbing question—by what mechanism are they formed—is not discussed. The next chapter treats of the non-cellulosic materials in raw cotton and their removal. The use of enzymes and acids in bleaching should have received more notice, and the work on solvent extraction described later on (pp. 109-126) and the properties of "steam distillates" of cotton (p. 139) might well have come in this chapter. The interesting fact that Egyptian cotton contains more phosphorus and nitrogen than American, even when grown in the same environment, may be compared with a recent discovery that the sap in the Egyptian plant is richer in mineral salts.

The author next proceeds to deal with the action of alkalis on cotton. Surely water should have come first. The moisture content of cotton and its variation with humidity and temperature are so important in all processes from spinning to dyeing and calico-printing, and also in testing and storing, that more might have been written than the notes on pp. 79 and 137-139.

The chapter on the action of alkalis is one of the best in the book. It seems to be true that a curve connecting

concentration of alkali solution with the quantity of alkali removed from it by cotton shows a few steps corresponding with definite compounds of cellulose and alkali, but the curves connecting dimensional changes in the cotton hair with alkali concentration are much more difficult to interpret. How far this is due to the presence of a tenacious "cuticle" remains to be seen, but it is possible that some of the published curves need confirmation. It would have interested the general reader to be told the five or six different objects of "mercerisation." The statement at the head of p. 81 that "no adequate explanation of the increased absorptive power of mercerised cotton has been put forward" already needs modifying. The recent work of Katz on the X-ray analysis of mercerised fibres is most suggestive.

Chap. iv., on the action of acids, is good, but Chap. v. is a medley dealing with viscose, and the effects of mechanical stresses, heat, salt solutions, organic solvents, light, ammoniacal copper hydroxide solutions, water, moulds, and bacteria. In a new edition this will require complete revision, particularly as many new facts are already available. Some figures on the amounts of various solvents and salt solutions which a given mass of cotton can soak up might have been recorded; they are frequently demanded, but are not readily accessible.

The action of oxidising agents on cotton is the subject of Chap. vi., which is a sufficient summary of much conflicting material. Scarcely anything better has been written on "Oxycellulose" than Witz's original communications of nearly 120 pages in the *Bulletin de la Société industrielle de Rouen*, 1882-1883, and it is a calamity that only abstracts of this paper have been available except at one or two libraries in the whole of England. A weakness of the chapter is that it does not sufficiently indicate how cotton may suffer oxidising attack in practice, and how this affects its mechanical and dyeing properties.

Chap. vii., "Cellulose and Dyes," deals overmuch with dyes, giving unnecessary graphic formulæ, and not enough with dyeing. Scarcely anything is said, for example, on the factors affecting the penetration of cotton, and more might have been made of the theories of dyeing. Chap. viii., on the constitution of cellulose, has received the oversight of Sir James Irvine himself, and is an adequate summary of the contributions of organic chemists. There should have been some mention, however, of the X-ray work done in Germany.

Artificial silks form the main subject of Chap. ix. An adequate book on this subject is long overdue in English; for the present purpose, the chapter is no doubt sufficient. The final chapter gives some select methods for the estimation of nitrogen, phosphorus, waxes and their characteristics, the "copper number," etc., of cotton. It was unnecessary to illustrate a pill press for cotton plugs (p. 221) and the space might have been given to some cross sections of various types of cotton and artificial silks.

The book is written in good style (except "this data is"), but a protest must be made against the constant use of "strength" of solution for "concentration" and "breaking strain" for "breaking load." The printing and illustrations are excellent though the tables are generally set too large. On pp. 76-77, for example, the story is broken into five times by small tables, and frequently much space is utilised to tabulate no more than two data. This makes the book less pleasant to read.

Whilst suggesting, therefore, that the book is not what one hopes to see written about cotton in a few years' time, the reviewer is justified in saying that a better summary of the knowledge available at the middle of 1924 does not exist. Mr. Hall is to be congratulated on his praiseworthy, though premature, attempt to reduce a colossal literature to its essentials in a readable manner.

J. C. WITHERS.

Seventeenth-Century Science.

Early Science in Oxford. By R. T. Gunther. Vol. 4: The Philosophical Society. Pp. viii + 259 + 4 plates. (Oxford: The Author, Magdalen College, 1925.) n.p.

THERE are still to be met scientists who display impatience at the *haec olim's* of their own antiquarians, and regard the science of the seventeenth century and that of the twentieth as two provinces totally distinct. But on many hands a more understanding survey of those distant realms is growing; and those who find pleasure in the methods of science as well as in its results are nowadays in the position of that Dr. Smith who (p. 22)

"has undertaken to procure a new Chart, made by a Gentleman who has lately travell'd from Muscovy to China; by this Chart it appears, that those two Countries are not so far distant from one another, as our Maps commonly make them."

Mr. Gunther fills the valued rôle of one of the chart-makers, whose labours are bringing to light the near apposition of the seventeenth and the twentieth centuries in the basic methods of science; and indeed, the two are alike in more than method.

Let us see what is to be extracted from his latest publication, which appeared opportunely for the proceedings at the Old Ashmolean Building, described in NATURE of May 2 (p. 651). Nearly the whole of the book consists of the Transactions of the Philosophical Society of Oxford (1683–1690), transcribed *literatim*.

These have been accessible hitherto only in the original Ashmolean manuscript and in a copy made about eighty-five years ago for the library of the Royal Society. The selections from these records which have been appearing recently in NATURE well illustrate their matter, and make quotation here unnecessary; but in this book Mr. Gunther has annotated them with explanations, citations, and cross-references, and the whole is most useful to the student. These notes, and the re-edited Index, must be the product of a very great deal of labour, coupled with an acquaintance with the relevant sources such as probably no one but Mr. Gunther can compass, and the reader will not fail to acknowledge the authority which these editorial notes too modestly attest.

Mr. Gunther has prefixed an introduction of sixteen pages, reviewing the establishment of the Society, and exhibiting its near concern with the early Royal Society. The Transactions of the Oxford assembly refer, of course, to a period twenty to thirty years after the founding of the Royal Society, towards which by this time it stood in the relation of an adopted daughter and handmaid. There is, indeed, room for doubt concerning the continuity of the Oxford Philosophical Society after 1651, near which date it was founded for the first time—whether under its later name or not—by the distinguished men who had had the still earlier "Invisible College" in London. In the 'fifties it was really a non-corporate cluster of brilliant workers, who were thereafter drawn for their organised scientific intercourse to Gresham College in London, where they founded the Royal Society. By 1683, however, a fresh generation of virtuosos had arisen at Oxford, with the grave old mathematician Wallis and the buoyantly inquisitive Dr. Plot as their mainstays, so that it became worth while to found the society anew; and it is at this stage that the doings portrayed by Mr. Gunther begin.

At a casual inspection, the spirit informing these doings is reminiscent of nothing so much as that of a private museum collected by Huckleberry Finn: excepting when it is in the vein of a solemn crank in a club—"what Creature makes ye greatest noise in proportion to its bigness? Probably 'tis ye *Teredo*." Such a comparison is unfair to many truly weighty contributions; but there is a measure of real truth in the attribution of a boyish love of oddities. For it was a time when an altogether new set of fairy tales had been made possible to read, in the shape of natural lore; and these charming amateurs were eagerly reading them for the delight of marvels newly revealed. For us, their tales have become old-fashioned, if we look merely at the facts told in them; but we still, like Huck and the old Oxford scientists, are lucky enough to have the boyish hope of new surprises; and it is to the seedling which men like them fostered, and which is fructifying so fast in the twentieth century, that we owe our gratification of that hope to-day. In two or three centuries hence, our own present delight in quanta, protons, or vitamins will doubtless be looked upon as pleasantly ingenuous and even amusing; but these things will have been no more and no less necessary to the science of posterity than are the *Quaere's* and discoveries of the seventeenth century to ours, for their purpose was our own and we derive it from them. Let us therefore "praise famous men and our fathers who begat us." IRVINE MASSON.

Our Bookshelf.

The Mammals of South Australia. By Dr. Frederic Wood Jones. Part 2: Containing the Bandicoots and the Herbivorous Marsupials (the Syndactylous Didelphia). (Handbooks of the Flora and Fauna of South Australia, issued by the British Science Guild (South Australian Branch) and published by favour of the Honourable the Premier). Pp. ii+133-270. (Adelaide: R. E. E. Rogers, 1924.) 4*s*.

WITH the appearance of the second part of his review of the mammals of South Australia, Prof. Wood Jones completes the account of the monotremes and marsupials. It is at once the most exhaustive and comprehensive guide to these two groups that has yet appeared, and is distinguished for its originality of treatment, for the vast amount of most interesting observations on the habits of these animals based on an intensive field experience, and for the large series of clearly reproduced illustrations from original drawings which serve to elucidate the text.

Prof. Jones is revolutionary in his conclusions on the problems which are connected with the marsupials as a whole. He rejects the division of the group on tooth characters in favour of one based on the characters of the pes, and classifies them into Didactyla and Syndactyla. The former have retained their primitive polyprotodont condition, while the latter have become further differentiated into those retaining the primitive dentition (polyprotodont) and those in which the dentition has become specialised (diprotodont). This classification is based on the grounds that the syndactylous condition is not the result of degeneration, but of a specialisation resulting in a highly organised anatomical mechanism for combing the hair. As such it is more likely to have arisen only once in evolution than to have become developed independently in two different phylogenetic races. There are, moreover, no didactylous diprotodonts. In this view of the phylogeny of the group the author follows Bensley, and is in opposition to the generally accepted arrangement. The argument is put forward with considerable force and, it must be said, with conviction. Prof. Jones's contention, too, that the marsupials reached Australia from the north, *via* Malay, is equally cogent, and deserves at least the considered attention of those who favour the alternative and generally accepted view of their immigration from South America.

Palgrave's Dictionary of Political Economy. Edited by Henry Higgs. New edition. Vol. 1: A-E. Pp. xviii+924. (London: Macmillan and Co., Ltd., 1925.) 36*s.* net.

THOUGH this is the first volume of Palgrave's standard work, it is the second of the new edition to appear, and students of economics will have reason to be grateful to the publishers for furnishing them with so excellent a reprint of an extremely useful book. The plan of vol. 1 is precisely the same as that of vol. 2, which was reviewed in NATURE of February 16, 1924, p. 233. Only a few changes of any moment have been made in the new edition. The editor has added in an appendix a good deal of new matter. In the present volume the new matter takes up ninety pages, and dealing as it does with such subjects as banking, censuses, the conversion of the national debt, recent budgets, canals, libraries on economics, and the development of economic teaching in recent years in Great Britain, it serves a very useful purpose in bringing up to date some of the more important topics in the body of the book.

This additional information is so good that one is inclined to ask for more. The article on bimetallism, for example, might perhaps with advantage have found a place in the appendix; it would have been helpful to have been provided with even a few notes on recent developments. So, too, with the article on commissions of inquiry, which in the body of the book are noted up to the year 1905. The list might well have been continued to include the commissions of inquiry during the last twenty years. The same applies to the article on communism, in which of late there have been some interesting developments. But where there is so much that is good, it is perhaps ungracious to be discontented with omissions. It ought to be noted that the biographies form a useful feature of the volume, and the index, which is the soul of a book of reference, is particularly full and elaborate.

Tychonis Brahe Dani opera omnia. Edidit I. L. E. Dreyer. Tomus VII. Pp. v+422. n.p. Tomus XI. Pp. iv+414. n.p. (Hauniæ: Libraria Gyldendaliana, 1924.)

THE appearance of these two volumes will be welcomed by all who are interested in Dr. Dreyer's monumental edition of the works of Tycho Brahe. We note that in the seventh volume Dr. Dreyer's name no longer stands alone on the title-page, but there is associated with him as co-editor Joannes Ræder. The present co-editor's assistance was acknowledged in the prolegomena to the tenth volume, which appeared in 1923, and the assistance given in the preparation of that volume is continued in the eleventh.

Vol. 6 of the series contained those astronomical letters written by or to Tycho Brahe which were published by him in his lifetime. Vol. 7 contains in chronological order the rest of his astronomical correspondence down to 1597. The series will be continued in Vol. 8, in which we are also promised notes on Tycho's correspondents and on the persons mentioned in the letters. The non-astronomical letters are reserved for Vol. 14. Most of the letters included in the new volume had been previously published, but the present text is based on MS. originals or MS. copies preserved for the most part at Vienna. Perhaps the most interesting part of the correspondence is that with Thaddæus Hagecius of Prague, physician to the Emperor Rudolf II. Much of the contents of the letters is only distantly related to astronomy. Among the most interesting topics are the presence or absence of parallax in the new star of 1572 and in comets.

Vol. 11 continues the records begun in Vol. 10, and comprises the observations made from 1586 to 1589. The volume also contains a catalogue made in 1589 of zodiacal stars. The observations are very varied, and it is to be hoped that a good index will be supplied in a later volume.

Life and Word: an Essay in Psychology. By Dr. R. E. Lloyd. Pp. xvi+139. (London: Longmans, Green and Co., 1924.) 7*s.* 6*d.* net.

DR. LLOYD'S thesis is that thought, which is verbal, "takes certain *definite* directions which are the directions of human behaviour, but circumstance does *not* lie around us in a *definite* order. How, then, can we take our thought from circumstance? It is, therefore, not taken from things, but given mysteriously." The very statement of the thesis would seem to exclude the problem from the purview of science; and, indeed, the book is rather one of philosophical reflection than otherwise, though it contains many acute observations of scientific relevance. The author raises the very ancient problem of the universals in a somewhat novel modern form; but his attempt to classify "humanity" by identifying it with "verbal-thought" will scarcely convince contemporary psychologists. This "verbal-thought" is looked upon by Dr. Lloyd as a function distributed among individuals, in a way similar to that in which a quality or characteristic is distributed among the members of a species, in that, as a whole, it is partly identical and partly different in any given individual.

The view that thought is a *differentia* of human individuals is not a new one. What Dr. Lloyd would emphasise is that it varies from one individual to another. But this has long been implicitly realised; and the stress laid upon individual differences by modern psychology is explicit. The difficulty is one inherent in classification, in which concepts must be used which neglect differences and consider only similarities. The little book is puzzling, but suggestive and stimulating to thought.

The Book of Receipts: containing a Veterinary Materia Medica, a Pharmaceutical Formulary, a Photographic Formulary; together with numerous Chemical and other Tables likely to be of use to Pharmacists and Manufacturers. By E. W. Lucas and H. B. Stevens. 12th edition. Pp. 473. (London: J. and A. Churchill, 1924.) 10*s.* 6*d.* net.

THE scope of this book is sufficiently indicated by its extended title. It is intended mainly for the use of pharmacists, but the photographic formulary and the sets of recipes for microscopical reagents and stains, waxes, varnishes, and special inks, etc., may be useful in scientific laboratories. The authors should consider the desirability of issuing these sections with additions as a separate laboratory receipt book. The collection is at present rather too eclectic to appeal to the average scientific worker.

Letters to the Editor.

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

The Essential Hormone of the Parathyroid Gland.

THE essential hormone of the parathyroid gland has been obtained in certain extracts of the fresh glands of the ox (*J. Biol. Chem.*, 1925, 63, 395). Potent extracts have been prepared by first submitting the glands to acid hydrolysis under carefully controlled conditions. The active principle has thus been fractionated along with co-existent substances from the hydrosylate and thus obtained in a relatively high degree of purity.

That a principle contained in these extracts represents the essential normal internal secretion of the parathyroid gland has been shown by the fact that thyroparathyroidectomised dogs on a lean meat diet, treated with these extracts, have been kept free from tetany so long as adequate dosage at proper time intervals has been maintained. The withdrawal of this treatment has resulted in the onset of tetany in these animals. Also, it has been shown that thyroparathyroidectomised dogs which have developed tetany could be restored to normal by the use of potent parathyroid extracts. There is at this time in our laboratory a thyroparathyroidectomised dog which was operated upon some four months ago. This animal is in perfect health. It has been treated continuously with parathyroid extract. Withdrawal of the extract for one day, even after four months of such therapy, has resulted in the precipitation of violent tetany, which has been relieved by the reinstitution of the treatment.

Along with many others, it has been our conviction that parathyroid tetany is primarily due to a lowered calcium content of the blood serum. It was a matter of great interest, therefore, to show that the administration of potent parathyroid extracts results in a mobilisation of calcium salts in the blood-stream. It has been found that potent parathyroid extracts cause a mobilisation of calcium not only in thyroparathyroidectomised dogs, but also in normal dogs. Just as there is a typical blood-sugar curve following the administration of insulin, so also there is a typical blood-serum calcium curve following the injection of active parathyroid extract into dogs. The degree of hypercalcæmia induced in a dog by the injection of a parathyroid extract was also found to be directly related to the size of the dose administered. The potency of parathyroid extracts can therefore be determined with a fair degree of accuracy by the use of several normal animals which are under dietary regulation.

Repeated injection into normal meat-fed dogs of an active extract at intervals of a few hours, has resulted in a condition of profound hypercalcæmia. This condition, if maintained, has ended in a fatal issue. In such cases a typical train of symptoms has been manifested. Many changes in the physical and chemical characteristics of the blood induced by parathyroid hormone overdosage have been observed. Probably the most important of these changes in relation to the fatal issue is a decrease in blood volume and the consequent thickening of the blood itself. Preliminary experiments directed towards the antidoting of the symptoms of parathyroid hormone overdosage seem to point to this as the main factor to avoid or, if present, to counteract. Repeated intravenous injections of hypertonic glucose or saline solutions have proved of definite value. When such treatment has been instituted early in the case of dogs receiving repeated injections of potent extract, the animals lived longer than the controls. No absolute antidote has as yet been found.

It is also of interest to note that typical guanidine tetany has been induced in normal dogs at a time when they were also manifesting a condition of profound hypercalcæmia as a result of repeated simultaneous adminstrations of guanidine hydrochloride and potent parathyroid extract.

Experiments have shown as well that there is some intimate relationship between the habits of life of an animal and the function of the parathyroid glands. The rabbit, for example, has been found to be peculiarly resistant to repeated injections of the hormone, whereas the dog has been shown to be highly sensitive to it.

J. B. COLLIP.

Department of Biochemistry,
University of Alberta,
Edmonton, Canada, April 18.

The Preservation of Fishing-nets, Mosquito-nets, and Tent Fabrics.

IT has been shown by H. F. Taylor and A. W. Wells (Bureau of Fisheries, Document No. 947, Washington, 1923) that copper oleate dissolved in petrol or benzol is an efficient preservative for nets immersed in salt water. To avoid the creeping out of the soap to the surface on drying, the ten per cent. oleate solution receives one per cent. of mineral oil or of creosote. In fresh water, less satisfactory results were obtained unless a considerable amount of tar was added as a binder.

I have carried out a few tests, using this method, and the results have all been favourable. Silk plankton tow-nets become weakened in about three months' use, varying with the amount of wear. Previous work showed that this is in part due to the action of sunlight, but the major part appears to be due to bacterial action. Silk netting treated with copper oleate was kept in sea-water for six months, the water being changed every other day, and though in time the soap vanished the netting remained sound. Controls were much weakened inside five weeks, and shortly after that could be torn like wet paper. Since silk nets are costly, about 11*l.* for a set of four, and the preservative costs less than a shilling per net, the advantage of using it is obvious.

When tried on stout "stramin" (hemp) netting good results were also obtained, but less striking, for this material is vastly more resistant than silk. In addition to copper oleate a mixed copper soap specially prepared by Mr. W. A. Davis, of Messrs. Lever Bros., was also tried. This, being less soluble than oleate, was used in five per cent. solution. It has proved as efficient, or rather more efficient, than the pure oleate, though used in half the concentration.

After six months in sea-water the lighter stramin netting was found to be rotten, but the piece treated with mixed soaps remained sound, and single threads could only be broken with difficulty. The stouter stramin stank after six months in sea-water; though it could not be torn its appearance and feel had altered and single threads could be broken. The portions treated with oleate and the mixed soaps remained perfectly sound; single threads could not be broken by hand. A sufficient amount of copper soap remained on these pieces to render them much darker in colour than the untreated; of the two the mixed soaps appeared to remain on better than the oleate.

Linen and cotton tentings treated with oleate or

Lever's product lost much of the preservative on the outer side when exposed on the flat roof of the laboratory during the very wet months January and February. Fishing-nets treated with these soaps should therefore be protected so far as possible from rain; nor does hanging up to dry appear to be necessary, for sunlight is injurious to all fibres, and the copper soaps protect very effectively against rotting. The use of these soaps, mixed with tar for the heavier gear to lessen the rain effect, seems desirable. It may be pointed out that the soaps dissolve only when the nets are in water, but bacterial action goes on so long as the net is damp, so the immersion tests are in this respect unduly severe on the preservative.

The treatment of tent fabrics with copper soaps would appear to be useful in climates where the rainfall is not excessive, but where heavy dews prevail, as in parts of Egypt. In such climates fungal hyphæ grow among and inside the cotton fibres and holes appear everywhere. The inner walls of the eastern pattern tents are also attacked.

The decay of mosquito netting in hot damp climates is sometimes a serious matter. Doubtless a dip in a dilute solution of copper soap would prove effective in prolonging the life of this netting. It could also be used for tennis nets and netting round the courts.

W. R. G. ATKINS.

Marine Biological Laboratory,
Plymouth.

Diagnosis of Ankylostomiasis.

LIEUT.-COL. CLAYTON LANE, in NATURE of March 28, p. 478, criticised the modified floatation method adopted in Egypt for the diagnosis of ankylostomiasis. The principal modification lies in using a conical Erlenmeyer flask to hold the fæcal emulsion in concentrated salt solution. This enabled the use of a large amount of fluid (100 c.c.), while the surface film does not exceed 1 cm. in diameter. Apparently Lieut.-Col. Lane did not give this method a trial, but applied to it the results he previously found in using an inverted metal cone.

Any trustworthy method for the diagnosis of ankylostomiasis intended for extensive campaigns should (1) be delicate enough to detect infection with one couple of worms of which one is a normally ovipositing female, (2) be simple and practical, and (3) not be time-consuming. It is not essential that the method should ensure the concentration in the surface film of the highest percentage of ova present in 1 c.c. of the stool so long as enough ova are present to ensure diagnosis. The examination is discontinued once a single ovum is detected.

If we accept Lane's statement, although it was not proved, that this method detects 7 per cent. of the total number of ova, and if we accept Stoll's result that a single fertilised female lays 44 ova per c.c. of the stool, we find that the method fulfils the requirements mentioned above, especially as the ova are unmasked and easily detected in films prepared by this method. Lane's results regarding the concentration of the ova, and Stoll's counts as regards the number of ova laid by a single female, have not yet been confirmed by other investigators. In view of this uncertainty, the anthelmintic (carbon tetrachloride) is administered to all patients attending the Ankylostomiasis and Bilharziasis Hospitals in Egypt since January 1924, regardless of the results of the microscopical examination. Re-examination after the first treatment is restricted to those in whose fæces ova were detected on the first examination.

In addition to the floatation method, a fæcal smear is examined from every case in order to detect bilharzia ova, and incidentally ankylostoma ova. It has been found that on an average 30 per cent. of the positive cases for ankylostoma are detected by floatation and missed in the smear. During re-examination after the first treatment, 90 per cent. of the positive cases are missed in the smear and detected by floatation.

Lane mentions as a proof of the inaccuracy of the method that in an Egyptian village in the Delta (Saft el Enab), only 16·6 per cent. were found to be infected with ankylostoma, while 40,000 examinations by the smear or centrifugal method showed an infection percentage in different parts of Lower Egypt of 48 to 97 per cent. I am unaware of the source from which he got his figures as regards the 40,000 examinations. I may, however, mention that the degree of infection in the Delta varies considerably. Using the technique mentioned above, it was found that in villages in the neighbourhood of Cairo the infection may be so high as 88 per cent., in the neighbourhood of Benha 60 per cent., in the neighbourhood of Mansura 34 per cent., in the neighbourhood of Dessuk 16 per cent. The percentage of infection diminishes as we travel northwards. It is probable that atmospheric temperature influences the incidence of infection in these different localities. This subject is being studied at present. The Delta of Egypt is a large territory, and it is inaccuate to treat it as a whole as regards the incidence of ankylostomiasis.

As regards the importance of accurate study of ankylostomiasis from its various aspects in Egypt, I may assure Lieut.-Col. Lane that the Egyptian Government is fully alive to its responsibility. It had already started, towards the end of 1922, a research section devoted to the study of ankylostomiasis and bilharziasis.

M. KHALIL.

Department of Biology and Parasitology,
Royal School of Medicine, Cairo, Egypt, April 4.

THE community percentages of hookworm infection for Egypt of 48 to 97 obtained by the use of Howard's, the least efficient concentrative diagnostic technique, emerge from analysis of Khalil's tables. A percentage of 16·6 for his floatation method indicates then either an unluckily chosen experimental site or an undependable technique. It was held that the evidence suggested that the latter factor was involved. This conclusion would indeed seem to be Khalil's also, since he writes: "It is probable that some of my negative results were due to the very few ova which escaped the attention of the examiner" (p. 82). Put otherwise, his first requisite for a trustworthy diagnosis—namely, that the technique must be "delicate enough to detect infection with one couple of worms of which one is a normally ovipositing female"—is an ideal which he seemingly holds unattained by his own technique.

But the fundamental point in the criticism lay in that, being without knowledge of the number of ova with which, in any instance, his technique started, he necessarily remained ignorant of the percentage which it finally delivered. The later statement, that it is better than the worst concentrative technique, does not even now rectify the matter. Its real value can only be indicated by such methods of control as are being applied in various parts of the world, already with a considerable measure of success. Without a controlled, and therefore scientific, basis for the work, the Egyptian campaign, so heavily subsidised by the Rockefeller Foundation—at the expense of which so much of the recent widespread experimental work on control has been carried out—must clearly remain of minor value.

CLAYTON LANE.

Homologies of the Genital Ducts of Insects.

IT is unfortunate that even the most recent text-books of entomology are not up-to-date in their accounts of the above organs. It is only with regard to the ectodermal parts of the ducts that opinions have differed; otherwise it is admitted by all that ovaries and oviducts correspond to the testes and vasa deferentia respectively. In every book, old or new, one finds the median ejaculatory duct homologised with the median vagina. This homology is open to serious objection: the ejaculatory duct opens in all insects, excepting the Ephemeroptera, behind the ninth sternite, and is unpaired from the very beginning, while the vagina or the uterus opens in

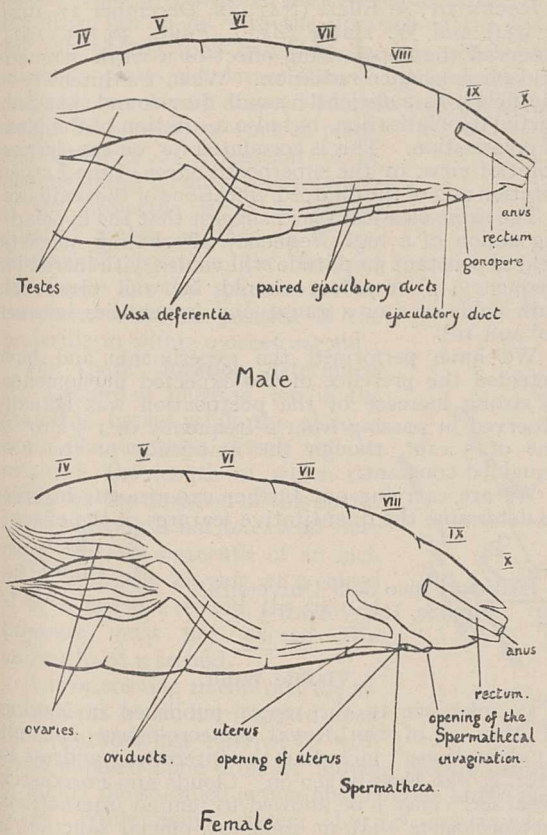

FIG. 1.—Scheme of the development of the reproductive organs of an insect. Accessory gland not shown.

most insects between the eighth and ninth sterna, and is paired in origin in many orders.

In the young male there is an hypodermal invagination of the body wall behind the ninth sternum, the rudiment of the median ejaculatory duct. This invagination at its anterior end, about the posterior region of the eighth sternum, meets and opens into a pair of ectodermal ducts, termed the paired ejaculatory ducts, which as development proceeds get into communication with the vasa deferentia. In the case of the young female there is also an invagination of the integument behind the ninth sternite which develops into the spermatheca. The spermathecal rudiment about the posterior margin of the eighth sternum opens into an ectodermal duct, the uterus or vagina, which, as mentioned above, arises in many insects by coalescence of a pair of ducts. The uterus at a later stage in development becomes continuous with the oviducts. Evidently, therefore, the median ejaculatory duct of the male corresponds to the spermatheca of the female, and not to the vagina or uterus. The homologue of the latter are the paired ejaculatory ducts. Diagrams of the scheme of the organs appended herewith illustrate the above remarks (Fig. 1).

The only difference (but which has caused a considerable amount of confusion) between the organs of the two sexes is that while the median ejaculatory duct meets and opens into the paired ejaculatory ducts at its extreme anterior end, the spermatheca does so about the middle of its length, with the consequence that its anterior half remains free, increases in size, and appears as a diverticulum of the uterus. Moreover, unlike the uterus, the paired ejaculatory ducts have no opening of their own in the present-day insects. But in Coleoptera, and probably in Diptera also, the uterus, like the latter, has, morphologically speaking, no opening of its own and communicates with the exterior through the opening of the spermatheca, and therefore the female gonopore, unlike that in other orders, lies behind the ninth sternum. The spermatheca, except in the Coleoptera, Diptera, etc., loses its proper opening and communicates with the exterior by the opening of the uterus. In the Lepidoptera, however, both the spermatheca and the uterus retain their proper apertures even in the adult stage, with the consequence that there are two "genital openings," one behind the other, in this order. In the Ephemeroptera also there are two openings, but they lie on the same segment, the seventh.

HEM SINGH PRUTHI.

Zoological Laboratory,
Cambridge, April 22.

Fossils and Leonardo da Vinci.

IN his valuable and sympathetic appreciation of Huxley on the occasion of the centenary celebrations on May 4, Prof. Poulton incidentally referred to the puzzled discussions of naturalists of former days concerning the fossil sharks' teeth ("glossopetræ") that were found in Italy.

It is interesting to compare their mental attitude and their almost complete and unimaginative ignorance with the acute and unerring perception of the supreme genius of all time—Leonardo da Vinci.

In "The Literary Works of Leonardo da Vinci" (Richter, 1883, p. 208 *et seq.*) he discusses very fully the presence of fossils in the Italian mountains. His immediate object is to show that the Noachian flood could not be responsible for this; and his many-sided arguments indicates the clearest understanding of the formation of strata by deposition from rivers, and of earth movements, in their connexion with the preservation and present position of fossils. His particular views are supported by the following statement:

"And if you were to say that these shells were created, and were being continually created in such places by the nature of the spot, and of the heavens which might have some influence there, such an opinion cannot exist in a brain of much reason; because here are the years of their growth, numbered on their shells, and there are large and small ones to be seen which could not have grown without food, and could not have fed without motion—and here they could not move." With such a mental attitude (existing at a period that was steeped in astrology) what a mighty ally Leonardo would have been to Darwin and Huxley!

One of his other arguments against the assistance of the Deluge, in the part of Italy that he investigated, is characteristic of his incessant interest and scientific watchfulness. "We have it in the Bible that this

deluge lasted 40 days and 40 nights of incessant and universal rain . . . and if you were to say that . . . the shells quitted their first home" [near the seashore] "and followed the increase of the waters up to their highest levels . . . I answer, that the cockle is an animal of not more rapid movement than the snail is out of water, or even somewhat slower; because it does not swim, on the contrary it makes a furrow in the sand by means of its sides, and in the furrow it will travel each day from 3 to 4 braccia; therefore this creature, with so slow a motion, could not have travelled from the Adriatic Sea, as far as Monteferrato in Lombardy, which is 250 miles distance, in 40 days; which he has said who took account of the time. . . ." The last few words are probably not free from an intended gentle sarcasm (we meet it again elsewhere); but how unanswerable is this argument, as are many others, of this brilliant observer and thinker!

Leonardo refers also to "the bones and teeth of fish, which some call arrows and others serpents' tongues . . ."—surely the very "glossopetræ" already mentioned.

What puzzled naturalists of later times was abundantly clear to him of the fifteenth century.

PERCY EDWIN SPIELMANN.

The Athenæum, May 5.

The Identity of "Alumen" in Pliny's Natural History.

"ALUMEN" is mentioned frequently in the Historia Naturalis of the elder Pliny, and there has been some controversy about its identity. It is probable that the term was used loosely to describe a number of astringent salts, and it is clear from the tests prescribed in Pliny, H.N. 35, 184-5 (the blackening of pomegranate juice and nut-galls), that the word was sometimes used to describe a compound of iron, perhaps the sulphate, derived from iron pyrites by oxidation. Ajasson, however, boldly identifies the "alumen" mentioned in H.N. 33, 88, as sulphate of aluminium, but gives no reasons for so doing.

The passage in question concerns the preparation, for use as a pigment, of "chrysocolla." Though the identity of this latter substance has been a matter of dispute in the past, there is now general agreement that it was malachite, or basic carbonate of copper. The passage runs as follows:

H.N. 33, 87. "(Chrysocolla) illa quoque herba quam lutum appellant tinguitur. . . .

88. "Pulvis (sc. chrysocollae) semper in catino digeritur et ex aceto maceratur ut omnis duritia solvatur, ac rursus tunditur, dein lavatur conchis, siccatur. Tunc tinguitur alumine schisto et herba supra dicta, pinguiturque antequam pingat. . . .

89. "Summa commendationis, ut colorem in herba segetis laete virentis quam simillime reddat."

There is little doubt that "lutum" is the "reseda luteola" or weld, an extract of which dyes yellow with aluminium mordants and greenish olive with iron mordants.

The writer prepared an extract of weld by boiling the chopped-up plant with water. Finely-powdered malachite (bluish-green in colour) was treated with vinegar, washed, and boiled with weld extract to which had been added (*a*) aluminium sulphate, (*b*) ferrous sulphate, or (*c*) iron alum. The colour finally obtained depended on the proportions of dye and mordant and on the time of boiling, but in a general way (*a*) gave an emerald green powder, while (*b*) and (*c*) gave dark greens—approximately the colour of the holly leaf.

It seems clear that the former is the colour referred to as "colorem in herba segetis laete virentis" rather than the latter. It is almost certain, therefore, that "alumen" includes salts of aluminium as well as salts of iron.

In conclusion, it should be added that Dioscorides (5, 104), in a sentence the exact meaning of which is uncertain, seems to describe "chrysocolla" as being of "a full leek green," but it is probable that he is speaking of the original material and not of the dyed product as he does not mention the dyeing process at all.

KENNETH C. BAILEY.

Trinity College, Dublin, March 23.

Effect of an Alternating Magnetic Field on the Polarisation of the Resonance Radiation of Mercury Vapour.

RECENTLY, A. Ellett (NATURE, December 27, 1924, p. 931) and W. Hanle (*Zs. f. Phys.*, 30, 93, 1924) observed the depolarising effect of a weak magnetic field on resonance radiation. When the intensity of the field was sufficiently small they found, not only partial depolarisation, but also a rotation of the plane of polarisation. This is accounted for, on the classical point of view, by the superposed effect of the Larmor rotation and of the damped vibrations of the oscillator.

The same classical views suggest that the depolarising action of a high frequency alternating magnetic field of constant amplitude will vanish with increasing frequency. The effect should be well observable with fields of 2 or 3 gauss, and frequencies between 10^6 and 10^7.

We have performed the experiment, and have detected the presence of the expected phenomenon. A strong increase of the polarisation was actually observed in passing from a frequency of $1{\cdot}5 \times 10^6$ to one of 5×10^6, though the amplitude of the field remained constant.

We are carrying out further experiments in order to determine the quantitative features of the effect.

E. FERMI.
F. RASETTI.

Istituto Fisico dell' Università,
Firenze, Italy, April 3.

Visible Wind.

IN reference to the report published in NATURE of May 2, of the Royal Meteorological Society's "Celebrations," including the interesting address by Prof. E. van Everdingen on "Clouds and Forecasting Weather," may I be allowed to remind international meteorologists that in 1906, by official sanction in Great Britain, the status of "wind waves" was raised from that of a purely theoretical deduction to that of a normally observable natural phenomenon. "Wind waves" operating in the free and cloudless air are recognisable as such from among other sources of deformation of the definition of telescopic images. They are most adequately observable by means of a telescopic image of the sun projected for the purpose into a darkened room. Their approximately horizontal progressive wave-motions describe prevailing conditions of atmospheric stratification, wind directions, and turbulence above the place of observation always ahead of and generally many hours ahead of any visible formation of associated clouds. Thus the main objects of cloud-observation are obtainable by means of *yet earlier* observations of winds, up to all heights of known cloud formation, in any brief moment of sunshine, with the utmost ease and expedition. But Ruskin is aptly quoted by the writer of the report to the effect that "the meteorologist is impotent if alone."

CATHARINE O. STEVENS.

The Plain, Boar's Hill, Oxford.

Single Spark Photography and its Application to some Problems in Ballistics.

By P. P. QUAYLE, Assistant Physicist, U.S. Bureau of Standards.

SPARK photography, in which the illumination is provided by an electric spark of such short duration that a moving object appears stationary, has many applications in the investigation of high-speed phenomena. The record obtained is not an image, no lens being used, but is simply the silhouette of objects between the light source and the photographic plate. Two distinct problems are presented in the photography of moving objects. One of these is the timing of the spark so that the desired epoch of the phenomenon under investigation may be photographed, and the other has to do with the duration of the spark. All the photographs described in this article were taken on plates not larger than 8 by 10 inches. A projectile moving at a speed of 2700 feet per second would be in front of such a plate, and therefore in a position to be photographed, for only 0·0003 second. If the projectile is to be photographed within an inch of a predetermined position, the time of occurrence of the spark must be correlated with the position of the projectile to within 0·00006 second.

The spark duration determines the amount of blurring, for if the projectile moves while the plate is being illuminated a streak will be recorded, the length of which depends on the duration of this spark. If the blurring is not to extend over more than one-sixteenth of an inch for a projectile moving at a speed of 2700 feet per second, the time of exposure must not exceed two millionths of a second.

It is interesting to contrast the requirements which are imposed upon the apparatus just referred to with those imposed upon ordinary moving picture cameras in taking the so-called action photographs of the daily press. While many camera shutters are rated to operate in 0·0006 second, they seldom function in less than 0·002 second, and 0·005 second is a more common time of exposure. In photographing a racing car moving at 120 miles per hour, using a shutter which operates in 0·002 second, the car will move approximately 4·2 inches during the exposure interval. Exposure times which are satisfactory for photographs of polo matches, track and field work, etc., are ten times too long for photographing a racing car and ten thousand times too long for photographing a projectile at right angles to its trajectory. If the photograph is not taken at right angles to the trajectory the requirements are less severe. This point is well illustrated in the case of a 4·7 in. field-piece, say, firing so that the projectiles are silhouetted against the sky. If the day is clear, an observer standing behind the piece can see the projectile with the naked eye at a distance of three hundred yards from the muzzle and follow it without difficulty for a thousand yards or more along its trajectory.

In order to secure a properly timed spark of suitable character there must be available a means of generating electrical energy at very high voltage; a means of storing such energy; apparatus for the regulation of the voltage; and finally, a means of releasing the stored energy at the proper time. The manner in which these parts are associated is shown diagrammatically in Fig. 1. In our equipment the generator consists of a motor-driven influence machine having two revolving plates 17 in. in diameter. A 0·024 microfarad Leyden jar condenser constitutes the means of storing the energy for the photographing spark. The apparatus for regulating the voltage of the condenser includes a dynamometer or potential regulator and a switch which disconnects the condenser from the influence machine when the voltage across its terminals reaches a definite value determined by the regulator adjustment.

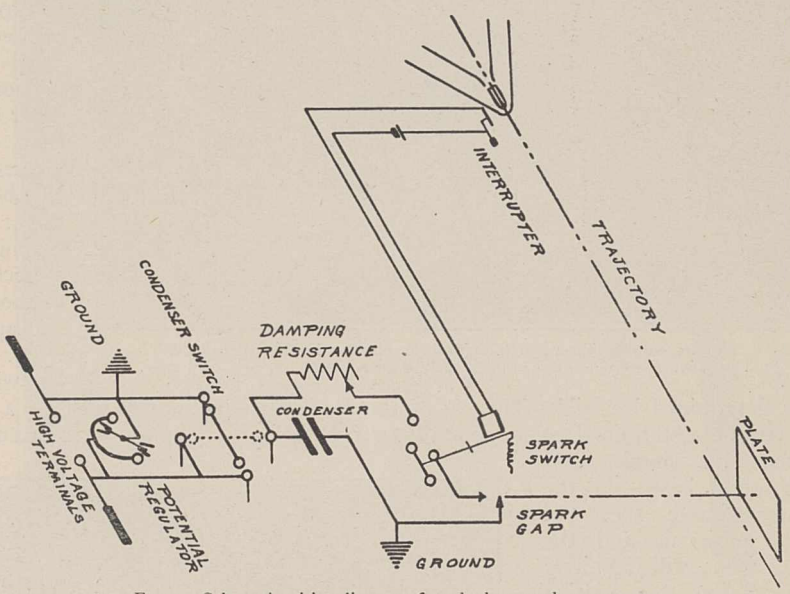

FIG. 1.—Schematic wiring diagram of spark photography apparatus.

The arrangement for releasing the photographing spark also consists of two parts. The first part is an electromagnetic switch which closes a trigger spark gap. The second is an auxiliary device which serves to time the operation of the previously mentioned switch with respect to the phenomenon to be photographed. This auxiliary device takes different forms in varying circumstances. For example, when projectiles are being photographed well away from the gun, an interrupter is used which is placed near the trajectory and opens an electric circuit when the head wave of the bullet passes over it.

CYCLE OF OPERATIONS.

When a photograph of a projectile is to be taken, the following steps are involved. The operator sets or cocks the spark switch and the condenser switch, having previously placed the interrupter a short distance away from the trajectory and at a sufficient

distance from the photographic plate to allow for the 0·0048 second time lag in the apparatus. This position is determined by trial. The lag of the spark switch may be determined experimentally. If this lag is known, a simple computation based on the approximate speed of the projectile and the lag value will definitely determine the position for the head wave interrupter. After the influence machine has been started, the voltage across the condenser builds up until the point is reached at which the regulator functions. The closing of the regulator contacts energises the tripping magnet of the condenser switch, which in turn promptly disengages the arm and short-circuits the influence machine, thus preventing the accumulation of further charge on the condenser. This arm, through the buffer, automatically turns on the signal light and the operator immediately fires.

The bullet moves out from the muzzle and passes the interrupter in its progress toward the plate. As the sound waves which accompany the bullet pass the interrupter the circuit breaker is thrown open, the magnet of the relay is de-energised and the armature catch is released. The switch arm then closes the trigger gap and the condenser discharges through it and the photographing spark gap with which it is in series. If the interrupter has been properly located, the spark occurs at the instant the bullet arrives in the desired position in front of the plate.[1]

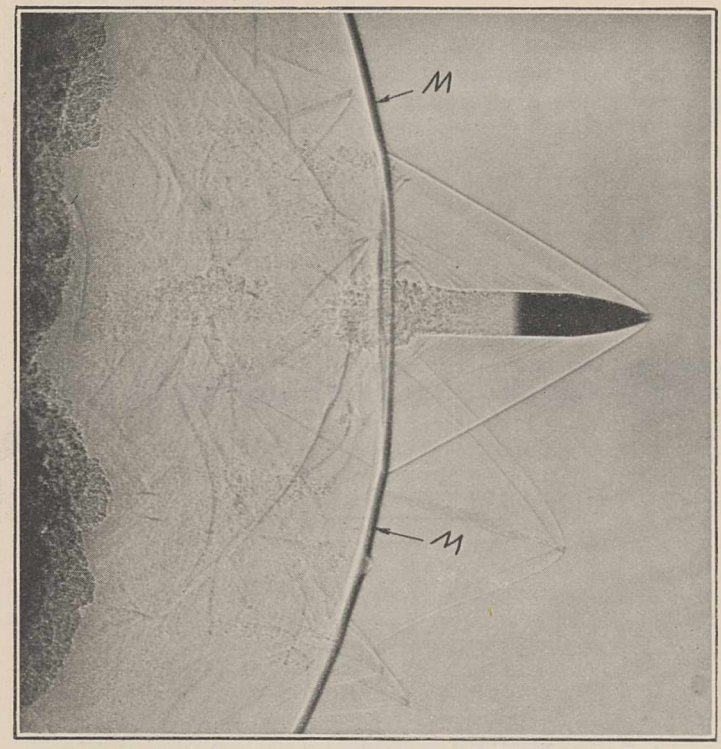

FIG. 2.—Bullet from a 0·30 Springfield rifle about 11 in. from the muzzle. The bullet is well in advance of the propelling gases. M is the boundary wave.

COMPARISON WITH OTHER METHODS.

The first spark photographs of projectiles in flight seem to have been taken about 1881 by Prof. E. Mach, of the University of Prague, who carried out a remarkable series of experiments along this line. Prof. Mach utilised the so-called Schlierenapparat devised by Toepler for making visible those portions of a transparent medium which differ but slightly in refractive index from that of their surroundings. Hence his images were small and required the utmost in photographic manipulation to develop them. Prof. Mach triggered his photographing spark by firing the bullet through a secondary trigger gap, and while this method is positive, the wires of the trigger gap appear in the photograph.

Dr. L. Mach, in 1893, attacked the problem with several modifications of the earlier apparatus and a most ingenious trigger device. His efforts were attended by marked success. L. Mach's

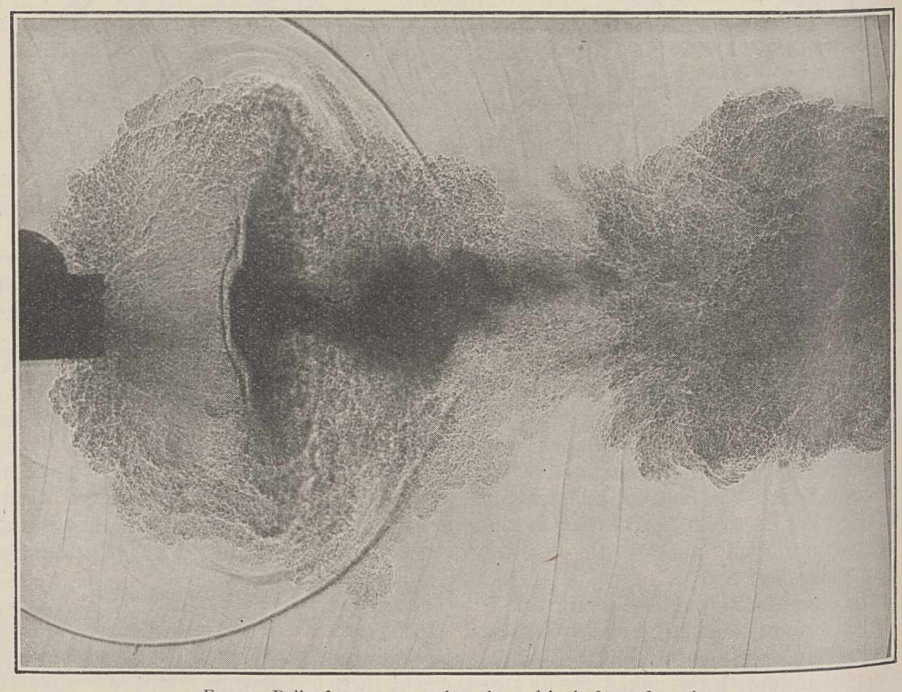

FIG. 3.—Bullet from a 0·45 revolver about 1¼ in. in front of muzzle.

[1] A more detailed description of the apparatus with illustrations is given in a Bureau of Standards paper now in press entitled, "Single Spark Photography and its Application to Ballistics."

apparatus was also based upon Toepler's method, but he replaced the lens of the earlier apparatus by a large concave mirror, which gave a larger field and more intense illumination. L. Mach triggered his spark by means of a compressional wave started by the passage of the projectile through a special device designed for the purpose.

From data found in Mach's papers, and from general information concerning the rifles in use at the time his work was done, it appears probable that the speed of the projectiles photographed by him did not exceed 1900 feet per second.

C. V. Boys [1] in 1893 introduced the direct shadow method of bullet photography employed in this paper. The sound waves and other air disturbances produced by the flight of the bullet are recorded in the photographic plate owing to the fact that their refractive indices differ from that of the surrounding air. Boys used the triggering device employed by E. Mach, which shows in each picture, but his photographs are among the best ever obtained.

Excellent photographs similar to those of Boys were published by W. A. Hyde in Ordnance Pamphlet, No. 422, U.S. Navy Department, in 1913.

All the methods of photographing projectiles in flight discussed up to this time have one point in common, namely, that in triggering the photographing spark the motion of the projectile is interfered with in some way. In the earlier triggers, the projectile closed a gap mechanically. Then L. Mach fired his bullets through paper cylinder heads causing a compressional wave in a small tube. The use of the interrupter described here, and in the earlier publication of the present writer [7] referred to, yields photographs in which no part of the photographing mechanism appears, and in which the bullet is not touched in any way.

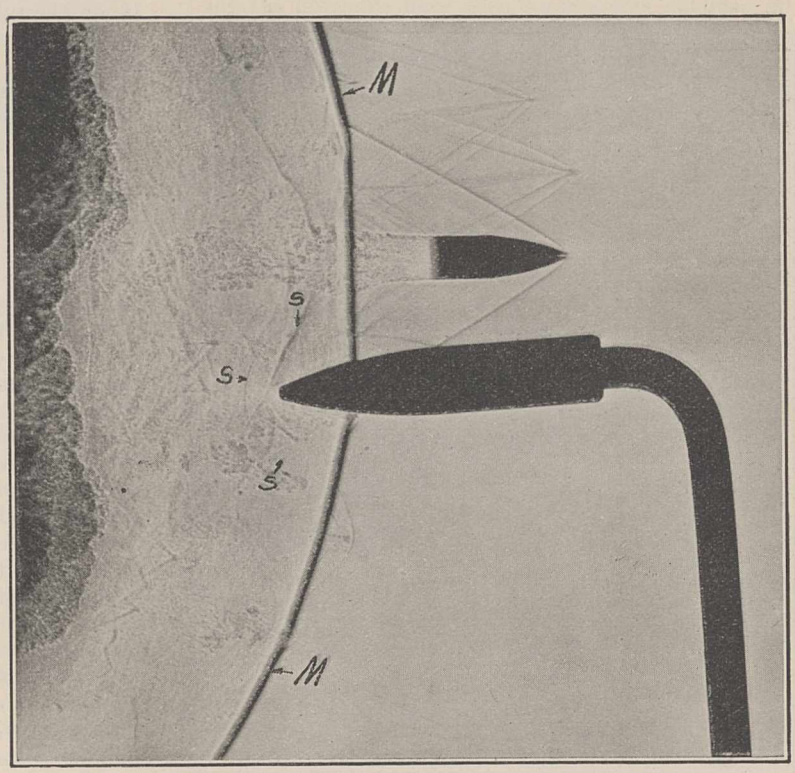

FIG. 4.—Stationary projectile within the boundary wave M sets up an ordinary sound wave S.

ACCELERATION OF PROJECTILES AFTER LEAVING MUZZLE.

Opinion appears to be prevalent that a projectile continues to be accelerated for a considerable distance after leaving the muzzle of the gun. Thus John W. Hicks in his book, "The Theory of the Rifle and Rifle Shooting" (1919), quotes Dunn of the Ordnance Department, U.S.A. (1897), as saying: "Small arm bullets should be considered as having their maximum velocity at points from 20 to 30 feet in advance of the muzzle. They should gain in velocity over this distance for the bullet is enveloped in gases moving in the same direction and with higher speed than that of the bullet. . . ." No refutation of this view has been found in the literature. Photographs taken during the course of this investigation indicate, on the other hand, that the service projectile of a calibre 0·30 Springfield rifle ceases to be accelerated within a foot of the muzzle. Such a photograph is shown in Fig. 2. The muzzle of the rifle does not appear in the photograph, but, from measurements made at the time the photograph was taken, it is known that the centre of the plate was eleven inches in advance of the muzzle. It will be seen that the bullet is already well in advance of the outermost boundary of the propelling gases, and since the bullet has set up its normal head wave, it is subject only to the retarding forces considered in exterior ballistics.

Other photographs, taken of a bullet four or five inches in advance of the muzzle, show that in this position the powder gases are being deflected from the base of the bullet and consequently the bullet is being accelerated. At a distance of from six to eight inches in front of the muzzle the speed of the powder gases falls below that of the bullet, and at a distance of eleven to twelve inches the bullet has outdistanced all the blast effects, with the possible irrelevant exception of a few stray powder particles, and cannot be overtaken by any accelerating forces of the discharge.

Fig. 3 shows one of a series of fifteen photographs taken of the discharge of a 0·45 calibre double action revolver, model of 1909. In this photograph the bullet is about $1\frac{1}{4}$ inches in front of the muzzle. The bullet is still being accelerated, since the propelling gases are being deflected from its base. Other photographs show that for this particular arm and ammunition the bullet ceases to be accelerated within a distance of 6 inches from the muzzle. Phenomena such as those depicted in these photographs are not to be considered

as representing a random distribution of the powder gases of the propelling charge which have been recorded by a fortunate exposure of the plate. They are, on the contrary, perfectly definite stages of a cycle which repeats itself over and over again for the same arm and powder, and any particular stage of the phenomenon can be duplicated within narrow limits.

GAS MOTION AT THE MUZZLE.

The photograph shown in Fig. 2 possesses features of interest in addition to its bearing on the acceleration of the projectile. Let us consider the state of the gases inside the boundary wave M. It will be seen that the head wave of the bullet does not extend rearward beyond the wave M. The absence of this wave inside

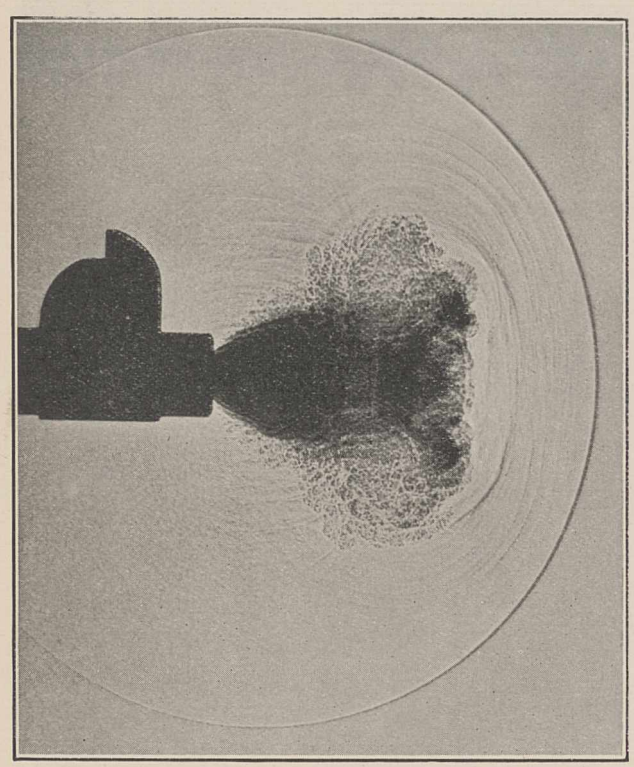

FIG. 5.—Gas leakage from a 0·30 Springfield rifle. Photograph taken before the bullet emerged.

of M is to be ascribed to the fact that in this region the speed of the projectile relative to the gas is less than the speed of sound in the gas, for otherwise a head wave would be formed. It therefore follows that the gases behind this wave are moving forward at considerable speed, or that the speed of sound in this medium is quite high, or that a combination of these conditions exists.

If the absence of the head wave, above mentioned, is due to the forward motion of the gases inside the wave M, a stationary projectile set up in this region should show a head wave pointing in the direction from which the gases are coming, providing that their speed is above that of sound in the medium. However, the actual experiment, the result of which is shown in Fig. 4, showed no such wave at the nose of the stationary projectile and therefore G, the speed of the gases, is less than the S_G, the speed of sound in them. However, when this fixed projectile pierced the wave M it started an ordinary sound wave S which at the moment it was photographed had attained a diameter as measured on the plate of 1·44 inches. We may assume that the centre of this wave was originally at the point of the bullet, but a pair of compasses will show that its centre is now displaced about 0·38 inch, and that it is practically undistorted. This absence of distortion of the spherical wave while its centre has been moved 0·38 inch indicates reasonably uniform motion of the medium in which it is propagated. Furthermore, if the gases inside the wave M were moving forward with the speed of sound in the medium, then the portion of the spherical sound wave nearest the muzzle could not move from the point of the projectile at which it started.

If, on the other hand, the gases were stationary, the wave would expand, keeping the point of the projectile as a centre. The actual case is somewhere between these two. While the sound wave has moved out until its radius is approximately 0·72 inch, it has been moved forward as a whole 0·38 inch; hence the forward speed of the gases must be 0·38/0·72 or 0·53 that of the speed of sound in the gases.

From the relative positions of the moving projectile and wave M, it follows that the average speed of the projectile is slightly greater than that of the wave M, assuming that the base of the projectile and the wave left the muzzle at very nearly the same time. If we also assume that the speed of the wave M has not increased, then since we know that the speed of the bullet has increased somewhat above its mean speed, it follows that the present speed P of the bullet is greater than the present speed W of the wave. Hence the speed of the gases is something less than half that of the projectile and the speed of sound in these gases is something comparable with that of the projectile.

If in Fig. 4 we let

P = speed of projectile,
W = ,, the wave M,
G = ,, gases immediately behind M,
S_A = ,, sound in free air.
S_G = ,, sound in gases immediate y behind M.

The arguments just presented may be summarised as follows:

$$G = \tfrac{1}{2}S_G, \quad . \quad . \quad . \quad . \quad . \quad (1)$$
$$S_G = W, \quad . \quad . \quad . \quad . \quad . \quad (2)$$
$$P > W. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The condition that no head wave shall exist behind the wave M is

$$P - G < S_G, \quad . \quad . \quad . \quad . \quad (4)$$

or in view of (1) and (2)

$$P < \tfrac{3}{2}W. \quad . \quad . \quad . \quad . \quad (5)$$

But it was found from the relative positions of the wave front M and the projectile that P is only slightly greater than W. It therefore follows that condition (5) is satisfied and the absence of the head wave in the region behind M is accounted for.

GAS LEAKAGE.

Since the first introduction of firearms, a leakage of the gases of the propelling charge past the projectile has represented a great waste of the available energy. Little could be done to reduce this loss in the case of the smooth-bore and rifled muzzle loaders in use up to half a century ago. The projectile could not be made to fit the bore too snugly since the ball and its accompanying wad could not then be forced down upon the powder charge; and when the size of the ball was so reduced as to make loading at the muzzle feasible, the fit was at best rather poor.

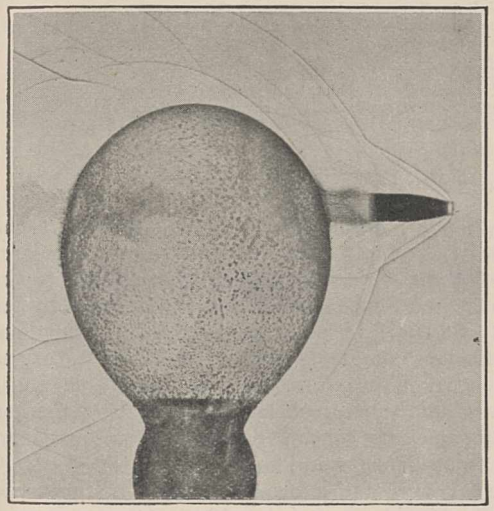

FIG. 6.—0·30 calibre projectile after passing through a bubble containing a mixture of hydrogen and air. The head and base sound waves are considerably modified.

With the introduction of the breech loader and fixed ammunition, the first real step towards reducing gas leakage was achieved. In these arms the cartridge fits nicely into a breech chamber, the forward end of which leads by a short cone to the lands and grooves of the rifling. In the case of a lead bullet, the metal is suddenly forced into a rifled tube having a diameter (measured between lands) slightly smaller than that of the projectile, so that the soft metal is forced into the grooves making a seal to which the older arms could never approximate. The improvement is, however, a relative one, since gas leakage is still present in the best arms of to-day, though, of course, on a greatly reduced scale.

Fig. 5 shows the gas leakage which accompanies the firing of a 0·30 calibre Springfield rifle. The photograph was taken before the bullet emerged from the muzzle, and the dark mass of gas in front of the muzzle consists largely of powder gases which have leaked past the projectile. The heavy black spherical wave which forms the envelope of all other disturbances produced by the discharge originated with the unseating of the bullet from the cartridge case. The resultant pulse or compression wave passed down the rifle tube and travelled outward from the muzzle.

MODIFICATION OF SOUND WAVES BY THE MEDIUM.

The explanation, by C. V. Boys, of the formation of the sound waves which attend the motion of a projectile makes it clear that the regular head and base waves cannot be formed unless the speed of the projectile is equal to or greater than the speed of sound in the medium. Since the speed of sound in hydrogen gas is considerably greater than that of the service projectiles, it follows that a projectile entering a soap bubble filled with hydrogen gas should lose its head and base waves, which should reappear when the projectile emerges into the air. These conclusions have been fully confirmed from photographs which have been taken at the Bureau of Standards with the apparatus described in this paper.

Fig. 6 shows a 0·30 calibre projectile after passing through a soap bubble filled with a mixture of hydrogen and air. In this photograph, the sound waves attending the projectile have been considerably modified in form due to travelling for a time through a medium in which the speed of sound was considerably greater than that of air.

TRACER BULLETS.

Fig. 7 is a photograph of a tracer bullet taken approximately 35 ft. from the muzzle. It appears to have been generally believed that the strong light which tracer bullets emit would make it impossible to photograph them successfully, and visual observation tended to confirm this belief. This photograph was obtained by using a rectangular tube of black paper with its axis at right angles to the trajectory and coincident with the line joining the spark gap and the centre of the photographic plate. By this device the plate was shielded against the tracer light before and after the bullet had traversed the tube. The plate is fogged, of course, but it nevertheless shows some interesting details.

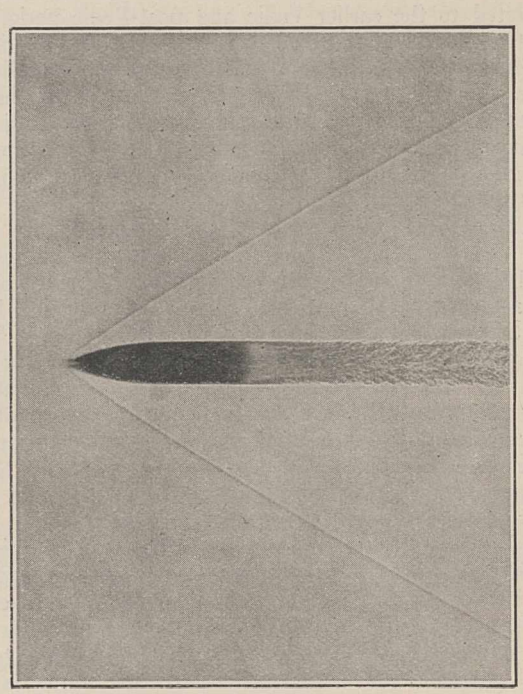

FIG. 7.—Tracer bullet approximately 35 ft. from the muzzle. The base wave is almost completely absent.

The most striking thing is the almost complete absence of a base wave. The usual base wave is undoubtedly associated with the rapid pressure drop at

the base of the projectile. Apparently the gases generated by the tracing compound prevent the formation of a region of diminished pressure, and hence the formation of a base wave. About two inches back from the base of the tracer bullet, particles of the tracing compound can be seen as they leave the wake.

In conclusion, the author wishes to express his indebtedness to Dr. E. A. Eckhardt for suggestions and assistance in the experiments and in the preparation of the manuscript, and to Drs. L. J. Briggs and E. Buckingham for their kindly interest in the experiments and their helpful suggestions and criticisms.

The courtesy of the Frankford Arsenal in furnishing some of the arms and ammunition is gladly acknowledged. Most of the photographs here presented were taken in the process of developing the design of bullet photography apparatus for the use of that organisation.

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Hindu Astronomy.

THE study of the origin and progress of Indian astronomy has attracted a good deal of attention among Orientalists and historians of astronomy during the last 140 years, and has given rise to a considerable amount of controversy, which now seems to have ceased, at least among competent scholars. The history of the literature of the subject down to 1893 was written by the late James Burgess (Journal of the Royal Asiatic Society, October 1893) and need not detain us here. While during the last seventy years critical editions and commentaries of the Siddhântas or textbooks have finally silenced the opponents of the connexion between the later Hindu astronomy and that of the Alexandrian Greeks, attention has also been directed to the earlier Vedic and post-Vedic periods. But a general account of the subject in the English language was wanting, and this has now been supplied in a valuable memoir by Mr. G. R. Kaye,[1] who had already published several minor papers on Indian science, and an exhaustive monograph on those strange aftermaths of Muslim astronomy, the great masonry instruments of Jai Singh.

The earliest sacred works of the Hindus, known as the Vedas, contain astronomical references of interest, and there is from the post-Vedic period a formal work on astronomy, the Jyotisha Vedânga, which claims by its title a fairly close connexion with the Vedas. The knowledge of astronomy in the Vedic period was very scanty; the year had 360 days, with an occasional intercalary month, not clearly defined; the ecliptic was divided into 27 or 28 nakshatras or lunar mansions. The Vedic seers must have had some knowledge of the planets, yet there is no explicit reference to them in any of the Vedic writings, though it is possible that in the Rigveda Jupiter is meant by Brihaspati, by which name the planet was known later on. In the post-Vedic period (about 400 B.C.–A.D. 200) we find a five-year cycle of 5×366 savana or civil days. The nakshatras are nowhere in these early works definitely connected with particular stars or constellations. Attempts have been made to assert that the early Hindu writers had knowledge of the precession of the equinoxes, but as their year was 18 hours too long, and their methods of observing were very crude, they could not possibly have anticipated the discovery of Hipparchus, which even the Babylonians, notwithstanding their accurate knowledge of astronomical periods, were unable to do.

About the fourth century A.D., however, a very great change took place in the Hindu astronomical teaching. As we have already remarked, no European scholar now doubts that the new teaching was solely due to Greek influence, and only some Indians, influenced by sentiment, continue to deny it. The Greek kingdom of Bactria had come to an end in the first century B.C., but a revival of intercourse between India and the West certainly began in the second half of the fourth century and was continued by Nestorian missionaries, who from Persia wandered all over the East. Our principal sources of information about the new science are the Aryabhatiya of Aryabhata (composed in A.D. 499), Varaha Mihira's Panchasiddhantika (about A.D. 550), a similar work by Brahmagupta (about A.D. 630), and the Sûrya Siddhânta, which in the form now extant is later than A.D. 1000, but is founded on a much older original. Albiruni's celebrated book on India (A.D. 1031) is also a valuable source.

The first glance at one of the siddhantas shows the Greek origin of the contents. Greek words connected with geometry, astronomy, and astrology have been transferred into Sanskrit books with very little modification; thus horizon became harija, diametron jamitra, trigonon trigona, lepte liptâ (a minute of arc), kentron kendra (also as meaning the arc of the excentric from the apogee to the centre of the epicycle), and many other terms. The nakshatra divisions of the zodiac were almost altogether superseded by the signs of the zodiac (previously unknown in India), and here again their origin is betrayed by their names: Kriya, Tâvuri, Jituma, Karkin, Leya, etc., are clearly nothing but Krios, Tauros, Didymos, Karkinos, Leon, etc., though later works also use translations of the Greek names. But even more remarkable is the fact that the motions of the planets, which formerly had been completely ignored, were now dealt with in considerable detail, and altogether by Greek methods, adopting the theories of excentric circles and epicycles developed in Alexandria. Everything in the siddhantas is borrowed from that seat of learning. Parallax and methods of calculating it were described, and it was shown how to calculate eclipses, a subject quite new to Indian works. The length of the year was properly determined and various problems of spherical astronomy were solved.

There are some details of the Ptolemaic theory of planetary motion, which are not found in Hindu astronomy, namely, the equant or centre of equal motion different from the centre of equal distances, and certain complicated details in the theories of the moon and Mercury. It looks as if the date of the

[1] Memoirs of the Archæological Survey of India, No. 18. "Hindu Astronomy," by G. R. Kaye (Calcutta, 1924, 134 pp.).

original work, which was introduced into India about the fourth century, was somewhat anterior to that of Ptolemy (A.D. 140), and this seems also to be indicated by the treatment of precession as a mere libration of the equinoxes. On the other hand, the apparent deviation of the epicycle from the circular form (which is not found in Ptolemy's work) may possibly be derived from an earlier attempt to represent what Ptolemy accounted for by the equant. Thus, Alexandrian astronomy at the very time when the knowledge of it became extinct in the West, and long before the Arabs revived it in the East, was transplanted to India, though not quite in the perfect form in which it was handed down to us by Ptolemy. J. L. E. D.

Obituary.

VISCOUNT LEVERHULME OF THE WESTERN ISLES.

THE death on May 7 at the age of seventy-three of Lord Leverhulme deprives the world of a man quite out of the ordinary. Possessed of an amazing vitality, which increased rather than diminished as the years passed, he exerted an influence that will be missed more than a little. For the greater part of his life his activities were confined to the building up of his own business: it is only more recently, with the conduct of the details left in the hands of competent lieutenants, that he has played a part in the affairs of the world at large. Primarily a salesman by nature, Lord Leverhulme had an intimate knowledge of every detail of the soap business; as a designer of a works he can have had few equals—indeed, to play the architect was one of his chief recreations. The great factory at Port Sunlight and the smaller plants which are growing up all over the world will for many years be memorials of this phase of his greatness.

Lord Leverhulme encouraged his technical staff in every possible way to keep abreast, if not ahead, of the times and spent large sums on original research both scientific and technical, himself taking the greatest personal interest in every detail of their progress, as exemplified by his practice of reading and making pertinent comments on every technical report sent to him. He was intensely interested in everything that concerned the betterment of the worker and was one of the very earliest pioneers in what is now coming to be regarded as the science of industrial psychology—the provision of educational facilities for the worker and his children played a large part at Port Sunlight village. Lord Leverhulme had little time to take any active part in higher education, though at times he was a generous patron of the University of Liverpool. His most generous gifts to the nation were latterly connected with art.

Lord Leverhulme was selected to deliver the Messel Lecture of the Society of Chemical Industry at the Liverpool meeting last summer, when he gave an address of prime importance and full of literary charm which in course of time will rank as one of the most remarkable testaments of ideals ever made by an industrialist. The great soap industry with all its ramifications — the Lever Brothers organisation — which he built up, replacing empiricism by science and scientific method, though leaving craft where craft meant quality, is his memorial: he himself would wish for no other.

WE much regret to record the death on March 10, at the age of fifty-six years, of Prof. John F. Hayford, whose passing has been the occasion of appreciative accounts of his life and work in several American scientific journals. John Fillimore Hayford was trained as a civil engineer at Cornell University and was appointed computer to the United States Coast and Geodetic Survey. During this time he served on the International Boundary Commission of the United States and Mexico. In 1895 he went to Cornell University as an instructor in civil engineering, but in 1898 he returned to the Coast and Geodetic Survey, where he remained as inspector of geodetic work and chief of the computing division until 1909. In that year he went to Northwestern University, Illinois, as director of the newly organised College of Engineering. While there he investigated on behalf of the Carnegie Institution of Washington the problem of the surface levels of the Great Lakes and the causes of their fluctuations. Hayford is best known, however, for his computation of the dimensions of the earth, or the Hayford spheroid, based on the theory of isostasy, which was accepted at the recent Madrid meeting of the International Geodetic and Geophysical Union. His work on isostasy was also acknowledged last year by the award of the Victoria Medal of the Royal Geographical Society.

PROF. GUGLIELMO KÖRNER, who died recently in Milan at the age of eighty-six years, was a native of Cassel. After extensive travels in European countries he became professor of chemistry at the Royal High School of Agriculture at Milan, remaining in that capacity for forty years. His work on the constitution of pyridine and quinoline and on the orientation of derivatives of benzene is well known. He was the Davy medallist in 1900 of the Royal Society, and an honorary fellow of the Chemical Society.

IN *Naturen* for March is a notice by A. E. Tråen of Dr. Barthold Hansteen Cranner, professor of botany at the Agricultural College in Aas, Norway, who died on February 2, at the age of fifty-eight. Cranner was best known for his work on the biochemistry of the cell-wall in plants.

WE regret to announce the following deaths:

Prof. Albin Haller, For. Mem. R.S. and Davy medallist, and honorary fellow of the Chemical Society, director of the Municipal School of Physics and Chemistry in Paris and professor of organic chemistry at the Sorbonne.

Prof. C. D. Woods, director from 1896 until 1920 of the Maine Agricultural Experiment Station, and since then director of information of the Massachusetts Department of Agriculture, who made noteworthy contributions to our knowledge of the nutrition of plants and animals and of foodstuffs generally, on March 30, aged sixty-eight.

Current Topics and Events.

ON Saturday last, May 9, the British Empire Exhibition at Wembley was reopened by the King amid scenes of much popular enthusiasm. The King was accompanied by the Queen and was received by the Duke of York, who is president this year of the Exhibition. In his address inviting the King to open the Exhibition, the Duke of York emphasised the many benefits which have resulted from last year's display and stated that, while the Exhibition of 1925 " has integrally the same purpose as in 1924—to show how great are the resources available within the Empire . . . it will present its lessons of Empire in a new manner." In a happy phrase, he referred to the Exhibition as the " University of Empire." The King congratulated the president, the board of management, and the executive council of the Exhibition on the results of last year's work, and again the educational side was brought out when the King, speaking of the importance of goodwill between the peoples of the British Empire, declared that " the one sure foundation for that goodwill is a full knowledge of our mutual aspirations, capacities, and needs. To seek knowledge, more knowledge, and again more knowledge, of the great heritage which has been entrusted to us is the soundest Imperial policy." As last year, the opening ceremony in the Stadium was broadcast from all the stations of the British Broadcasting Company. The general features of the Exhibition will be familiar to most readers of NATURE, and we hope in future issues to deal in detail with specific scientific aspects such as the display illustrating physical and biological science arranged by the Royal Society, the pure chemistry section which the Association of British Manufacturers has organised, and so on.

THE Salters' Institute of Industrial Chemistry, which was founded by the Salters' Company to further the interests of industries with which it is historically connected, has now been in existence for seven years, and during this time, under the successive directorships of Dr. M. O. Forster and Prof. Arthur Smithells, it has been very successful in assisting the education of those destined for the career of industrial chemistry. For the first few years of its existence, the Institute devoted itself to helping students whose chemical training had been interrupted by the War; now it is following the policy originally laid down, namely, of awarding fellowships, of the normal value of 250-300*l.* per annum, to those who have obtained an honours degree at a university, or the equivalent, and have had a little experience of research; and of giving grants-in-aid to young men or women employed in chemical works for the purpose of continuing their chemical studies. It is interesting to note that in the award of fellowships, academic distinctions and purely mental attainments are not taken as the sole criteria of eligibility. Those conversant with the conditions in industrial works know well how often the academic man fails either because he has little or no power of applying his knowledge, or because he lacks the ability to co-operate with those whose mental or social level is different from his own; and we wish the Salters' Institute every success in its endeavour to supply the chemical industry with men of character as well as of intellectual attainment.

THE Bolshevik commercial publication in England, the *Soviet Union Review*, in its number for April 25, has published a formidable list of scientific institutions, learned societies, museums, etc., in the R.S.F.S.R., which means the Russian Soviet Federation of Socialistic Republics, and is the overwhelmingly dominant partner in what is known as the S.S.S.R., the Soyuz (Union) of Soviet Social Republics, which in turn corresponds to what we have always known as the Russian Empire, though shorn of Finland, the Baltic States, its Polish provinces, and Bessarabia. The catalogue includes 21 institutions connected with the Academy of Sciences in Leningrad, 15 physico-mathematical institutions, 12 physico-scientific, 6 biological stations, 7 physico-historical and mathematical research institutes, 4 concerned with political economy and culture research, 4 with scientific research pedagogic institutes, 6 for social study, 11 scientific libraries, 6 scientific societies in Moscow, 9 in Leningrad and 13 in the provinces, 25 regional societies, a substantial catalogue of museums and 6 State Nature preserves. The object is evidently to show the work the Bolsheviks are doing in the arts and sciences, and a certain amount of credit must be granted to Lunacharsky, Commissar of Education, for his protection. But the vast majority of these institutions existed in tsarist days; only their titles have been altered. Novelties are the institutes for the promotion of Bolshevism, such as the Institute of Red Professors in Moscow, the chair for the study of Marxism at Kazan, and the Marxist Society in Leningrad. The museums have been enormously enriched in material and multiplied in number by the confiscation of private collections and conversion of aristocratic palaces into museums. But the article throws no light upon the efficiency of these institutions. It is known that the serious workers are hampered by incessant interference, and the financial grants, generous enough on paper, are ludicrously inadequate in fact. Thus, a grant of 130,000 gold roubles for the maintenance of one of the big scientific institutions was made and properly confirmed, but of this only 3000 roubles reached the treasurer, so that it exists to-day entirely upon the very high admission fees, which the workers of the proletariat have to pay if they want to see the museums. Truly, in Russia, " the man who holds the honey-pot licks his fingers," as the Turks say.

ARRANGEMENTS have been made by the American National Geographic Society, in co-operation with the Smithsonian Institution of Washington, to establish a station at some convenient spot for the purpose of making daily observations of the solar constant of radiation over a period of four years. An expedition, of which Dr. C. G. Abbot (director of the Astrophysical Observatory of the Smithsonian Institution)

will be the leader, will be sent out to the station chosen in order to make the necessary observations. Sites in Baluchistan, South-west Africa, and Morocco have already been selected for inspection. The project has arisen as the result of certain conclusions drawn by Dr. Abbot and his assistants—from their refined observations of the solar constant for several years past—with regard to the dependence of terrestrial weather on changes in solar radiation. It is hoped that the observations will assist in solving the problem of long-range weather forecasting. The National Geographic Society has set aside the sum of 55,000 dollars for the purpose of the expedition.

DR. ALES HRDLICKA has left Washington in charge of a survey of the field of early man and his predecessors in Southern Asia, Java, Australia, and Africa by the Smithsonian Institution in co-operation with the Buffalo Society of Natural History. The object of the expedition is to examine personally all traces of ancient man and his predecessors in these localities. In India, Dr. Hrdlicka will endeavour to examine all collections of Palæolithic implements as well as all other specimens relating to ancient man and extinct sub-human forms. He expects to visit the Siwalik Hills and also two or more of the most important centres of the non-Aryan Indian population. In Java the localities of the finds of the now known representatives of the early man Pithecanthropus will be visited. In Australia, Dr. Hrdlicka expects to examine the fossil Talgai skull and other skeletal remains of the Australian aborigines. In South Africa an effort will be made to visit the sites of the find of the Rhodesian man, of recent finds of fossil anthropoid apes and of prehistoric human skulls preceding the Bushman and Negro.

AN expedition under the leadership of Dr. D. B. Macmillan is leaving for the Arctic regions at the end of June under the auspices of the National Geographic Society of Washington. The first aim of the expedition will be to examine the ruins of the old Norse settlements in Greenland around Julianehaab and Godthaab, comparing these with ruins found on the coast of Labrador. It is hoped by this means to prove or disprove the Norse settlement of Labrador. From Godthaab the expedition will sail for Etah, which should be reached early in August. Here a base will be made for exploration by amphibian aeroplanes of the Greenland ice cap, Ellesmere Land and Grant Land. From Etah, oil and other supplies will be carried by air to a second base at Cape Thomas Hubbard on the north of Axel Heibergland, a distance of about two hundred and fifty miles. This base will be used for an aeroplane reconnaissance of the unexplored area of the Arctic Ocean lying between the Canadian Arctic Archipelago and the New Siberia Islands. The distance to the centre of this unknown area is about six hundred miles, and Dr. Macmillan hopes to cover the double journey in a continuous flight. If any islands are discovered, a landing will be made. On the completion of this ambitious programme in the north, the expedition will go southward along the eastern shores of Ellesmere Land to Bylot Island, which will serve as a base for the aeroplane exploration of Baffin Land. Lastly, Nachvak Bay will serve as a base for flights over northern Labrador. Meteorological observations of the upper air will be taken during all the flights. It is expected that the expedition will be away until the autumn.

A COMMUNICATION in the *Times* of April 28 describes investigations carried out last year by Prof. Hrozny in Syria and Asia Minor with the object of throwing light on Hittite problems. Prof. Hrozny, who is well known to scholars for his researches in the Hittite language, which led to the discovery of its Indo-European affinities, has planned a series of excavations on sites on the borders of the Hittite Empire in the hope that the discovery of a bilingual inscription may lead to the decipherment of the Hittite pictographic script. Excavations at Sheik Sa'ad in Bashan near the monolith of Rameses, called by the neighbouring inhabitants " the Stone of Job," revealed an Amorite shrine of a deity Arkan Saphon, which was the centre of a widespread cult. This cult, as was shown by the later Hellenistic shrine, was adopted by the Greeks. It was surrounded by a number of edifices and remains ranging from the Hittite period in the Second Millennium B.C. down to the Roman times. It is clear that the inhabitants were Amorites who were affected by Hittite culture, and possibly under Hittite rule. The site may mark the frontier of the Hittite Empire. A projected excavation at Kaisarieh in Anatolia could not be carried out, but the hitherto unknown source of the well-known Cappadocian tablets was identified at Kul Tepe.

DR. H. H. DALE, in his discourse at the Royal Institution on May 8, on the circulation of blood in the capillary vessels, said that about the year 1917 evidence from several independent quarters began to appear, necessitating an extensive revision of the older conception of the capillaries as playing a purely passive rôle in the regulation of the blood flow. Ebbecke in Germany, and Lewis and his co-workers in Britain, began to publish evidence that the capillaries are capable of closing completely by their own contractile force. In the following year Krogh, of Copenhagen, showed that, in the muscles at rest, only a very small part of the rich network of capillary vessels is open for the passage of blood, the remainder being completely closed by their own contractile tone. Meanwhile similar conclusions had been reached by another independent group of investigators, including Dr. Dale, who were studying the collapse of the circulation produced by a group of substances resulting from the decomposition of proteins, a typical member being the base histamine. Such substances caused relaxation of the peripheral blood vessels, apparently largely of the capillaries. When the effect was intense, a large part of the blood passed out of circulation, becoming stagnant in the generally relaxed capillary vessels, and losing a large part of its plasma through their permeable walls. The deduction was made, and almost immediately

confirmed by Krogh's direct observations, that the capillaries possess a power of independent contraction, by which a large proportion of them are normally closed. These conceptions have acquired increasing importance, not only for the understanding of the fine adjustment of the blood-flow to the varying metabolic needs of the tissues, but also in explaining a number of pathological conditions, where, as the result of massive injury of the tissues, or of the invasion of the body by bacteria, poisonous protein derivatives are distributed in the circulation producing in a generalised and dangerous form a relaxation of the capillary vessels, which, in the form of a localised inflammation, is protective and restorative. There is evidence that the internal secretions of the suprarenal and pituitary glands have an important effect on the tone of the capillary vessels.

THE first Fison Memorial Lecture was delivered by Sir Joseph Thomson in the Medical School, Guy's Hospital, London, on Thursday, May 7, the chair being taken by Lord Balfour. Sir Joseph selected as his subject "The Structure of Light," in the course of which he stated that the optical properties of light appear to be explicable only upon a wave theory, whereas the electrical properties are more easily explained on a corpuscular theory. Newton himself really combined the two theories, as the assumption of waves generated by the corpuscles was an essential part of his explanation of simultaneous reflection and refraction. The followers of Newton were "more corpuscular" than Newton himself, and a purely corpuscular theory of light was generally adopted until the work of Young and Fresnel once more focussed attention upon the wave theory. By the end of the nineteenth century, Maxwell's electromagnetic theory, and the pioneer experiments of Hertz and Lodge on electromagnetic waves, had made the wave theory of light probably the most complete and satisfactory in physical science. Then the study of gaseous ionisation, the photo-electric effect, X-rays and black body radiation, began to throw doubts upon the sufficiency of the ordinary wave theory.

As an alternative, Sir Joseph Thomson put forward a new theory designed to explain both electrical and optical properties of light (see *Phil. Mag.*, vol. 48 (1924), p. 737). Imagine an electron and a positive nucleus joined by a tube of force. If the electron jumps from one stable state to another of smaller energy, we may suppose that the tube of force is thrown into a loop, which becomes detached as a closed "ring of force." Such a ring would travel out like a vortex ring in a direction perpendicular to its own plane. It would also carry with it a definite "quantum" of energy. Immediately before and after the formation of the ring ordinary electromagnetic waves would also be started, but the ring would carry nearly all the energy liberated by the movement of the electron. Absorption of energy by an atom could take place by a converse process, and would normally occur only when the energy in the ring was sufficient to move an electron from one stable state to another, *i.e.* when the energy was great enough to produce partial or complete ionisation of the atom. The circumference of a ring of force would be equal to the wave-length of the light, and so a ring of visible light would be too large to be absorbed easily by an atom except by a process involving resonance, whereas an X-ray ring would be comparable in size to an atom. This would account for the observed differences between X-ray and optical absorption. The waves which accompany the ring would undergo interference and diffraction, and the rings would tend to follow the waves, so that the probability of a ring reaching a given point would depend upon the amplitude of the wave at that point. Thus interference and diffraction fringes would be statistical effects.

THE eighth lecture of the series on "Physics in Industry" being given under the auspices of the Institute of Physics was delivered by Dr. W. Makower on April 29 and dealt with "Physics in the Rubber Industry with special reference to Tyre Manufacture." In this industry there are many stages where the skilled assistance of the physicist has proved valuable in improving the product or in reducing costs. In testing the raw material, hardness is the decisive quality and this is determined by viscosity measurements, made by forcing the rubber at a constant temperature of 80° C. through an orifice and measuring the rate of flow. In all properties related to hardness, temperature is a most important factor. Thus, rubber must be stored at a low temperature and processes such as calendering and rolling must be carried out at constant temperatures, to which end thermocouples are now used extensively. To measure the physical effects of addition agents on hardness, it is usual to construct stress-strain diagrams. In vulcanisation, physical control is used in determining the amount of sulphur absorbed at different depths of the tyre, thermocouples being embedded in it and the temperature attained noted. The way the tyre is built up will determine largely its ultimate strength, which is found chiefly to depend upon that of the cotton case. Other necessary tests are for fatigue and abrasion, and these have to be so designed as to imitate the effects of actual practice. Of great interest are the hysteresis heat losses, which may amount to one-half to one H.P. per tyre. These depend upon the deformation of the rubber as well as on the rate of application of the cyclical stresses. In this connexion, Dr. Makower pleaded for closer co-operation between tyre manufacturers and automobile engineers so that there may be careful adjustment between springs and tyre equipment.

BROADCASTING reception in Great Britain is by no means confined to the programmes transmitted by stations in this country, and a number of continental stations can now be easily received. The Oslo station is the most recent addition, and the number will soon be increased by transmission from Stockholm and Madrid, when the stations which are now in course of erection by Marconi's Wireless Telegraph Co., Ltd., are completed. The new stations are

Standard Marconi 6 kw. Type " Q " stations, similar to those of the British Broadcasting Company's main stations. The transmitter consists essentially of four panels; rectifier; independent drive; main oscillator and modulator. The use of the independent drive in the Marconi transmitters ensures the invariability of the carrier wave frequency, with consequent absence of alteration of tuning adjustments at the receiver. One of the features of transmissions from the Oslo station so far as British reception is concerned, appears to be the absence of fading. The aerial is supported by two lattice steel masts 70 feet high and is a " T " type of four-wire cage aerial, with a span of 150 feet. The Oslo station has avoided causing interference with other European broadcasting stations by using the wave-length of 382·5 metres.

THE twelfth International Physiological Congress will be held in 1926, at Stockholm, on August 3-6. The Congress will be under the presidency of Prof. Johansson. Prof. Liljestrand will be honorary secretary, and Prof. Santesson honorary treasurer.

THE Lawes Agricultural Trust Committee has appointed as its chairman Lord Clinton, in succession to Lord Bledisloe, who resigned on accepting the post of Parliamentary Secretary to the Ministry of Agriculture and Deputy Minister of Fisheries.

DR. EMILE BRUMPT, professor of the Faculty of Medicine of the University of Paris, will deliver two Chadwick Public Lectures, on May 25 at the Barnes Hall of the Royal Society of Medicine on " How to conduct an Anti-Malarial Campaign," and on May 29 at the Royal Society of Arts on " The Prophylaxis of Sleeping Sickness."

DR. E. F. ARMSTRONG, F.R.S., technical director of Joseph Crosfield and Sons' Soapworks at Warrington, has been appointed managing director of the British Dyestuffs Corporation. Dr. Armstrong, who was president of the Society of Chemical Industry in 1922–24, is well known for his work on the chemistry of plant products and on the nature of enzymes; he has also made noteworthy contributions to the study of catalysis. His work covers a wide field in both pure and applied chemistry, and together with his administrative experience, eminently qualify him for the important post which he has now accepted.

THE Council of the Royal Society of Edinburgh has made the following awards :—The Gunning Victoria Jubilee Prize for the period 1920–1924, to Sir Joseph Thomson, in recognition of his great discoveries in physical science; and the Makdougall-Brisbane Prize for the periods 1920–1924, to Prof. H. Stanley Allen, for his papers on the quantum and atomic theory, published in the Society's Proceedings within the periods.

THE Council of the Institution of Electrical Engineers has made the following award of premiums for papers read during the session 1924–25, or accepted for publication : — *The Institution Premium* : Mr. H. W. Clothier. *Ayrton Premium* : Major E. I. David. *Fahie Premium* : Col. T. F. Purves. *John Hopkinson Premium* : Mr. G. Rogers. *Kelvin Premium* : Lieut.-Col. K. G. Maxwell and Mr. A. Monkhouse. *Paris Premium* : Mr. D. Murray. *Extra Premiums* : Messrs. J. D. Cockcroft, R. T. Coe, J. A. Tyacke, Prof. Miles Walker, and Mr. S. Holmes. *Wireless Premiums* : Major A. G. Lee and Mr. A. J. Gill; Capt. H. J. Round and Messrs. T. L. Eckersley, K. Tremellen, and F. C. Lunnon; Prof. E. Mallett and Mr. A. D. Blumlein; and Mr. L. C. Pocock.

PROF. T. C. CHAMBERLIN, of Chicago, has been awarded the first Penrose Medal of the American Society of Economic Geologists. The Medal, which is to be given once in three years for " exceptionally original work in the earth sciences," was established by Dr. R. A. F. Penrose, jun., first president of the Society of Economic Geologists, and is of gold. We learn from *Science* that in making the award, Prof. Kemp, president of the Society, referred in particular to Prof. Chamberlin's work on the lead and zinc ores of the Upper Mississippi Valley, and to his contributions on the Ice Age, on the planetesimal hypothesis and related topics, and on diastrophism as a principle in the subdivision of geological time.

WING COMMANDER HAROLD E. WHITTINGHAM has been awarded the Chadwick Gold Medal and 100*l.* prize for his work on sand-fly fever. The award is made under the provisions of the Chadwick Trust, whereby the Trustees may, once in every five years, present the sum of 100*l.* and a Gold Medal to be called the Chadwick Naval, Military or Air Force Prize to such officer of the Navy, Army or Air Force Medical Service as shall during the preceding five years have " specially assisted in promoting the health of the men " of the Service to which he belongs.

A CONFERENCE of women in science and industry at the British Empire Exhibition, Wembley, on July 15–17, has been convened by the Women's Engineering Society in co-operation with the British Federation of University Women, Industrial Welfare Society, Institute of Industrial Welfare Workers, The National Union of Scientific Workers, The Standing Joint Committee of Industrial Women's Organisations and the Women's Electrical Association. H.R.H. the Duchess of York has consented to become president of the conference, and amongst those speaking on the opening day will be: The Hon. Lady Parsons (Engineering), and Miss Ellen Wilkinson, M.P. (Industrial Organisation). The following two days will be devoted to papers by women workers on such subjects as engineering, chemistry, industrial welfare, factory inspection and commerce. Particulars can be obtained from the Secretary, Women's Engineering Society, 26 George Street, Hanover Square, London, W.1.

A PRELIMINARY meeting of the International Congress of Radiology will be held at the Central Hall, Westminster, on July 1-4, under the presidency of Mr. C. Thurstan Holland. The Congress will meet in three sections: (1) radiology; (2) electrotherapy and physiotherapy; and (3) physics. During the meeting there will be an exhibition of apparatus and books at the Central Hall, Westminster, and an exhibition of radiograms in the British Institute of Radiology, including those relating to papers read at the Congress.

On July 1 the Duc de Broglie will deliver the Silvanus Thompson Memorial Lecture, and on July 3 Sir Berkeley Moynihan will deliver the Mackenzie Davidson Memorial Lecture, taking as his subject "The Relationship of Radiology and Surgery." Communications regarding the Congress should be addressed to the Secretaries, International Congress of Radiology, c/o British Institute of Radiology, 32 Welbeck Street, London, W.1.

FOR its May meeting the Society of Glass Technology has arranged a symposium of papers on the constitution of glass, to which a number of important contributions have been promised. Two sessions will be held, the first at 7.30 P.M. on Monday, May 25, at the Royal Society of Arts, John Street, Adelphi, London, and the second on Tuesday, May 26, at 2.30 P.M., in the Chemistry Lecture Theatre, University College, Gower Street, London. Papers have been promised by Prof. W. E. S. Turner (Sheffield), Prof. G. Tammann (Göttingen), Dr. F. Eckert (Essen), Dr. A. Q. Tool and E. E. Hill (Bureau of Standards, U.S.A.), Prof. Le H. Chatelier (Paris), Sir William Bragg (Royal Institution, London), Mr. V. H. Stott (National Physical Laboratory, Teddington), Dr. G. W. Morey and Dr. N. L. Bowen (Geophysical Laboratory, Washington), Dr. A. A. Lebedeff (Optical Institute, Leningrad), Dr. G. W. Morey and Dr. R. W. G. Wyckoff (Geophysical Laboratory, Washington). Members of the Faraday Society, the Optical Society, the Physical Society, and others interested in the subjects of discussion are invited to be present.

WE welcome the appearance of the opening part of the *Japanese Journal of Mathematics*, which is announced to appear quarterly, sponsored by the National Research Council of Japan. Ninety-three pages of Transactions contain 16 papers (of which 14 are in English and 2 in German), all in pure mathematics and nearly all on the higher analysis. There follow 12 pages of English abstracts of recent mathematical papers published in other Japanese journals. This new venture, together with similar publications already in existence or promised, covering such subjects as astronomy and geophysics, chemistry, physics, geology and geography, botany, zoology, medical science, and engineering, are likely to enhance the quality of scientific research in Japan; and if they are well distributed they cannot fail to improve the status of Japanese work in the world of science.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: an assistant in mathematics in the Queen's University, Belfast—Prof. Dixon, the University; a lecturer in agriculture at Armstrong College, Newcastle-upon-Tyne—The Registrar; a laboratory assistant in the agricultural department of the Government of Kenya—The Crown Agents for the Colonies, 4 Millbank, S.W.1; two zoologists for the *Discovery* Expedition—The Secretary, *Discovery* Committee, Colonial Office, Downing Street, S.W.1 (May 25); a junior assistant under the directorate of explosives research of the research department, Woolwich—The Chief Superintendent, Research Department, Woolwich; a biology teacher, either sex, at the Municipal Secondary School, Wolverhampton—The Director of Education, Education Offices, Wolverhampton (May 30); full-time lecturers in biology and mathematics at the Technical College, Cardiff—The Principal (May 30).

Our Astronomical Column.

COMETS AND MINOR PLANETS.—Dr. W. H. Steavenson obtained an observation of Orkisz's Comet on May 6^d 0^h 1^m, G.M.T. (new), R.A. 23^h 15^m 26·12^s, N. Decl. 55° 14′ 53·9″, equinox 1925·0. The comet was of magnitude 7·5 and growing slightly fainter.

Owing to its high north declination it is observable all night:

EPHEMERIS FOR 0^h (by Möller and Johannsen).

	R.A.	N. Decl.	log r.	log Δ.
May 15.	23^h 51^m 4^s	67° 25′		
19.	0 18 23	72 24	0·129	0·184
23.	1 1 31	76 51		
27.	2 14 57	80 23	0·152	0·206
31.	4 12 18	82 11		
June 4.	6 18 19	81 36	0·175	0·235

EPHEMERIS FOR 0^h OF COMET SCHAIN, COMAS SOLA (by H. Kobold).

	R.A.	N. Decl.	log Δ.
May 16.	10^h 31^m 45^s	4° 28′	
20.	10 28 27	4 29	0·604
24.	10 25 30	4 30	
28.	10 22 54	4 29	0·619
June 1.	10 20 36	4 26	
5.	10 18 37	4 22	0·634

It is of magnitude 12 and slowly fading.

Astr. Nach., No. 5365, contains an important series of observations of planet TD (the interesting object discovered last October by Baade, the period of which is 4·36 years), made by G. Struve at Berlin Babelsberg, extending from November to March 3, when its magnitude was 13·0.

No. 5366 contains observations by J. Hartmann from April to July 1924 of the planet RK, which he discovered last year. Its period is five years and its eccentricity is very small. He has given it the name La Plata, after the town where it was discovered.

GRAVITATIONAL FORCES IN SPIRAL NEBULÆ.—Prof. Ernest Brown contributes a paper on this subject to the *Astrophysical Journal* for March. His aim is to see whether the observed motions can be explained without the assumption of non-gravitational forces such as those suggested by Dr. Jeans's investigations. He first analyses the motions given by Mr. van Maanen, and shows that these are by no means uniformly outward, though the latter direction predominates at points where the spiral arms are well defined. The angular velocities diminish rapidly at first, and then become nearly constant, indicating a force varying as the distance from the centre; this would be the law of force in the equatorial plane of an ellipsoid of uniform density for a particle within the ellipsoid. The suggestion is, therefore, that there is considerable concentration at the centre, and outside this an extended ellipsoid of low and nearly constant density. The orbits of the constituent particles are supposed to fall into groups of which the "arms" of the spiral are envelopes. The space density is of the order of 10^{-15} of that of the sun; this gives masses of the order of 10^8 times the sun, assuming a parallax of 0·001″, which is, however, much larger than that indicated by the recent researches of Hubble.

Research Items.

THE SEQUENCE OF TYPES IN STONE IMPLEMENTS IN RHODESIA.—Stone implements in South Africa exhibit two definitely demarcated periods of human habitation, one characterised by hand axes of Chellean or Acheulean type, the other by flake implements of Aurignacian facies. In many localities the hand axes are associated with flakes, some showing unmistakable evidence of design and secondary chipping; but there is no evidence whether they indicate two distinct periods. Mr. Neville Jones, in vol. 54 of the Journal of the Royal Anthropological Institute, describes implements from Sawmills, Rhodesia, showing two distinct periods of human activity which can be differentiated by geological evidence. This is the only site in Rhodesia as yet known on which this is possible. Hand axes of pointed and oval form are found in a bed of coarse gravel on rising ground near the Umguza River. A lower terrace resting on alluvium and largely derived from the older terrace is the site of a factory of implements made from flakes struck from pebbles of various forms of silica. Most are worked on one side only, and show an exquisitely fine retouch. By some it is thought that these latter are the work of early Bushmen, though, as a rule, Bushmen implements are smaller and lack the same definiteness in form.

THE ORIGIN OF AMERICAN MAN.—In the *Quarterly Review* for April, Mr. Lewis Spence surveys and discusses the evidence bearing upon the origin and antiquity of man in America. His conclusion is that the New World received its main human stock from Asia at a period when the Eastern portion of that Continent had developed only a slender degree of culture at the closing stages of the glacial period or possibly at one of the recurring intervals of mildness; but there were later accessions. European influence, apart from the Norsemen, may be seen in the banner stones and the stone gouge of New England and farther north; and there is also the tradition of Madoc's expedition from Wales. The architectural remains of Central America and south-eastern Asia present close similarities in certain features, though the correlation of Mayan dating with our system precludes influence much later than two thousand years ago. The cult of Quetzalcoatl in his earlier forms exhibits analogies to Buddhism. Polynesian influences have been discerned in several customs and forms of artistic endeavour in South America. The extreme view of the entirely indigenous origin of American culture is untenable, but America probably was visited by a number of bands or units who brought with them the knowledge of an alien culture which only partially affected that of the older settlers from north-eastern Asia.

RUSSIAN INVESTIGATIONS OF THE FAUNA OF ASIA.—While expeditions of the American Museum of Natural History have been for several years exploring the past and present fauna of Mongolia, where, apparently, a large proportion of Palæarctic forms originated, the same problems have been attacked by Russian workers from the north. Prof. P. P. Sushkin made a study of the fauna of Altai mountains and of northern Mongolia during his expeditions in 1912 and 1914, results of which were so rich that he has only recently been able to arrive at some conclusions published in the recent issue of the *Comptes rendus* of the Russian Academy of Sciences. An analysis of the present ornithological fauna, in connexion with the geological history of the country, enables P. P. Sushkin to reconstruct the history of the fauna in the following way. In the palæolithic, the Eastern, or Trans-Yenissean, Siberia formed a continuous mass of land together with Mongolia (the Angara-continent of geologists), while western Siberia was covered by sea. The ancient endemic elements which are numerous in the eastern Siberian fauna are relics of the Angara fauna. The fauna of western Siberia is very poor in endemics, and it bears, on the whole, European characters; this results from the fact that the country became dry land only at the beginning of the neolithic, when it was populated by the animals driven from Europe by the glaciation, which began in Europe earlier than in Siberia. The glacial period in Siberia was followed by a dry and hot period when steppes and deserts extended very far to the north. After the desert period came a more moist one, continued until the present time, and it resulted in the extensive development of forests which have driven the steppe and desert forms southwards, while a few desert "islands" remained surrounded by forests. Prof. Sushkin is at present in the United States completing his studies and comparing his results with those attained by the American zoologists; he is also making arrangements for publication in English of his results in book form.

DIMORPHISM IN EARWIGS.—Ever since the work of Bateson and Brindley on the length of the forceps in the common earwig, Forficula, this has been quoted as a typical case of dimorphic variability. In a posthumous paper D. M. Diakonov (*Journ. Genetics*, vol. 15, No. 2) has made an elaborate experimental and biometric study of this dimorphism, from Russian specimens living under the bark of tree-stumps. The dimorphic condition is confined to the males, and is known in several species. Other features of body-size vary continuously, but there is some correlation between body-size and length of forceps. The relative frequency of the two types, *brachylabia* and *macrolabia*, varies greatly with the conditions, and there is other evidence that these modes or types are non-inherited modifications. Under unfavourable conditions, a larger number of *brachylabia* occurs. The reaction-norm is not a linear but a more complex function of the environmental conditions. Various similar cases in plants, such as the *Zwischenrassen* of de Vries, are cited.

GOLGI APPARATUS.—In a summary account of the form and function of the Golgi bodies in cells, Mr. Leslie A. Harvey (*Sci. Progress*, April 1925) points out that they have now been found in practically all vertebrate tissues, and also in many tissues of invertebrates and plants. First discovered in 1898 in vertebrate ganglion cells, the demonstration of this apparatus in cells has resulted from the fact that it reduces osmic acid, and can be impregnated with silver salts—a technique developed by Cajal, Da Fano, Kopsch, and others. In many tissues it takes the form of a network of threads, but in invertebrates it is in rods or vesicles, and it has been seen in the living cell. It takes various other forms, and there is much evidence that it is concerned in secretion. Its history has also been traced in spermatogenesis, and it is believed to have a lipoid constitution. It is suggested that in the living cell it exists in the form of a system of vesicles each surrounded by a fluid membrane.

THE VOLCANIC ROCKS OF BANKS PENINSULA.—A petrographic and chemical study of these interesting New Zealand rocks has been carried out by R. Speight, and is described in the Records of the

Canterbury Museum, N.Z., vol. 2, No. 4. Most of the rocks present features which make their nomenclature and classification a matter of difficulty. According to the silica percentage they would be called basalts, and by some petrologists this classification would be confirmed by the usual presence of olivine. On the other hand, the ratio of felsic to mafic minerals would lead other authors to regard them as andesites. The plagioclase rarely affords a conclusive test, as the phenocrysts are frequently labradorite, while the groundmass felspars are oligoclase. Petrologically, however, the rocks are much more closely related to the basalts of the Pacific Islands and the Brito-Arctic region than to the typical andesites of the circum-Pacific belt. This is shown by the high percentage of titanium dioxide and the generally under-saturated character of the lavas, and is confirmed by the association of dykes of trachyte and trachytoid phonolites. The succession of magmas in the region appears to be as follows: (*a*) rhyolites and andesites of Cretaceous age (these being Andean in type, and not referred to above); (*b*) olivine "andesites" and basalts of Middle Tertiary age; (*c*) dykes of trachyte and dolerite, nearly contemporaneous with (*b*); and finally (*d*) basalts, of which some are definitely alkaline, of late Tertiary or early Pleistocene age.

EVAPORATION AND TEMPERATURE CHANGES IN THE ENGLISH CHANNEL.—A paper by Mr. H. W. Harvey in the March number of the Journal of the Marine Biological Association describes a series of observations of temperature and salinity of the sea carried out since April 1921, at a station 20 miles south-west of Plymouth, where the depth is 70 metres. There was an inflow into the area surrounding the station of warm highly saline water during 1921, after which there have been no marked movements of water, but an irregular decrease in salinity. A diagram shows the monthly averages of the mean temperature of the whole column from top to bottom. The yearly minimum occurs in each year in March, and the maximum in September or October. From the changes of temperature from month to month is derived the net daily loss or gain of heat of a column of 0·1 square cm. cross section. From this and the solar radiation recorded at South Kensington, a calculation is made of the difference between the net gain or loss of heat and the incoming radiation. This difference is attributed to evaporation. The result arrived at is that the water gains heat from the spring to the autumn equinox, and loses heat from the autumn to the spring equinox, and that the loss by evaporation overshadows the loss by radiation, the loss due to direct heating of the atmosphere being relatively small. It is concluded that the changes in temperature of the sea were controlled to a marked extent by evaporation. A very interesting observation was that, in the absence of windy weather and consequent mixing by waves, the upper layers may be heated by solar radiation in early May, giving a shallow warm layer separated from the cold water below by a sharp surface of discontinuity. Several days of rough sea are necessary to disturb materially this distribution of temperature. It is also pointed out that in fine clear weather with only light winds the upper inch or two of water become very hot. The normal method of sampling sea water in a bucket represents the surface 6 inches, more or less, so that the sample is considerably cooler than the actual surface temperature of the sea. The records discussed appear to show that there is no correlation between wind during the month and either the fall in temperature or the loss of heat due to evaporation, and it is concluded that, in the open sea, vapour pressure is the major factor controlling evaporation, and overshadows the effect of wind. It is possible that a clearer relation between wind and evaporation might have been obtained if the observations had been discussed in two separate classes, according as the air is warmer or colder than the sea surface.

MODERN COLOUR PROBLEMS.—In recent years, considerable attention has been directed to the problems involved in the perception and measurement of colour. The solution of these problems is not only a matter of academic interest, but is also of considerable practical importance. In the series of Cantor Lectures, delivered before the Royal Society of Arts on November 24 and December 1 and 8, 1924, and recently published in the Society's Journal, Dr. L. C. Martin gave a critical review of the present position of colour theory and standardisation. The selective effects of transmitting and reflecting materials were discussed, and the early attempts to produce artificial daylight described. Modern developments in this direction have resulted in the production of corrected units which, when properly applied, are fairly satisfactory and efficient for most of the requirements of commerce and industry. An interesting fact in this connexion is that retinal reflex actions exercise an important influence in enhancing visual sensitiveness and discrimination. Since the reflex action is much greater at the violet than at the red end of the spectrum, the deficiency in the violet in artificial daylight may result in a relative diminution of retinal sensitiveness, and therefore a somewhat greater intensity than is necessary in the case of real daylight may be called for if the same facility in colour matching is to be attained. In the third lecture of the series, the various methods of colorimetric measurement were described. In this branch of the subject rapid advances are being made. The study of the action of the visual receptor mechanism, its fatigue, adaptation and response characteristics, is placing the operations of photometry and colorimetry on a new and sounder basis. For the development of the more utilitarian applications of colour measurement, further study is required of the phenomenon of diffuse reflection and of the transmission and scattering of light in relation to the measurement of the surface colours of material objects.

EFFECT OF ALTERNATING MAGNETISM ON HÆMATITE.—A lecture given by Mr. W. M. Mordey to the Royal Institution on May 18, 1923, on "Some New Effects of Alternating Magnetism" has just been published. Mr. Mordey discusses the anomalous behaviour of specular hæmatite, a black crystalline form of ferric oxide in the form of powder, when placed in an alternating magnetic field and in a rotary magnetic field. On sprinkling iron filings on a glass plate placed over an alternating current magnetic pole, the filings lie on radial lines of force proceeding from a point. When, however, specular hæmatite is sprinkled on the plate a very small amount of the material is attracted to the pole, but most of it is repelled briskly in all radial directions, forming a large ring round the pole. On slightly raising the plate the small amount of attracted material is repelled to the other particles forming the ring. The particles when in a very strong field are attracted, but when in a weaker field are repelled from the pole. For a certain strength of field there appears to be neither attraction nor repulsion. The phenomenon is analogous to the electrostatic actions which take

place between two conductors having unequal but like charges of electricity. In this case, as Snow Harris showed many years ago, they attract one another when close together, but repel one another when they are far apart, the neutral position where neither attraction nor repulsion takes place being well defined. If a heap of the ore containing the hæmatite be placed on the glass plate, then the hæmatite is driven out of the heap and deposited in the feebly magnetic regions, leaving the inert material behind. When polyphase magnets are used, we get rotary magnetic fields produced, and the motions of the particles become much more complicated, especially those which exhibit strong magnetic hysteresis. The field is an inviting one for experimenters, but there are too many variables in it to make it attractive to the theoretical physicist.

ZIRCONIUM ORES.—The examination of a large number of zirconium ores, described by G. Hevesy and V. T. Jantzen in the *Chemical News* for March 20, shows that there is no connexion between density and hafnium content, whereas there is a rough relationship between the latter and the radioactivity. In minerals of nepheline syenitic origin (*i.e.* products of alkaline residual crystallisation) the ratio HfO_2/ZrO_2 is about 0·015; in minerals of granitic origin this ratio is probably about 0·03.

LUMINOUS PAINTS.—An article on luminous paints and enamels is published in the *Chemical Trade Journal* for March 27. In the latter part of the sixteenth century, Vincenzo Cascariolo, a cobbler and alchemist of Bologna, experimented with some specimens of heavy spar which he obtained at Monte Paterno. On calcining the mineral with charcoal he obtained a substance "which absorbed the rays of the sun by day and emitted them by night." This power is shown by sulphides of barium, calcium, strontium, magnesium, zinc and other metals, though the actual cause of the phosphorescence is apparently the presence of minute quantities of certain impurities, which govern the colour of the glow, and in the absence of which no luminescence is observed. Highly luminous products, suitable for practical use, are now obtained by heating mixtures of alkaline earth oxides or carbonates with sulphur, to which small quantities of lithium carbonate, and in addition traces of bismuth nitrate, rubidium nitrate, lead acetate or other metallic salts, have been added. This addition is usually made in the form of a standard alcoholic solution. The article describes the manufacture of typical luminous bodies and gives several formulæ. The effective life of such substances and their practical applications are considered in full detail.

CADMIUM.—Dr. N. F. Budgen describes the production and commercial uses of cadmium in an article in the *Chemical Age* for March 7. The metal was first isolated in Stromeyer's laboratory from the oxide (1818); several names were proposed for it (*e.g.* melinum), but the present name, suggested by Stromeyer, was finally adopted. Cadmium is always found associated with zinc in its ores, but more recently lead and copper ores containing considerable amounts of the metal have been found. Cadmium can only be profitably produced as a by-product in the treatment of ore for the main metal; the cadmium always concentrates in the flue-dusts, condensed fumes, etc., and it is obtained from these either by direct distillation or by solution followed by chemical or electrolytic precipitation. The chemical properties of cadmium are described in detail and a good account of the uses of the metal in alloys is given. "Stain-resisting" silver contains cadmium. The electro-deposition of the metal and its alloys is also described.

DECAY AND PRESERVATION OF STONE.—The decay of stone and preservation of buildings are the subjects of a paper by Dr. A. P. Laurie in the Journal of the Society of Chemical Industry for February 27. The rapid disintegration of stone is caused mainly by the formation of calcium sulphate crystals within it, which by persistent growth in certain layers or pockets ultimately break up the stone. Analyses of decaying stone from various cathedrals show, however, that a stone can carry considerable quantities of calcium sulphate without breaking up. The results of experiments described in the paper lead the author to propose a complete change of policy with regard to our public buildings. He suggests they should be washed down three or four times in summer so as to ensure rapid evaporation. The purpose of this is to help the rain to dissolve out as much calcium sulphate as possible. A new cement for repairing decaying stonework is mentioned, namely, "silicon ester," prepared by the action of alcohol on silicon tetrachloride. When exposed to air and moisture it deposits transparent silica. It is suggested that sandstone with a binding material of silica is most suitable for buildings in modern cities.

GAS TURBINES.—In a recent paper before the N.E. Coast Institution of Engineers and Shipbuilders, Mr. M. König surveys the attempts to produce a gas turbine and gives an interesting account of current work on this difficult problem. A gas turbine might compare favourably with an internal combustion engine of the ordinary reciprocating kind by an improvement in thermal economy, by a reduction in weight per horse-power, or by a reduction in harmful vibration: but in the author's view the temperatures required for high efficiency are beyond the capabilities of materials at present available, and it is only for certain specialised purposes that the second and third possible merits are of importance. Holzwarth's work on the gas turbine has for long been a source of interest to English engineers, but little was known of details of the progress which had been made. Mr. König quotes over-all efficiencies of 16·8 and 17·8 per cent. for the Holzwarth 300 kw. and 700 kw. turbines respectively, and states that a large unit of 5000 kw. at 1000 r.p.m. has been built and is now ready for testing. This large unit has a single turbine wheel of 10 ft. in diameter and 12 tons in weight. The maximum gas temperature is given as "almost 3000 deg. F." The field in which the gas turbine has won its way already to the front is in the compounding of the petrol engine used in aircraft by the employment of an exhaust turbine to pump air into the engine intake and so overcome the disadvantage of diminution in atmospheric pressure at altitude. It is stated, for example, that in January 1924 the General Electric Company of America gave particulars of such a supercharger turbine which ran at 33,000 to 41,000 r.p.m. and fed its engine, when the aircraft was at 35,000 ft. altitude, with air at sea-level pressure. The weight of this turbine plant is given as 140 lb. and the additional power delivered under these conditions by the engine as 280 h.p. The author points out that this aeronautical development may lead the way to progress in other fields, and he instances the work being undertaken in this direction by Brown, Boveri and Co., by the English Electric Co., and by the Curtis Gas Turbine Co. of America.

Recent Researches in Positive Rays.[1]

PROF. W. WIEN, in delivering the tenth Guthrie Lecture to the Physical Society, described the researches on positive rays carried out in his laboratory at Würzburg, passing over the subject of isotopes, as worked out in England, on the ground that this was already familiar to British audiences.

Prof. Wien dealt mainly with the determination of the mean free paths appropriate to the various states of the particles composing the positive or canal rays. Such a particle is alternately in the charged state, owing to loss of an electron by collision, and in the uncharged state, owing to the recapture of an electron in a further collision. The mean free path in the first state being denoted by L_1, in the second by L_2, the first problem attacked was the determination of the ratio L_1/L_2. It is not difficult to show that this is equal to n_1/n_2, where n_1, n_2, are the respective numbers of charged and uncharged particles composing the stream; and it is found that n_1 is less than n_2.

In the first apparatus employed, a narrow pencil of canal rays has to run the gauntlet of a series of ten condensers 1 cm. wide and separated each from its neighbour by a distance of 1 mm., the plates of each condenser being also 1 mm. apart. These ten condensers are arranged side by side in a line and the pencil of rays passes between each pair of plates in turn and finally strikes a thermopile, which thus measures the kinetic energy of the aggregate of particles falling upon it; and when the condensers are short-circuited, this energy is the sum of those of the charged and of the uncharged particles. When, however, a potential difference is established between the plates of the condensers, a diminution is observed in the thermopile reading in consequence of the elimination of some of the charged particles, and as the potential difference is increased this reading approaches a constant value which gives the energy of the uncharged particles alone. From these data the ratio of L_1 to L_2 can be calculated.

If now the pencil of canal rays be entirely freed from charged particles by the first condenser, the remaining uncharged particles continue the process of acquiring and losing charges after they have passed away from that condenser, and a fresh determination similar to that just described can be made by charging a further one of the ten condensers, in addition to the first. It is then found that the ratio of L_1 to L_2 for this (initially uncharged) beam depends on the distance between the two charged condensers, and in this way L_2 itself can be found.

In the investigation just described the pencil of positive rays consisted of particles of very mixed velocities and chemical character. Rüchart, however, afterwards employed a tube made in two parts with a universally swivelling joint, and spread the pencil out into parabolic sheets by applying simultaneous electric and magnetic fields. Particles of a particular velocity and chemical character were selected by means of slits, and the selection could be varied by relative movement of the two parts of the tube. The measurements already described were then repeated with the homogeneous pencils obtained. If the reciprocal of L_2 as thus found be plotted against the pressure in the tube, the resulting graph is a straight line the gradient of which depends on the velocity, as would be expected, but it does not pass through the origin. The latter discrepancy has been explained by Rüchart as due to residual gases emitted from the metal parts of the tube and from the cement, and can be reduced by reducing the size of these elements. As the velocity of the particles is increased by increasing the accelerating potential, L_2 becomes smaller while L_1 becomes larger, the ratio L_1/L_2 ranging from about 0·05 to 0·5. From the mean free path the collisional radius of an atom can be calculated, and this is found to lie between the first and second Bohr orbits in the case of hydrogen. The free paths are given by Rüchart's method with an accuracy of a few per cent.

A further investigation has been made on the subject of the mean free paths by the study of the light emitted. Three kinds of mean free path have to be considered in this connexion. (1) The first is the path for the "duration of luminosity"; this path begins when the atom is excited by the raising of an electron to a higher energy level within the atom, and ends when the electron returns with emission of light. Eighteen years ago Prof. Wien compared the luminosity of a black body at a temperature of about 1100° C. with that of the canal rays, in a vacuum so high (0·001 mm. for hydrogen) that the effect of collisions could be neglected. The energy emitted by the canal rays as light was thus determined in absolute measure, and from this it was possible to calculate the light energy emitted per atom per cm. of an atom's path. The observations were made in a vacuum chamber separated by a very fine slit (through which the canal rays passed) from the tube in which the rays were produced, and were concerned with the strongest lines of hydrogen, oxygen, nitrogen, helium and mercury. It was found that the luminosity fell off exponentially with distance along the path of the rays, and from the exponential constant the mean free path for duration of luminosity can be calculated by introducing quantum considerations. It amounts to a few centimetres. The measurements just mentioned related to the state of things in a very high vacuum, the slit referred to being so fine that the vacuum in the experimental chamber could be kept at much lower pressure than that in the discharge tube.

At higher pressures, however, the effect of collisions comes into play, and it becomes necessary to consider two further kinds of mean free path, namely, (2) the path which begins when an atom becomes normal and ends when it is excited, on collision, by the raising of an electron to a higher energy level; and (3) the path which begins when the atom is excited, as described, and ends not with the emission of light but with ionisation by a further impact. Prof. Wien termed the latter process "perturbation."

This question has recently been investigated by Prof. Wien by the use of a discharge tube separated from the experimental chamber by a slit so fine that a great difference of pressure could be maintained between its two sides by the use of a diffusion pump; with a vacuum in the tube of 0·02 mm., the pressure in the experimental chamber could be raised to 8 mm. or more. The intensity of the line H_α (displaced by the Doppler effect) was then compared at various pressures, and it was found that for high vacua the intensity was proportional to the pressure, but for pressures above about 0·5 mm. the intensity was constant. At low pressures few perturbations take place, and as the excitations are proportional to the number of collisions, the intensity is proportional to the pressure. At high pressures, however, the mean free path for collision is small compared with that for the "duration of luminosity"; the excited atoms are more frequently prevented by "perturbing" collisions from emitting light, and ultimately the perturbations balance the excitations and the intensity becomes constant.

The apparatus used for measuring the "duration of luminosity" has also been adapted for use in a method

[1] Substance of the tenth Guthrie Lecture delivered before the Physical Society of London on April 25, by Prof. W. Wien.

for discriminating between the spectral lines from charged and those from uncharged particles. A small condenser is placed close to the slit so that the canal rays pass between its plates, the vacuum being as high as possible so that the particles may not, after passing through the slit, become charged or uncharged through collisions. The spectrum of the light emitted by the rays is then photographed, first with the condenser short-circuited and then with the condenser charged. (Apparently the slit ordinarily employed in a spectroscope is here dispensed with, the line corresponding to each wave-length being an image of the pencil of rays itself.) Since the charged particles are deflected by the electric field, the lines due to these particles are distorted when the condenser is charged and can thus be distinguished from the lines due to uncharged particles. Photographs were shown in which certain oxygen and hydrogen lines were seen to be undistorted by the influence of the condenser, while others were clearly distorted. The latter belong to the spark spectrum of oxygen, while the former are arc lines. A similar distortion was observable with the band spectrum of nitrogen.

The foregoing considerations throw light on an apparent discrepancy between measurements of the velocity of the rays by electromagnetic methods and by the Doppler effect respectively. The velocities as measured electromagnetically increase in proportion to the square root of the accelerating potential, in accordance with theory, but the velocities as measured by the Doppler effect have been found by several observers to reach a limiting value as the accelerating potential rises beyond a certain stage. Dr. Krefft, however, raised the accelerating potential in a tube filled with hydrogen to 70,000 volts, and in this case he found no limiting value for the Doppler displacement; the latter indicated a velocity increasing in proportion to the square root of the potential, but its absolute value was less than what would be expected from the velocities measured electromagnetically. The arc lines of oxygen also show an unexpectedly small shift, while the spark lines show a larger shift. The discrepancy referred to may therefore be attributed to the fact that the bulk of the luminosity comes from uncharged atoms while the electromagnetic measurements relate to charged particles, which on the average have greater velocities.

A further investigation has been made by Ran, who arranged a glass cylinder close to the canal rays and with its axis perpendicular thereto. In this way light from both approaching and receding particles is collected by the cylinder and focussed on the slit of a spectroscope. Ran found some evidence for regarding the band spectrum of nitrogen as emanating from positively charged particles.

New results have been obtained by Döpel in the analysis of positive rays by Sir J. J. Thomson's method, negatively charged particles of H, H_2, He, and Ne (or ? O) having been found. Most positive-ray parabolas show two regions of maximum intensity, and a new explanation is suggested for this phenomenon, namely, that the second maximum is due to particles of double mass originating in the discharge chamber but afterwards dissociated. The existence of molecules of He_2 and H_4 would be implied by this theory, but not H_6, since there is no second maximum in the case of H_3.

Prof. Wien remarked in conclusion that the work on positive rays affords an excellent example of the results of international co-operation in science, which he regards as of the utmost value and importance. C. W. H.

International Commission for the Investigation of the Upper Air.

A MEETING of the International Commission for the Investigation of the Upper Air was held in London on April 17-22.

At the meeting of the Commission in Bergen in July 1921, the Commission adopted the view that the international publication of the results of the investigation of the upper air ought to be resumed, and that an International Bureau should be established and supported by contributions from the different States, so that the preparation and compilation of the results should not in future be done at the sole cost of the National Service which undertook the work. Unfortunately, it did not prove practicable, in the stringent economic times which followed the meeting of 1921, to obtain the funds which were necessary to carry out the recommendations of the meeting at Bergen. In consequence of this, Prof. V. Bjerknes, who had been president of the Commission, resigned his position, as he could not spare the time from his purely scientific work to carry out unaided the large amount of work involved in the preparation and publication of the international upper air results. Sir Napier Shaw, then President of the International Meteorological Committee, took over the presidency of the Commission at the request of the members.

Various methods for securing the object of an international publication of upper air results have been considered or tried experimentally since that time. No satisfactory solution of the question has been achieved. A short meeting of the Commission was held after the International Conference at Utrecht in 1923 at which the results of the inquiries were briefly surveyed, and a preliminary discussion took place on the most appropriate form for an international publication.

In 1924, at the meeting of the International Union for Geodesy and Geophysics at Madrid, the Union voted the sum of 500*l.* towards the expenses of publication of a specimen volume of upper air data, and Prof. van Everdingen, the director of the Meteorological Institute of Holland, promised a contribution of about 100*l.* for the same purpose.

The meeting of the Commission in London was concerned primarily with the consideration of the form which the specimen publication should take. Representatives from the following countries attended: France (Capt. Wehrlé); Germany (Prof. Hergesell); Great Britain (Sir Napier Shaw, Sir Gilbert Walker, Capt. C. J. P. Cave, Lieut.-Col. E. Gold, Mr. L. H. G. Dines, Mr. L. F. Richardson); Holland (Prof. van Everdingen, Prof. van Bemmelen); Italy (Lt.-Col. Matteuzzi, Prof. Gamba); Norway (Dr. Hesselberg); Russia (Dr. Molchanoff); Spain (Col. Meseguer). The meetings of the Commission were divided into business meetings and scientific meetings, on the ground that a right solution of the questions which the Commission had to consider could only be achieved by a correct appreciation of the scientific principles involved. There were four business meetings and three scientific meetings.

At the first meeting of the Commission on Friday, April 17, the president read a letter from Mr. la Cour, director of the Danish Meteorological Service, giving the Commission the welcome news that four wireless stations would be in operation in Greenland during the coming summer, at Angmagsalik, Julianehaab, Godthaab, and Godhavn; and that all four stations would be equipped with instruments for observations of pilot balloons. The work of the four stations as regards investigation of upper wind would be co-ordinated by wireless with the view of obtaining simultaneous ascents to great heights from all stations at the same time.

In a communication from M. Fontséré (Barcelona) an account was given of some observations on oscillations of short period, indicated by the well-known oscillations of the motion of pilot balloons, as seen in a pilot balloon theodolite. These oscillations appear to have a period of about three seconds, and do not appear to be due to natural oscillations of the balloon. The Commission decided to recommend that a similar investigation should be undertaken in other places, and that the influence of the size and form of the balloon on the character of the oscillations should be explored, and that a comparison of the oscillations observed in balloons with those observed in the tension of kite wires should also be made.

After some discussion of the use that should be made of the funds placed at the disposal of the president, the Commission decided that they should be applied to the publication of a specimen volume of upper air results for 1923 and 1924, and that in the specimen volume the observations obtained from *ballon-sonde* and similar records from the places selected for international investigation, should be published in the form of tables giving full details, and that the tables should be supplemented by graphical representation on "tēphīgrams." This is the name given to the representation of the results of the *ballon-sonde* ascents, by plotting corresponding values of temperature t, and entropy ϕ, which is proportional to the logarithm of potential temperature T. This form of representation, which was invented by the president and explained by him at the scientific meeting, is peculiarly appropriate for presenting the results of temperature (and humidity) observations in the upper air. It shows immediately the relation of the temperature gradient observed in the ascent to the adiabatic gradient for dry air and the adiabatic gradient for saturated air. It shows the energy which would be required to raise air vertically in the atmosphere under the conditions of the ascent, or alternatively, the energy that would be set free in a kilogram of air rising in the atmosphere under the conditions of the ascent. It also has the great advantage of presenting these results in a diagram of very moderate dimensions, even when observations at heights of 50,000 feet or more are included.

Considerable discussion took place on a proposal sent by Dr. Marvin for concentrating all the international *ballon-sonde* ascents in any one year into a single month. The proposal to obtain ascents daily for a month in addition to ascents on single days in other months of the year, was advocated by Lieut.-Col. Gold at the meeting at Bergen in 1921, but it was rejected by the Commission on the ground that the funds available for upper air investigation should be devoted to obtaining results for detailed investigation on the lines adopted by the Norwegian Geophysical Institute. After much discussion of Dr. Marvin's proposal, it was agreed that countries participating in the international investigation of the upper air should be asked to make, so far as possible, daily ascents distributed throughout a month in each year, the month to be selected by the International Commission, these ascents to be additional to those indicated in the scheme of international days prepared by the Commission at Bergen for the years up to 1928. The first month selected for this more extended investigation is May 1926, and the next month is October 1927. (It was considered that the time was too short to warrant an "International Month" in 1925, but it was agreed that any auxiliary *ballon-sonde* results which any country might be able to make, should be made in August.)

In the course of discussion of this resolution, Prof. Hergesell emphasised that the international investigation of the upper air has two aspects, the world aspect and the regional aspect. From the world aspect, ascents over a month would be appropriate, and from the regional aspect, ascents concentrated into shorter periods of time, and made more frequently, would lead to better results. Dr. Simpson, following up this line of thought, made the suggestion that the Commission itself should deal only with the world aspect and should appoint regional sub-commissions to deal with regional aspects. The Commission eventually decided that the regional aspect could, in the meantime, be dealt with satisfactorily by the nomination of deputy-presidents in the following different regions: Europe, with Russia, Siberia, and North Africa; North America; the East Indies and the Philippines; Australia; South Africa; South America. It was agreed that the six ascents left at the disposal of the president should be concentrated in the international months, and the exact dates in the different regions should be left to the deputy-presidents for these regions. Dr. Marvin was designated as deputy-president for North America and Mr. J. H. Field for the East Indies.

The question of adopting an international formula for the rate of ascent of balloons, put forward by Dr. Weinberg (Leningrad), led to the appointment of a sub-commission to consider this and other questions relating to balloons, and to report to the next meeting of the Commission. The members of the sub-commission are: Prof. Hergesell (president), Dr. Hesselberg, Mr. J. S. Dines, Dr. Molchanoff, Col. Matteuzzi, Dr. Marvin, and Mr. Fujiwhara.

The importance of aeroplane observations, and the difficulty of securing satisfactory instruments for them, was emphasised by Capt. Wehrlé, and the Commission decided to ask for complete particulars of the instruments and methods used in different countries to be communicated, with the view of their publication in collected form by the French Meteorological Service.

As regards the future, it was decided that the question of a regular international publication could only be settled satisfactorily after the specimen volume had been issued and considered. The question of the publication of results after 1924 was, therefore, remitted to the next meeting of the Commission, which it is anticipated will be held at Prague in 1927.

On Thursday evening, April 16, the delegates were entertained by the president at an informal "At home" at his house. Various graphical methods of presentation and illustration of upper air results were exhibited, and some interesting photographs were shown illustrating the growth and decay of vortices in a fluid in connexion with the theory which Mr. Fujiwhara has developed of the vortex motion exhibited in clouds. On Friday, April 17, the delegates were entertained to dinner by the Meteorological Office. On Sunday, April 19, they were invited by Capt. C. J. P. Cave to lunch at the Beacon Hotel at Hindhead, and afterwards to tea at Stoner Hill, Petersfield, where they had an opportunity of seeing an unrivalled collection of cloud photographs, while the rain outside witnessed to the accuracy of the Meteorological Office forecasts. On Tuesday afternoon, April 21, they paid a visit to Kew Observatory in connexion with the seventy-fifth anniversary of the Royal Meteorological Society, and on Wednesday evening they were entertained at the anniversary dinner of the Society.

The outstanding impression left by the meeting may be illustrated by a remark to me of one of the foreign delegates: "What I like about this international work is the way everybody is ready to help things forward; the only consideration being, 'Is the thing good?' It is very pleasant." E. GOLD.

Historic Scientific Instruments in the Old Ashmolean Museum, Oxford.

ON Tuesday, May 5, the Old Ashmolean Museum at Oxford was reopened as a home for old scientific instruments, especially the magnificent collection presented to the University by Mr. Lewis Evans, on whom the honorary degree of D.Litt. was first fittingly conferred. After this, a large and brilliant gathering assembled in the Divinity School under the chairmanship of the Vice-Chancellor to hear an account of the collection from Mr. R. W. T. Gunther, fellow of Magdalen, who has been appointed curator; and an address from the Earl of Crawford and Balcarres, president of the Society of Antiquaries, who performed the opening ceremony.

The Old Ashmolean Building, which embodies many of the features of Wren's design for a College of Science, was originally opened on May 21, 1683, by the Duke of York, afterwards James II.; and it was pleasant to have at this second opening, nearly 250 years later, a cordial message from the present Duke of York, transmitted through a specially appointed representative, the president of Magdalen. Lord Crawford, in some inspiring words, welcomed the dispelling of the mischievous fallacy that there is a necessary antagonism between science and art; for in the present exhibition the two are practically combined. Instruments that have become scientifically obsolete survive as beautiful works of art.

The company had ample opportunity to verify this statement; for many of the exhibits have indeed great beauty of workmanship. A little crucifix, the arms and sides of which constitute a vertical sundial, while the interior is filled with drawing instruments, came in for special admiration. Its instruments were spread out beside it, and their number almost suggested that it might be difficult to get back the "genie into the bottle." Dr. Evans has told us that his collection began (when he was only eleven !) with sundials; and though it expanded later to include astrolabes and other instruments of precision, it took him twenty years to find his first astrolabe. He was really trying all that time to get one, and prepared to spend money on it, but there were none to be had. In view of the number he has now accumulated, this is very surprising. An interesting development of his collecting tastes is represented by a very fine set of gunnery levels, specially admired by another collector of these treasures.

Besides the Lewis Evans collection itself, there are many other loans and gifts, attracted partly by the new and splendid opportunities for presentation, and partly no doubt by Mr. Gunther's persuasiveness. Miss Willmott has lent a remarkable astronomical clock, with an astrolabe as dial, two hands to show the positions of the sun and moon, and a mean time clock at the back—all beautifully ornamented. Christ Church and Oriel have both lent important collections—the former a collection of orreries. Doubtless other gifts and loans will come. Mr. Gunther was specially gratified to receive a note from Mr. E. B. Knobel after his visit: "I see from your catalogue you want a Davis's Backstaff: I'll send you one." There are copies of two Galilean telescopes and a Hooke microscope which come from special funds. Perhaps the best example of the advantages brought by the new opportunities is the conjunction of (*a*) the first circular slide rule (1632), invented by Oughtred, (*b*) portraits of Oughtred and of Elias Allen, the maker, (*c*) two books on the subject by Oughtred and Allen. Now (*a*) is a loan from St. John's College, (*b*) from the Hope collection of portraits in Oxford, while (*c*) are from the Evans collection. Thus we see the value of Oxford as a collecting and combining medium; but again, we must not undervalue the knowledge which Mr. Gunther had gradually acquired of the (formerly) hidden resources of Oxford.

We may regard Tuesday's ceremony as the very satisfactory ending of a period of doubt and difficulty with regard to the Lewis Evans collection. The joys of collecting are great; but there comes a time when some anxiety as to the ultimate fate of the collection must temper those joys. Such anxieties must now have been dissipated; and for this happy result we have in great measure to thank the Vice-Chancellor, without whose sympathy and liberal views of the functions of a University even Mr. Gunther's energy might have failed to clear the path from difficulties.

Two points of detail may be mentioned. The little catalogue of the instruments is on sale in the *Old* Ashmolean Building, *not* in the Ashmolean Museum as (erroneously) printed on the cover. The danger of this confusion is well-nigh unavoidable. Secondly, those interested will find some really excellent pictures of building and exhibits in *Country Life* for May 9.

H. H. T.

Growth Stages of a Crustacean.

EVERY student of zoology has some acquaintance with the larval stages of those Crustacea that undergo metamorphosis, but there has hitherto been no detailed account of the changes during growth in any of the species in which development is direct. In the course of researches on the genetics of *Gammarus chevreuxi* carried out at Plymouth, Mrs. E. W. Sexton found it necessary to have fuller information as to the characters of the successive stages from hatching to maturity. She therefore set herself to the laborious task of studying and depicting, with her well-known artistic skill, complete series of the moulted skins of isolated individuals. The results are now recorded in a paper (Journ. Marine Biol. Ass., vol. 13, No. 2, pp. 340-396, 21 pls., 1924) which is of unusual interest and importance from several points of view.

Apart from certain changes in the proportions of the body, the differences between the various stages are slight and concern mainly the form, number and position of the hairs and spines on the body and limbs. These trivial differences, however, are remarkably constant, and by means of them the successive stages can be as sharply defined and as surely recognised as can the larval stages of those Crustacea in which the changes of form are more striking. It is especially noteworthy that this constancy is undisturbed even by considerable changes in the environment. *Gammarus chevreuxi* will live and breed equally well in fresh, brackish or sea-water; it breeds all the year round, and the winter broods take more than twice as long to reach maturity as do those hatched in the summer; yet "the stages of growth were found to be identical, even to the number and position of the hairs." As these statements are based on the study of more than 3000 moults obtained during a period of twelve years, we may confidently take Mrs. Sexton's word for it.

Sexual maturity is reached by both sexes after the seventh moult. The females continue to grow and to moult without further change of form. The males, however, do not attain their definitive characters until the ninth moult. There are, therefore, three

forms of breeding male which might well be taken to belong to different species. It is suggested that this fact, hitherto unknown, may have caused much confusion in the taxonomy of these Amphipoda.

The occurrence of "intersexes" in this species has already been recorded in earlier papers by Mrs. Sexton. These were "female intersexes," and the study of their life-history now shows that they begin as females and develop more and more of the male characters as they grow. "Male intersexes" are also mentioned, but these might be better described, perhaps, as incomplete males, since their effeminate appearance is due rather to the persistence of immature characters than to the assumption of those that are peculiarly female.

Brief accounts are given of the life-history of three other species of Gammarus found at Plymouth. Although the structural characters which distinguish them might be thought trivial by any one but a specialist, the differences in their breeding habits are very marked and "probably form an insuperable bar to cross-breeding" even when the species occur together.

A small detail of interest to the morphologist was observed in the antennules. On the upper surface of the first segment is a narrow longitudinal groove planted with a row of plumose sensory hairs. This is, no doubt, a vestige of the so-called "auditory sac" or statocyst, found in many decapods and also in the Syncarida but not hitherto recognised in any other Crustacea.

In passing, Mrs. Sexton deals with "a picturesque legend" which has been widely quoted from Spence Bate, who gives it on the authority of Dr. James Salter. It is to the effect that the young gammarids, on quitting the brood-pouch of the mother, keep close to her as she swims about and, on the approach of danger, rush back to the pouch for shelter. Spence Bate not only expends some rhetoric on this "interesting instance of maternal solicitude," but also gives us a pretty picture of the mother Gammarus accompanied by her brood. Mrs. Sexton tells us that there is not a word of truth in the whole story. The young could not possibly re-enter the pouch if they tried, and in *G. locusta*, the species to which Spence Bate refers, hatching is followed immediately by emergence of the young, moulting of the mother and deposition of a fresh batch of eggs. W. T. C.

University and Educational Intelligence.

CAMBRIDGE.—The Museum of Archæology and Ethnology has received from the Earl of Denbigh the Pennant Collection consisting of a very important series of ethnological objects collected by Captain Cook himself in the Pacific, a series of archæological specimens which is of great interest and value.

Dr. Scott, Trinity College, has been reappointed curator in entomology; Mr. P. M. S. Blackett, King's College, has been appointed assistant demonstrator of experimental physics; J. Barker, Trinity College, has been reappointed to the Frank Smart studentship in botany; A. B. Deacon, Trinity College, has been elected to the Anthony Wilkin studentship in ethnology and archæology; G. E. Hutchinson, Emmanuel College, has been nominated to use the University table at the Zoological station at Naples.

Prof. Niels Bohr is lecturing on "Problems of the Quantum Theory" at the Cavendish laboratory, on Friday, May 15.

The annual report of the Board of Research Studies provides interesting reading. The number continues to rise and there are now 248 students registered and working under the administration of the Board. The chief increase in any subject is in physics, where there are now 40 research students. The number of Cambridge graduates who have registered as research students continues to increase and has now reached 80. The number of American students shows a marked increase. The distribution in colleges still remains very unequal, the numbers ranging from 46 at Trinity College, 38 at Emmanuel College, and 34 at Gonville and Caius College to 2 at Pembroke College, 1 at Jesus College, and 0 at Selwyn College.

LONDON.—A free public lecture (in English) on "Modern Conceptions of Light Stimuli in Plants" will be given by Prof. F. A. F. C. Went, of the University of Utrecht, at the Imperial College, Royal School of Mines, on Monday, May 25, at 5.15. No tickets will be required.

The University Studentship in Physiology, value 50*l.*, will be awarded to a student qualified to undertake research in physiology. Applications should reach the Academic Registrar by, at latest, June 1.

Applications are invited for grants from the Thomas Smythe Hughes Medical Research Fund for assisting medical research. They should be sent, accompanied by the names and addresses of two references, to the Academic Registrar, University of London, South Kensington, S.W.7, not later than June 15.

MANCHESTER.—In connexion with the Municipal College of Technology the Edmund Mills Harwood Memorial Scholarship, value 50*l.* a year, and tenable for three years in one of the University engineering courses, is offered for competition. Forms of nomination and further information are obtainable until June 15 from the Registrar of the College.

PROF. B. HELFERICH, of Frankfort-on-Main, has been invited to occupy the chair of chemistry at Greifswald in succession to Prof. R. Pummerer, who has been transferred to Erlangen.

THE Society for the Advancement of the Training of Mechanics, Leyden, has arranged for the holding in August of vacation courses for mechanics and glass-blowers in the workshops of the Physical (Cryogenic) Laboratory of the University of Leyden. Information respecting the courses can be had from the Secretary, Dr. C. A. Crommelin, at the laboratory.

THE University of Birmingham has evolved a system of research economy which deserves to be commended to the notice of other institutions. Four years ago, the University established a Joint Standing Committee for Research with the object of making a general policy and recording from session to session as completely as possible all the research work conducted by members of the University staff. The committee's main work is now to grant financial assistance from its own resources, to support, at its discretion, applications by heads of departments to outside bodies, to keep in close touch with all work properly described as research work going on in University Departments or in Departments working under the University, and to record and publish work completed and in progress. With the third annual report (1923–24) particulars were published of 170 researches in progress in the faculties of science, art, medicine, and commerce, and of 150 publications embodying completed researches, and, in addition, accounts of archæological excavations and of work carried out under the City and University Joint Board of Research for Mental Disease. The resources of universities are so diverse that a common policy in regard to the promotion and organisation of research may not be called for, but in regard to systems of recording and classifying particulars of research, the advantages of uniformity are very

evident, and ought to be attainable without much difficulty.

IN his presidential address on "University Ideals" to the Yorkshire Natural Science Association in Bradford, which has recently been issued, Prof. A. F. Barker of Leeds discusses the ideals characteristic of the schools of the humanities, of pure science, and of applied science, and the relation to them of the scientific and technological bias, which is the most distinguishing feature of the modern universities. He adopts the view of Dr. L. P. Jacks, that so long as civilisation remains predominantly industrial, all attempts to find culture, religion, salvation outside the sphere of our daily work must "resolve themselves ultimately into spoken nothings." To render the training of the faculties fruitful, they must be made sensitive to the appeal of natural science. The student must be taught to regard Nature, natural science, technology, and the objective world generally as a mirror in which man may see himself. "The limitation of our powers of vision is in ourselves; and the University's highest and deepest concern lies in the stimulation, through contact with the subjective and objective worlds and with the everyday life of the world which lies about us, of the light within ourselves—of our evolving consciousness." This is to apply in the university the principles of what is known in American pedagogical terminology as the "project method." The same principles are advocated in a pamphlet by Prof. J. W. Scott of University College, Cardiff, under the name of "the regional idea," for revitalising the teaching in our elementary schools to the end that their pupils may be better equipped for life in the world of industry ("Unemployment—a suggested remedy," A. and C. Black, 1925, 1s. net). In connexion with the encouragement of individuality in organisation, which seems to Prof. Barker an essential feature of the modern university system, he refers to "the fight for the inclusion of the Research Associations within the university," and "the fight which is now being waged in several of the modern universities in England for the reintroduction of religion into the university life in some form or other."

THE morning session of the annual Conference of the Universities of Great Britain and Ireland, held at King's College, London, on May 9, was devoted to a discussion on "The Function of the Universities in Relation to Agriculture." Sir Daniel Hall, chief scientific adviser to the Ministry of Agriculture, was the principal speaker. He is of opinion that agriculture students and courses fall into three groups: at certain universities, notably Oxford and Cambridge, many of the future landowners of the country form a considerable proportion of the students. For them a degree course in agriculture is required which will awaken in them a sense of their responsibilities and opportunities. Then there are the men who actually intend to farm; they require a technical training, which might be more conveniently given at a university than at a separate agricultural college, where they would miss that opportunity of widening their knowledge which contact with students of different subjects in a university affords. Finally there are teachers, scientific workers and officials, whose training should be based on a degree course in arts or in pure science. Sir Daniel thinks that there are sufficient agricultural colleges already in Britain and that each should pick out its special group and cater for its needs. In the discussion which followed, Mr. M. J. R. Dunstan, principal of the Royal Agricultural College, Cirencester, suggested a round-table conference of university authorities in Great Britain to decide the scope and training for an agricultural degree.

Early Science at Oxford.

May 18, 1686. Some of this Society having considered that place of Tacquet's Geometry, mentioned in the Minutes of the Dublin Society of March ye 8th. observed that there is this difference betwixt Mr. Caswell's first Problem and Tacquet's; viz. that in each of Tacquet's Triangles there is one side and 2 Angles given, which is an ordinary case of Trigonometry: But none of Mr. Caswell's Triangles has one side and 2 angles, or 2 sides and one angle, or 3 sides given; and this makes a greater difference in the Solutions than that mentioned, in those minutes.

Then was read an account of the Torricellian experiment, tried on the Mountaines of Snowdon, Cader Idris, &c. with the heights of those mountains taken by Mr. Caswell.

An account was given of *four children* born at a birth, at Marston near Oxford, the last Mounth.

May 19, 1685. A Letter from Dr. Mark, Physitian to the Elector of Brandenburg, and Member of this Society, dated Potsdam, March 28, 1685, was read; It brought an account how well his Electorall Highnesse is pleased with ye design of this Society. His Highnesse having commanded Dr. Mark to continue a strict correspondence with us, and promising him assistance, by furnishing him with matter to comunicate, when his own stock shall be defective. The Elector also commanded him to enquire concerning ye Concha, which affords ye Purple, and of ye way of making Amianthus-paper, and to procure both, if possible. He has also given orders for some of ye Philosophical Transactions to be sent over. The Society ordered their humble thanks to be returned to Dr. Mark for this welcome newes; for the Honour done them in it; and for (the occasion of it) ye character he has been pleased to give of this Society to the Elector; and that answers be speedily sent to ye queries in ye Letter; and that ye Letter itself be carefully preserved among ye papers of this Society.

Proceeding then to other matters, two specimens of bookes, now in the presse, were shewn us; one a History of Fishes, written, some years since, by Mr. Willoughby, and Mr. Ray: the other, a History of Plants, by Mr. Ray, after his new method.

A Sort of Earth, dug at Hogsdon, 8 or 10 foot deep, of an Aromaticall smell, was communicated by Dr. Plot; who inform'd us, that the Water under this Earth is found Bituminous, from whence, he conjectures, ye Earth may be supposed to have this flavour.

May 20, 1687. Mr. President was pleasd to communicate a letter from Mr. Halley, which gives an account of Mr. Newton's Book *de Systemate Mundi* now in ye presse, giving an account of ye reasons of ye Celestial motions &c.; and of Mr. Hooks finding ye meridian line with great exactnesse by the help of a Small constellation near ye Pole.—Mr. President also communicated a Letter written by him in answear to Mr. Hally's, giving an account of ye reasons, why he can not be of Mr. Hooke his opinion, concerning the figure of ye earth.

May 22, 1688. Mr. Molyneux sent an account of the Inhabitants of the Barony of Forth in the County of Wexford, who are the Progeny of the first English Planters that came over with Fitzstephen and conquered Ireland in Henry 2ds Time. Till the times of their late confusions in Ireland (he says) they retain'd in great Measure their Antient Language, neither good English nor Irish, but easyer understood by a perfect Englis man then Irish. That till of late they allways kept their Marriages intire amongst themselves.

Societies and Academies.

LONDON.

Royal Society, May 7.—W. **Rosenhain** and Miss J. **McMinn**: The plastic deformation of iron and the formation of Neumann lines. Experiments have been made to ascertain the effect of variations of speed on the mode of deformation of nearly pure iron. Small rectangular prisms, having one face prepared for microscopic examination, have been compressed slowly in a testing machine and also under the blow of a falling weight. Within the range of speeds possible on the testing machine used (from 20 minutes to approximately 1 second) slip bands of very similar character are formed. When, however, such a specimen has been compressed by the blow of a falling weight very few slip bands are formed, but the crystals are crossed by much heavier and usually very straight black bands, which have been identified with the well-known Neumann lines. The formation of Neumann lines is probably not due to twinning; they are rather of the nature of broad slip regions, possibly formed by the close juxtaposition of a large number of slip planes. The surfaces on which slip has recently occurred are regions of weakness for further deformation by shock, although they do not appear to behave in the same way with further gradual deformation. —A. E. H. **Tutton**: (1) The monoclinic double sulphates containing thallium.—Thallium nickel and thallium cobalt sulphates. The two salts are $Tl_2Ni(SO_4)_2 . 6H_2O$ and $Tl_2Co(SO_4)_2 . 6H_2O$. They show close isomorphism with salts of the series containing the alkali metals, but not "eutropism" (progression with atomic number). Thallium in its thallous capacity is thus capable of replacing the alkali metals in the crystals of these double salts, with only a relatively small amount of change like that produced by alkali metal interchange, but without relationship to atomic number. The two new thallium salts, in common with those previously studied and also with the simple rhombic sulphate and selenate of thallium, are distinguished by their very high (relatively to other salts of the two series) refraction and dispersion. This is probably where the more complicated nature of thallium atoms produces its effect. (2) The crystallographic and optical properties of iodo-succinimide. Miss Yardley's X-ray results indicated a structure corresponding with the symmetry of Class 9, the pyramidal polar class of the tetragonal system, one of the classes in which optical activity in two optical antipodes is possible. It has hitherto been assumed that iodo-succinimide is ditetragonal pyramidal (Class 13). New morphological constants were found and optical activity has been discovered, blocks about 4 mm. thick being required to exhibit it clearly. Hence, Miss Yardley's conclusion that the symmetry is that of Class 9 is in every way confirmed. —Kathleen **Yardley**: An X-ray examination of iodo-succinimide. The dimensions of the true unit cell are $6{\cdot}29 \times 6{\cdot}29 \times 15{\cdot}55$ Å.U. This minimum cell contains four molecules. The X-ray measurements predict that the crystals should be optically active; Dr. Tutton has since shown that this is actually the case.—B. **Lambert** and S. F. **Gates**: An investigation of the relationships existing between hydrogen and palladium. The "ascending" pressure-concentration isothermal drawn through equilibrium points obtained after successive additions of hydrogen to palladium is not, in any sense, an equilibrium curve. The "descending" pressure-concentration isothermals, drawn through equilibrium points obtained after successive withdrawals of hydrogen from the system, are regular, but interruption of the smooth withdrawals of gas by occasional additions of gas, and temporary cooling, have marked effects; the "descending" isothermal cannot, then, be considered an equilibrium curve. The existence, under some conditions, of a simple compound, Pd_2H, is considered not improbable.—C. G. T. **Morison**: The effect of light on the settling of suspensions. Fine-grade suspensions of soil and kaolin were used in the absence and presence of light. When a suspension settles in the absence of light the settling is uniform and normal. In the presence of light it develops well-marked striations and discontinuities.—Colonel N. T. **Belaiew**: On the inner crystalline structure of ferrite and cementite in pearlite. Pearlite, the "pearly compound" of Sorby, is built up of grains of alternating lamellæ of cementite and ferrite. The orientation of these lamellæ is different in different grains. The cementite lamella shows its "petal-like" structure and seems warped and twisted. The exposed outer edge shows rectangular steps pointing to a constant linear unit. The ferrite lamella reveals, at the edge, "isolated cubes" of ferrite of about 250 $\mu\mu$ edge. The ferrite lamella seems to be built up of a multitude of such small cubes, and both the warping of the cementite lamellæ and the cracking of ferrite may be traced to the Ar_1 point, where the expansion of volume, due to the change from the face-centred to the cube-centred lattice in iron, counteracts—in the pearlite areas—the normal contraction of the cooling specimen. Reacting to the ensuing stresses, the cementite lamella becomes warped and twisted, and the ferrite splits up into a multitude of blocks or cubes.

Royal Microscopical Society, March 18.—C. **Da Fano**: (1) On the mounting in series of specimens stained by the Weigert-Pal method. Well-bichromated material is embedded in celloidin. The blocks are cut serially and the sections placed in order on slips of smooth paper. After drying with filter paper a progressive number is written with a mixture of 10 c.c. of indian ink and 3 c.c. of equal parts of ether and acetone on a corner of the celloidin by means of a brush. The sections are floated in weak alcohol, washed, and mordanted in a mixture of potassium bichromate 5 gm., chromium fluoride 2·5 gm., distilled water 100 c.c. They are then stained in Kultschitzky's hæmatoxylin, differentiated by Pal's method, counter-stained and mounted according to the progression of their numbers. (2) Golgi-Cox preparations mounted permanently in series. Relatively large pieces of nerve tissue or even entire brains from small animals are placed in Cox's mixture. The fluid should be changed after 24 hours and again on the third day. The pots containing the material are sealed and kept for a month at 24° C. and then for about 6 months at room temperature. The pieces are washed, dehydrated, embedded in celloidin, and serial sections made. —A. S. **Parkes**: The age of attainment of sexual maturity in the albino mouse. The examination of the gonads of young mice showed that mature spermatozoa are produced by the male at a much earlier age than ova are produced by the female. In the case of the male, active spermatozoa first appear in the epididymis during the sixth week of life. Testis sections corroborated this finding. In the case of the female the first ovulation occurs about the eighth week, though the condition of the animal obviously has a considerable influence in determining the time of the first production of both ova and spermatozoa. The vaginal orifice first opens towards the end of the seventh week, at which time also the uterus develops to a condition approaching maturity.

Royal Meteorological Society, March 18.—C. K. M. **Douglas**: The relation between the source of the air and the upper air temperature up to the base of the stratosphere. Trajectories of "gradient" wind were drawn, showing the previous history of the air in which *ballon sonde* ascents were made, in cases where the place of fall of the balloon showed no great change of wind with height. These showed that the latitude of the air three days previously is highly correlated with the temperature at all heights to the base of the stratosphere, with the height of the stratosphere, and with the pressure at 9 km. The latitude effect, which in general represents the temperature difference between "polar" and "equatorial" air, increases somewhat with height, up to at least 6 kilometres.—A. H. R. **Goldie**: Waves at an approximately horizontal surface of discontinuity in the atmosphere. Autographic instruments with open time scales show examples of fluctuations of atmospheric pressure which are undoubtedly periodic. By way of determining the origin of these, the general problem of wave-motion at the common boundary between two air currents differing in density and in velocity and direction of motion is discussed. The theory can account plausibly for the observed facts; waves with amplitudes in the bounding surface of from 150 to 750 metres or, perhaps more, and with lengths of the order of from 5 to 20 kilometres, must be of comparatively frequent occurrence.—Sir **Napier Shaw** and H. **Fahmy**: The energy of saturated air in a natural environment.

DUBLIN.

Royal Dublin Society, March 31.—H. **Pringle**: The identity of vitamin A: the comparative effects of human and cow's milk. Cow's milk is much more efficacious than human milk in promoting growth in rats.—J. **Wilson**: The variations in the quantities of food required by cattle for maintenance and fat production with various kinds of rations. From Kellner's own experiments, the quantity of food required by cattle for idle maintenance is not constant, as Kellner found, but varies with the kind and quantity of long fodder in the ration. With 11 to 12 cwt. bullocks, it is equivalent to about 13, 15, and 16·5 lb. of hay, when the ration contains less than 0·6 lb. of hay, about 1 lb. of hay, and about 1 lb. of hay and straw respectively per live hundredweight of the animal. When the bullock is fattening, the quantity of food required to put on fat varies with the kind and quantity of long fodder in the ration and with the rate of fat production. If all not retained by the animal be regarded as maintenance, the bullock, like the pig, puts on a pound of fat with a little more than 2 lb. of meals.

PARIS.

Academy of Sciences, April 6.—The president announced the death of M. Rabut, member of the Academy.—H. **Vincent**: New researches on the pathogeny of colibacilluria. The action of an anti-colibacillus therapeutic serum.—L. **Vegard**, H. **Kamerlingh Onnes**, and W. H. **Keesom**: The emission of light by solidified gases at the temperature of liquid helium, and the origin of the auroral spectrum.—P. J. **Myrberg**: Arithmetical invariants.—H. **Eyraud**: Two complementary deformations of space.—Léon **Pomey**: The integration of differential equations with general initial conditions comprising those of Cauchy.—Mlle. O. **Jasse**: Observations of the Schain (1925 *a*) and Reid (1925 *b*) comets made at the Marseilles Observatory (Eichens equatorial, 26 cm. aperture). Positions given on March 29 and 30. Schain's comet forms a nebulosity 2′ in extent, with a nucleus of 11·5 magnitude. Reid's comet, 9·5 magnitude, shows a strong condensation surrounded by a nebulosity 3′ in extent.—P. **Chofardet**: Observations of the Schain (1925 *a*) and Reid (1925 *b*) comets made at the Besançon Observatory with the *coudé* equatorial. On March 30 Schain's comet was of the 11th magnitude, 40″ diameter, with a nearly central nucleus: Reid's comet on March 31 was of the 8th magnitude, with nucleus 8″ diameter, tail faintly outlined.—Emile **Belot**: The trajectory of the proto-sun in the primitive nebula: the origin of comets.—Jean **Villey** and Pierre **Vernotte**: The electrical maintenance of pendulum oscillations without physical contact. The oscillations can be maintained by the electrostatic attractions between the pendulum and its fixed supports. An outline of the necessary conditions is given.—A. **Grumbach**: The surface phenomena in photo-voltaic elements with a fluorescent liquid. The effect of the illumination on the electromotive force of the cell platinum—fluorescent solution—platinum has been studied. The variation of potential caused by the illumination is a function of the lighting, and of the nature and concentration of the solution, but is independent of the initial electrical conditions.—Charles **Chéneveau**: Some optical properties of turbid solid resinous media. Opaque resins, natural or artificial, which may be regarded as the inverse of suspensions of resins in water, obey the general optical laws of turbid media containing large particles.—G. **Réchou**: The spectrographic study of the *K* series of the heavy elements. Values are given for the α_2, α_1, β, and γ lines for ten elements (tantalum to uranium).—P. **Job**: The spectrographic study of the iodocadmium complex. The existence of the complex ion CdI_4 is proved, and the equilibrium constant k of the reaction $Cd^{++}+4I^- \rightleftharpoons CdI_4^{--}$ deduced from the measurements.—A. **Mailhe**: The catalytic decomposition of the acid chlorides. The vapours of isovaleryl, isobutyryl, propionyl, acetyl, and benzoyl chlorides were passed over nickel at about 420° C. Analyses of the gases produced in each case are given.—I. P. **Voitesti**: Faceted pebbles in the tectonic breccia in the salt massif of Roumania.—J. **Savornin**: Djebel Hadid (Eastern Grand Atlas).—Frédéric **Hermann**: The fan of Bagnes and the Dent Blanche layer.—L. **Eblé**: Magnetic measurements in the centre of France. The magnetic elements are given for 45 stations in the Departments of Loir-et-Cher, Cher, and Nièvre.—R. **Bureau** and M. **Coyecque**: Atmospherics on the oceans. Their meteorological characters.—Henry **Hubert**: Practical problems of meteorology concerning French West Africa.—P. **Lavialle**: The embryonic sac of the Dipsaceæ.—H. **Colin** and Mlle. Y. **Trouard-Riolle**: The crossing of smooth-haired black barley with rough-haired white barley (Albert barley).—A. **Goris** and M. **Métin**: The preventive action of anthorine towards aconitine. If less than a lethal dose of anthorine is injected into guinea-pigs, followed by a fatal dose of aconitine, the animal is protected by the anthorine, but the latter has no action as an antidote after injection of aconitine. The preventive effect of anthorine persists for at least twenty-four hours.—M. **Parat** and J. **Painlevé**: The exact concordance of the characters of the vacuome and the classical apparatus of Golgi.—Edouard **Chatton** and Mme. **Chatton**: The action of external factors on the Infusoria. The conjugation of *Glaucoma scintillans* is determined by the modification of the proportion of the constituents of a chemically defined medium.—— **Paillot**: The cytoplasmic and nuclear alterations in the course of the evolution of *grasserie* of the silkworm.—G. **Guittonneau**: The formation of thiosulphate at the expense of sulphur by the micro-organisms of the soil.

Official Publications Received.

Field Museum of Natural History. Zoological Series, Vol. 14, No. 2: Review of Living Caenolestids, with Description of a new Genus from Chile. Reports on Results of the Captain Marshall Field Expeditions. By Wilfred H. Osgood. (Publication 222.) Pp. 163-173. Zoological Series, Vol. 13: Catalogue of Birds of the Americas and the Adjacent Islands in Field Museum of Natural History; including all Species and Subspecies known to occur in North America, Mexico, Central America, South America, the West Indies, and Islands of the Caribbean Sea, the Galapagos Archipelago, and other Islands which may be included on Account of their Faunal Affinities. By Charles B. Cory. Revised and continued by Charles E. Hellmayr. Part 3: Pteroptochidae, Conopophagidae, Formicariidae. (Publication 223.) Pp. vii+369. (Chicago.)

Department of the Interior: United States Geological Survey. Water-Supply Paper 513: Surface Water Supply of the United States, 1919–1920. Part 12: North Pacific Slope Drainage Basins. B: Snake River Basin. Pp. vi+318+2 plates. 30 cents. Water-Supply Paper 519: Ground Water in Santa Clara Valley, California. By William O. Clark. Pp. vii+209+19 plates. 35 cents. Water-Supply Paper 520-D: Base Exchange in Ground Water by Silicates as illustrated in Montana. By B. Coleman Renick. Pp. ii+53-72+plates 3-5. Water-Supply Paper 520-E: The Artesian-Water Supply of the Dakota Sandstone in North Dakota, with special reference to the Edgeley Quadrangle. By Oscar E. Meinzer and Herbert A. Hard. Pp. ii+73-95+plates 6-7. Water-Supply Paper 525: Surface Water Supply of the United States, 1921. Part 5: Hudson Bay and Upper Mississippi River Basins. Pp. v+191+2 plates. 20 cents. Water-Supply Paper 532: Surface Water Supply of the United States, 1921. Part 12: North Pacific Slope Drainage Basins. A: Pacific Basins in Washington and Upper Columbia River Basins. Pp. vi+222+2 plates. 25 cents. Water-Supply Paper 538: The San Juan Canyon, Southeastern Utah; a Geographic and Hydrographic Reconnaissance. By Hugh D. Miser. Pp. v+80+22 plates. 30 cents. Water-Supply Paper 560-A: Water Power and Irrigation in the Madison River Basin, Montana. By John F. Deeds and Walter N. White. Pp. ii+30. (Washington: Government Printing Office.)

Sudan Government. Wellcome Tropical Research Laboratories, Khartoum. Report of the Government Chemist for the Year 1924. (Chemical Section, Publication No. 35.) Pp. 42. (Khartoum.)

Report of the Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii for the Biennial Period ended December 31, 1924. Pp. iv+49+10 plates. (Honolulu, Hawaii.)

Diary of Societies.

SATURDAY, MAY 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—G. L. Bickersteth: Byron and Italian Literature (II.).

BRITISH PSYCHOLOGICAL SOCIETY (Jointly with the General and Æsthetics Sections of the Society) (at King's College), at 3.—Mrs. Ursula Roberts: Intuition and Beauty.—Miss H. M. Wells: The Influence of the Relation between Values and Choice.

MONDAY, MAY 18.

CAMBRIDGE PHILOSOPHICAL SOCIETY, at 4.30.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Prof. H. Wildon Carr: Review of Philosophic Tendencies since Hegel.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—N. E. Odell: The Physiography of Mount Everest.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London) (Annual Meeting), at 7.—P. W. Thomas: Some Factors in the Choice of the Best System of Traction for Handling Dense Suburban Rail Traffic.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—G. T. Forrest: The Architectural Development of American Cities (Lecture).

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. W. H. Moberley: Some Ambiguities in the Retributive Theory of Punishment.

TUESDAY, MAY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. R. Whiddington: The Passage of Electricity through Vacuum Tubes (Tyndall Lectures) (I.).

ROYAL STATISTICAL SOCIETY, at 5.15.—Sir Napier Shaw: The Week or Month as an Intermediate Time-Unit for Statistical Purposes.

ROYAL SOCIETY OF MEDICINE, at 5.30.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions made to the Society's Menagerie during the month of April 1925.—Dr. H. H. Scott: A Streptothrix Disease of Wallabies.—Dr. C. F. Sonntag: A Monograph of *Orycteropus afer*. II. Nervous System, Sense Organs, and Hairs.—R. H. Burne: Note on the Cerebral Arteries of the Angler (*Lophius piscatorius*).—Dr. E. A. Spaul: (*a*) On the Retarding Influences of the Posterior-lobe Pituitary upon the Development of Frog-tadpoles; (*b*) Iodine and Amphibian Metamorphosis.

ILLUMINATING ENGINEERING SOCIETY (at Lighting Service Bureau, 15 Savoy Street, W.C.2), at 7.—W. J. Jones and H. Lingard: A Survey of Lighting in 800 Retail Shops.

ROYAL PHOTOGRAPHIC SOCIETY (Kinematograph Group), at 7.—E. Blake: Film Mutilation.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. R. Ruggles Gates: Mendelian Inheritance in Man.

WEDNESDAY, MAY 20.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Late F. W. Harmer and C. E. P. Brooks: Further Remarks on the Meteorological Conditions of the Pleistocene Epoch.—Sir Gilbert T. Walker: On Periodicity.—Dr. H. Jeffreys: On Fluid Motions produced by Differences of Temperature and Humidity.—A. H. R. Goldie: Gustiness of Wind in Particular Cases.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—J. W. Tutcher and Dr. A. E. Trueman: The Liassic Rocks of the Radstock District (Somerset).—H. Dewey: Palæolithic Implements of Chellean Type from the Gravels of Hyde Park.

INSTITUTION OF PRODUCTION ENGINEERS (at Engineers' Club, Coventry Street, W.1), at 7.30.—S. C. Downes: Mechanical Costing.

ROYAL SOCIETY OF ARTS, at 8.—Prof. J. A. Fleming: William Sturgeon and the Centenary of the Electro-magnet.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Prof. R. Chambers: The Technique of Micro-dissection and Injection of Cells.—F. I. G. Rawlins: A Note on the Use of the Neon Lamp in Microscopy (with Demonstration by J. E. Barnard).—Dr. R. J. Ludford: The Cytology of Cancer.

THURSDAY, MAY 21.

MEDICO-PSYCHOLOGICAL ASSOCIATION OF GREAT BRITAIN AND IRELAND (at Medical Society of London), at 2.30.—Dr. J. Shaw Bolton: Mind and Brain (Maudsley Lecture).

ROYAL SOCIETY, at 4.30.—Dr. W. E. Curtis and R. G. Long: The Structure of the Band Spectrum of Helium. III. The Doublet Bands.—G. S. Adair: (*a*) A Critical Study of the Direct Method of Measuring the Osmotic Pressure of Proteins; (*b*) The Osmotic Pressure of Hæmoglobin and the Absence of Salts.—J. W. Fisher: Some Further Experiments on the Gyromagnetic Effect.—G. A. Elliott and Prof. I. Masson: Thermal Separation in Gaseous Mixtures.—*To be read in title only*:—Prof. O. W. Richardson: Structure in the Secondary Hydrogen Spectrum.—C. N. Hinshelwood and C. R. Prichard: The Catalytic Decomposition of Nitrous Oxide on the Surface of Gold.—E. H. Callow: The Velocity of Ice Crystallisation through Supercooled Gelatin Gels.—R. C. Johnson: Further Spectra associated with Carbon.—W. Sucksmith: The Gyromagnetic Ratio for Magnetite and Cobalt.—I. Sandeman: The Secondary Spectrum of Hydrogen at Higher Pressures.

ROYAL SOCIETY OF MEDICINE (Dermatology Section) (Annual Meeting), at 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. F. O. Bower: The Natural Classification of Ferns as a Study in Evolution (I.).

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Watergate House, Adelphi), at 7.30.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street, W.C.2), at 8.—Prof. A. M. Carr-Saunders: The History of the Limitation of Numbers.

CHEMICAL SOCIETY, at 8.—Dr. P. C. Austin and J. R. Park: The Rotatory Dispersion of Derivatives of Tartaric Acid. Part II. Acetyl Derivatives.—J. Kendall and J. E. Booge: The Stability of Additive Compounds between Esters and Acids.—J. Kendall and C. V. King: Additive Compounds in the Ternary System, Acid Ester Water.—Prof. J. F. Thorpe: The Nature of Unsaturation in Carbon Compounds. Part I. The Ethylenic Linkage.—E. H. Farmer, S. W. Switz, and Prof. J. F. Thorpe: The Nature of Unsaturation in Carbon Compounds. Part II. Conjugation (cis-hexatriene).—H. J. Emeléus: A Spectroscopic Study of the Combustion of Phosphorus Trioxide and of Phosphine.—E. L. Holmes and Dr. C. K. Ingold: The Nature of the Alternating Effect in Carbon Chains. Part III. A Comparative Study of the Directive Efficiencies of Oxygen and Nitrogen Atoms in Aromatic Substitution.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.1), at 8.15.—Lieut.-Col. J. Cunningham: Serological Observations on Relapsing Fever in Madras.

FRIDAY, MAY 22.

DIESEL ENGINE USERS' ASSOCIATION (at Engineers' Club, Coventry Street, W.1), at 3.30.—C. E. Foster: Pyrometry of Exhaust Temperatures of Internal Combustion Engines.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir Alfred Chatterton: The Industrial Progress of the Mysore State.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Prof. L. S. Ornstein: The Intensity of Spectral Lines—Measurement and Theory (Lecture).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. E. A. Allcut: Some Tests on a Two-Stroke Cycle Oil-Engine.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—G. J. T. Walford: The Photography of Architecture: a Thrice-told Tale.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. Thorne M. Carpenter: The Nutrition Laboratory of the Carnegie Institution of Washington and its Investigations on the Metabolism of Man and Animals.

SATURDAY, MAY 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. Dr. E. M. Walker: Democracy in the Ancient World (I.).

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Brighton), at 3.30.—Dr. D. Forbes: The Climate of Brighton.

FREE PUBLIC LECTURES.

MONDAY, MAY 18.

BIRKBECK COLLEGE, at 5.30.—Sir Richard Paget, Bart.: The Nature and Mechanism of Human Speech.

WEDNESDAY, MAY 20.

SCHOOL OF ORIENTAL STUDIES, at 5.30.—Dr. D. G. Hogarth: The Origin and Character of the Hittite Civilisation. (Succeeding Lecture on May 21.)

THURSDAY, MAY 21.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Prof. E. W. MacBride: The Inheritance of Acquired Qualities.

FRIDAY, MAY 22.

BIRKBECK COLLEGE, at 8.—Prof. F. O. Bower: Personal Reminiscences of Botany in the Victorian Age—and after.