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Physique, Nutrition and National Health

THE incursions of the Lords and Commons into regions where the voice of science should be, and is occasionally, heard, are always of interest to the scientific worker. A notable debate of this kind was held on November 10 in the House of Lords on the Government's declared intention to raise the general standard of physical fitness, and especially that of the young. The subject was first introduced by the Chancellor of the Exchequer in an address to the Conservative Party at Margate on October 2, and was afterwards mentioned in the King's Speech to Parliament on November 3. As on neither of these occasions was any reference made to the subject of national nutrition, and as no responsible minister can be unaware of the relation between national nutrition and national health, one can only assume that the Government does not propose to attack the major issue, with all its far-reaching implications.

However, as Mr. Gladstone said, it is always best to take the charitable view, especially in politics, and it may be that the Government took its cue from the recent disclosure that recruiting for the Army has been seriously affected by the large proportion of rejections on medical grounds. In the Lords' debate, this aspect was emphasized by Field-Marshal Lord Milne, who recalled that in 1932 no less than 57 per cent of would-be recruits was refused from this cause, and that about 25 per cent is usually rejected by the recruiting officers prior to medical examination. Lord Milne urged the necessity for improved and extended physical education of a non-military type, and regretted that, outside the Services, there is a great shortage of qualified instructors.

Although it is to some extent fallacious to argue from a section of the community to the whole community—for recruits are not drawn from the better-to-do classes who are well-nourished from infancy onwards and have ample opportunities for regular physical exercise—no one will deny the value of a good physique ; but adequate nourishment is of prior importance. This view was well brought out by Lord Horder. Fitness can never be obtained by physical measures, be they educational or recreative ; more basic and imperative are food, shelter, air and leisure. The Ministries of Health and Labour, and the Board of Education must continue their present good work ; their methods, however, must be intensified and expedited, and more co-operation is needed. Government offices are necessarily departmental : why must they be so compartmental ? The national interest must be aroused ; and the cost need not frighten us ; it would be very small compared with the cost of revolutions elsewhere. So far we have spent nothing on bloodshed, and we have retained the greatest of all our assets—individual freedom. Regimentation is not wanted ; if our people are given the modest requirements of security at home and security of sustenance, their sturdy common sense will do the rest. Democracy, and especially a democracy asked to be physically fit, advances on its stomach.

Lord Dawson of Penn asked that the subject be viewed from the wider point of view of eugenics. Although we are to some extent neglecting the laws of sound breeding, and hence must be careful, it would be wrong to say that as a nation we are deteriorating. Inspection of our elementary

schools, notably in London, would corroborate this view; but deficiencies do exist, more particularly among adolescents in factories, and are to be seen among hikers and Territorials, who, although they may be good at games, yet possess bodily defects that bode ill for their future health. The boys and girls of to-day may be taller, stouter and heavier than their predecessors, but mere bulk of frame is not evidence of fitness. The demands on our race are greater than ever; and the defects which compel us to take stock of the present situation go deeper than political considerations. By correcting Nature's methods of a high birth-rate and a high death-rate, by allowing the unfit to survive and multiply their kind, we have incurred the heavy responsibility of exercising selection ourselves, so as to prevent the unfit from vitiating the race. While securing for the child of average abilities every opportunity in the limited sphere of usefulness for which it is cast, we should sieve out the fittest at the ages of, say, fifteen and sixteen or seventeen years, and spare no expense in pushing them forward; and at each stage, mind and character must be tested as well as body.

By saving our unfit children we are harming the community, but we are striving to repair the damage by having fewer and fitter children. It is a fact that the smaller families of to-day have a higher proportion of fitter children; and the mothers of those children appear to be better than those of any previous generation. Contraception is very closely related to the infant death-rate. Whereas formerly twelve pregnancies resulted in five children reared, to-day they result in ten; so that unless families are to become impossibly large, contraception must be practised. At the same time, we do not want too small a population; an appeal for adequate parenthood is needed, and would be answered if it were based on reasoned arguments. The inherently unfit, including the 250,000 mental defectives, should be discouraged from reproduction. The medical profession is always being exhorted to think in terms of prevention; why therefore should it not use measures to prevent the birth of children who are not wanted, who are a misery to themselves and their parents, and damaging to the race? To-day doctors dare not offer relief from the dangers of parenthood owing to the operation of a law which was passed centuries ago to prevent maiming as an escape from military service. That law was never meant to apply to any skilled profession, and medical men should be exempted from its scope.

The Earl of Listowel maintained that malnutrition is the root cause of poor physique; he quoted Sir John Orr's findings to the effect that about half the population is suffering from inadequate nourishment, and stated that increased attention to sports or physical training can never mitigate the ill effects of a bad diet. The main problem, he said, is how to increase the purchasing power of the working-class family and to reduce the cost of foods that are essential to health.

The discussion is thus seen to have covered a wide field and to have been remarkable for the contributions of the two eminent medical men who took part in it. On the whole, perhaps too little attention was given to the underlying economic aspects of the problems involved. It was, for example, not pointed out that increased physical exercise must entail an increased consumption of energy-producing foods: the human engine must have more fuel if it takes in more oxygen; and the extra supply of food must be made accessible. The Government, fortunately, does not contemplate compulsion; but it realizes that "financial aid will have to be considered", though the main burden is to fall on local authorities and on existing voluntary institutions.

Another omission was any reference to the urgent need of a census of distribution and consumption. If, as many believe, adequate nutrition can only be achieved by raising wages or lowering prices, in lieu of Government subsidies and doles in cash or kind, it is of the utmost importance to know the causes and the extent of the wastes that are now alleged to occur in distribution and consumption; and accurate statistical data on these points are seriously lacking. While such a census is being compiled, progress could be made by undertaking some accurate social-economic experiments like that which was carried out last year by the Potato Marketing Board at Bishop Auckland.

Lastly, poverty is one of the main causes of ill-health and poor physique not only because it involves deprivation of certain essential foodstuffs and a bad environment, but also because it imposes a great mental strain upon those who suffer from it. This truth must have been in the mind of Rousseau when he wrote, nearly two hundred years ago, that "Un corps débile affaiblit l'âme".

The Receding Horizon

The Realm of the Nebulae

By Edwin Hubble. (Yale University: Mrs. Hepsa Ely Silliman Memorial Lectures.) Pp. xiii+210+15 plates. (London: Oxford University Press, 1936.) 12*s*. 6*d*. net.

"THE history of astronomy is a history of receding horizons." So the author tells us in his first chapter, and sets to work to record, in simple language and with much charm, the story of the recent enlargement of the horizon of the visible universe. This is so obviously a task for giant telescopes, that we naturally expect to find that the great bulk of the work has been done at Mount Wilson. Indeed the author himself has contributed the lion's share, but he has gathered round him a group of very able collaborators, and their labours and thoughts have been so interwoven that "the individual often speaks for the group".

It is a chapter of scientific history which has stirred the imagination not only of professional astronomers, but also of the public at large. The greatest popular appeal is undoubtedly made by the immense size of the now known universe, and its corollary—the relative insignificance of our home in space—although it is not easy to see how a further million million-fold increase in the volume of the visible universe can add much to what Galileo had already achieved in 1610. So recently as twenty years ago, many astronomers were inclined to regard the spiral nebulæ as members of the Galactic System, thereby limiting the visible universe to a radius of perhaps 50,000 light years. Dr. Hubble now tells us (p. 191) that the average distance of the faintest visible nebulæ is of the order of 500,000,000 light-years: "images of still fainter nebulæ, which cannot be distinguished from stars, are recorded on the photographic plates", but "it is improbable that any object has been recorded whose distance is double the average distance mentioned above".

These nebulæ have an average mass of about 10^{11} suns, and each shines with the light of about 10^{9} suns (p. 180). Within the limiting horizon at 500 million light-years' distance, about 100 million nebulæ are to be expected (p. 191), which means that nebulæ are scattered over the face of the sky at the rate of some 2,400 for every square degree. In the direction of the galactic poles, where the obscuring matter between us and outer space is least, some such number can actually be seen telescopically, so that in these directions we actually see more nebulæ than stars (p. 191). The nebulæ are to all appearances receding from us at immense speeds, those which are already farthest away running fastest; their speeds are about 101 miles per second for every million light-years of distance. If this relation between distance and speed were exact, nebulæ at the limiting distance of 500 million light-years would be receding at 50,500 miles a second, but nebulæ at a greater distance than about 250 million light-years do not emit enough light for their speeds to be deduced spectroscopically, so that the highest speeds so far definitely recorded are 24,500 and 26,000 miles a second—about a seventh of the velocity of light—from clusters in Boötes and Ursa Major respectively.

Such is the arresting feast of 'plums' which Dr. Hubble might have served up in sensational setting had he elected to play the sensation-monger. He has preferred, and we will all thank him, to give a straightforward record of patient and often laborious work, carried through with a skill, persistence and flair which often remind us of Faraday. He sees the whole exploration as "a case history of scientific research in a rather simple form" (p. 6), and this determines the style of his record.

A few pages of general astronomy, written to put the layman in a position to understand what follows, introduce us to novæ, Cepheid variables and the period-luminosity law for the latter. After this the record is chronological. In 1914 Slipher published a list of radial velocities of nebulæ, and in 1917 various photographic plates were found to carry records of a number of novæ which had appeared in the Andromeda nebula from 1885 on. The extreme faintness of the novæ and the large speeds of the nebulæ both suggested that the latter must be very remote, and almost certainly beyond the confines of the Galactic System. In 1924 the question was decisively settled by Hubble himself. He succeeded in resolving parts of a few of the nearest nebulæ into swarms of stars, and as these included a number of Cepheid variables, the distances of the nebulæ could at once be calculated from the periods of these variables. The distances proved to be nearly a million light-years, showing that the nebulæ were well outside the galaxy.

The next big advance was the classification of nebulæ into standard types, and the discovery, again by Hubble himself, that all the nebulæ of any one type exhibited the same surface-brightness. This suggested that all nebulæ of the same type were similar articles, and so gave a means of estimating the distances of all nebulæ whose type could be determined. This in turn made it possible to plot out the distribution of nebulæ in space.

Finally, we come to a discussion of the apparent recessions of the nebulæ, for which the author prefers the non-committal description "reddening of the light". The main labourer in this part of the field has been Milton Humason, using the remarkable Rayton lens of focal ratio f 0·6. The still more speedy f 0·35 lens designed by R. J. Bracey is not yet in use. Humason has measured the velocities of about 150 nebulæ and clusters of nebulæ, and their close agreement with the velocity-distance relation (101 miles a second for each million light-years of distance) is very remarkable, especially in the case of the clusters, where the superposed random motions of individual nebulæ average out.

So far the author has been an observer writing solely of observers and observations, but he is now compelled (a little regretfully ?) to admit the impossibility of keeping observation and theory in distinct compartments.

"As we look out into space, we look back into time. The light left the twenty-first magnitude nebulæ perhaps 120 million years before it passed the twentieth magnitude nebulæ, and 250 million years before it reached the 18·5 magnitude nebulæ. During these immense periods the nebulæ, if red shifts were velocity-shifts, would have receded to appreciably greater distances than those estimated from their apparent faintness. Thus the observed distribution would require corrections to reduce it to a 'simultaneous description'. Attempts to determine the corrections . . . force the research into the field of relativistic cosmology".

This leads to an all too brief discussion—only four pages—of cosmology, in which the author reaches the arresting conclusion that two schemes at most are consistent with the observed distribution of nebulæ in space. In one, the so-called "velocity-shifts" do not result from velocities at all, so that the observed reddening of the light must be the result of some "hitherto unrecognised principle whose implications are unknown". In the second, the universe is "very small". "In order to save the velocity-shifts, we would be forced to conclude that the universe is so small that we are now observing a large fraction of the whole." And this second alternative seems almost—but not quite—ruled out by the low density of matter in space.

Thus the book ends, as the author says, "on a note of uncertainty. And necessarily so. With increasing distance our knowledge fades, and fades rapidly. Eventually we reach the dim boundary—the utmost limits of our telescopes. There we measure shadows, and we search among ghostly errors of measurement for landmarks that are scarcely more substantial".

In this way, after conducting us to the absolute frontiers both of knowledge and of the astronomical universe, Dr. Hubble leaves us. We regretfully but gratefully take our farewell, with the hope that many years of health and vigour may be in store for him, to enable him to carry on his work with a yet larger telescope, and perchance to stretch the visible universe to many times its present dimensions. J. H. J.

Evolution of the Elephants

Proboscidea :
a Monograph of the Discovery, Evolution, Migration and Extinction of the Mastodonts and Elephants of the World. By Prof. Henry Fairfield Osborn. Edited by Mabel Rice Percy. Vol. 1 : Moeritherioidea, Deinotherioidea, Mastodontoidea. (Published on the J. Pierpont Morgan Fund by the Trustees of the American Museum of Natural History.) Pp. xl+802+13 plates. (New York : American Museum Press, 1936.) 5 dollars.

SINCE the discoveries of the late Dr. C. W. Andrews and Mr. H. J. L. Beadnell in Egypt at the beginning of this century, the origin and evolution of the elephants seem to have become clear. They began at the dawn of the Tertiary period in northern Africa as small amphibious pig-shaped hoofed mammals, with a nearly complete set of teeth but the second pair of incisors above and below growing large to become tusks and predominate over the others. In the course of ages, while the primitive elephants developed into larger and less amphibious animals with longer legs, the neck always remained short, so that the head and jaws had to lengthen to reach the ground. The bone of the lower jaw continually lengthened for this purpose, but that of the upper jaw did not do so, and the extension of the face was thus left entirely without hard parts. Throughout the middle portion of the Tertiary period, the long soft face was supported only by the rigid lower jaw. Then in the elephants of later Tertiary times the lower jaw began to shorten, until eventually it left the soft face hanging downwards as the familiar proboscis.

About thirty years ago, the late Prof. H. F. Osborn started to recount this fascinating story in detail. After that time he devoted much labour to the collection, study and description of the requisite fossils ; and when he died in 1935 he

had nearly completed an exhaustive volume on the subject, which has just been published by the American Museum of Natural History with the aid of the J. Pierpont Morgan fund. It is one of the most handsome contributions ever made to palæontology, beautifully printed and excellently illustrated.

At the outset, Prof. Osborn remarks that his selection of generic names may give "a shock to many zoologists", but he has decided to respect "soundly established usage and commonsense". His nomenclature can therefore be readily understood by those who are familiar with the classic writings on Proboscidea. The technical definitions of species, genera and higher groups are supplemented by numerous discussions of relationships; and there are useful synoptical tables of comparison, measurements, and geological and geographical distribution. Most important of all perhaps are the remarkable illustrations, which include photographic reproductions of nearly all the published figures of fossil proboscidean remains, besides numerous new figures that are often conveniently arranged in groups for comparison. To these are added maps showing the distribution of the various species, genera and families, and also striking restorations of the possible appearance of the extinct proboscideans when they were alive.

The small *Moeritherium*, of which the greater part of the skeleton has been found in the Upper Eocene and Lower Oligocene deposits of Egypt, is still the only known ancestral proboscidean in which the face has not yet begun to develop into a proboscis. Its skeleton seems to show that the animal was more adapted for an aquatic life than the hippopotamus, and it probably fed on succulent plants mainly under water. The many resemblances of *Moeritherium* to the aquatic mammals of the order Sirenia are thus very interesting, and there cannot be much doubt that common ancestors of the proboscideans and sirenians existed somewhere during the Cretaceous period. As neither *Moeritherium* nor any of its allies has hitherto been discovered outside Egypt, Africa still appears to be the region in which the search for these ancestors may be most hopefully made.

Contemporary with the latest species of *Moeritherium* in the Lower Oligocene of Egypt are two more advanced proboscideans, *Palæomastodon* and *Phiomia*, in which there is a long soft face supported by the elongated front of the lower jaw. As might be expected, the species of these genera are larger than those of *Moeritherium* and they seem to have lived in forests, hence the comparative scarcity of their fossil remains. Very curiously, it is difficult to regard them as the direct descendants of *Moeritherium* which flourished earlier in the same region, and Prof. Osborn considers that they represent the beginning of two distinct groups of mastodonts which are traceable in later Tertiary rocks of both the Old and New World.

A little later, in the Lower Miocene of Africa, Europe and Asia, *Deinotherium* suddenly appears. It ranges upwards to the Middle Pliocene in Europe and even to the Pleistocene in Africa, but it does not appear to have reached America. Although the species increase in size until the latest and largest attain the dimensions of the largest true elephants, they all keep comparatively small crushing teeth much like those of the primitive *Moeritherium*, and all have lost the upper tusks. As the crushing teeth are adapted for succulent food, and as the downwardly turned lower tusks might well be used to hold on to a bank, *Deinotherium* was long supposed to have been an aquatic animal; but Prof. Osborn has pointed out that the skeleton which has been discovered in recent years is as completely adapted for life on land as that of the ordinary elephants. It is therefore interesting to observe that many of the true mastodonts—the Rhynchorostrinæ of both the Old and New World—are now known to have had the same downwardly directed lower tusks.

The mastodonts ended everywhere in large animals with a short skull and lower jaw and a freely hanging proboscis, like the corresponding parts of a typical elephant. All their earlier representatives, however, had the long soft face resting on the bone of the elongated lower jaw, and they exhibited astonishing variety in this arrangement. The account of the variations occupies the greater part of Prof. Osborn's volume, and it suggests that there were several distinct lineages of primitive mastodonts evolving in nearly parallel directions. In some, such as *Platybelodon* from the Upper Miocene of Mongolia and an allied genus from the Pliocene of Nebraska, the lower tusks become large and flat, with a sharp edge, giving the front of the lower jaw the appearance of a shovel. These tusks are strengthened with a bundle of parallel cylindrical rods of dentine which occupy the ordinary position of the pulp cavity. In some mastodonts, such as *Serridentinus*, the lower tusks are comparatively small, while in others the long and slender lower jaw loses its tusks. Sometimes, as in *Megabelodon* from the Lower Pliocene of Nebraska, the slender tuskless lower jaw expands at the end into a 'spoonbill' where the roughened bone seems to have been covered with a hard dermal pad. In several lineages there is an ultimate tendency to the shortening of the lower jaw, but it is at present impossible to decide which became extinct and which led to the mastodonts with a completed proboscis.

The best known of the later mastodonts with an elephant-like proboscis is still the *Mastodon americanus*, to which Prof. Osborn devotes thirty

well-illustrated pages. It occurs both in the pre-glacial Pleistocene formations and in many post-glacial deposits in North America, and the molar teeth in the latest variety seem to differ from the earlier teeth in having sharper ridges. Teeth from southern Russia and China have been ascribed to the same species, but Prof. Osborn decided that these were wrongly named.

The next best known later mastodonts are those from the Pleistocene of South America, which are no longer referred to *Mastodon*, but to two or three distinct genera. Prof. Osborn thinks that the immediate ancestors of these proboscideans are recognizable in the Pliocene of North America, whence they must have migrated.

In the present volume, Prof. Osborn makes a great addition to our knowledge of the fossil Proboscidea, and provides an indispensable work of reference which will take its place among the classics of palæontology. Our only regret is that the printing of the volume began so long ago as 1924, and an appendix of nearly sixty pages, bringing the subject up to date, makes much of the text obsolete. The student must begin by reading the appendix, and then annotate the volume where the annotation has not already been done by footnotes or disturbing intercalations in black type. Even the reading is not easy, owing to the method of compilation, frequent repetition, and lack of literary style. A second volume, on the typical elephants, is due to be published next year, and we may express the hope that when it was unfortunately left by the author, the printing had not progressed too far to avoid some of the difficulties which the first volume presents.

A. S. W.

The Layman's Library

The University Series: Highlights of Modern Knowledge

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THE different aspects of the task which faces a reviewer of scientific works may be grouped roughly under three heads. He should tell his readers in some detail the topics dealt with in the work under review; he should explain something of its scope; and he should attempt, with becoming modesty, to assess the value of the contribution made by the author to the spread or to the advancement of knowledge. Exigencies of space warrant some modification of this process when one is attempting an omnibus review. It is impossible, for example, to analyse separately the contents of twelve volumes, and the titles must be taken as indicating sufficiently clearly the topics dealt with.

The scope of the volumes may best be illustrated from a consideration of the audiences to whom such works may, or may not be expected to appeal. Taking the series before us as a whole, the volumes which comprise it are admirably fitted to assist students who are members of adult education classes of one or other of the many types in existence; they will assist workers in one branch of science to learn something of what is happening in regions unfamiliar to them; they are very suitable for a school library; and they will certainly prove useful aids to the inquiring layman who would know something of the trend of scientific thought in this restless universe of ours. The series is not likely to be of much use to the specialist or to the honours student seeking that conspectus of his subject which it is part of his business to make for himself. He may, however, find the volumes of very deep interest as illustrating the difficult art of presenting technical topics in elementary, and yet accurate, fashion.

Finally, have the authors succeeded in their task of limning an accurate and convincing picture

of the state of existing knowledge of the topics with which they have concerned themselves? Obviously, an author who deals with sciences which have broken away from the simpler traditions of the nineteenth century and which employ a highly specialized jargon is, on a surface view, faced with a problem much more difficult than that which confronts an author dealing with a science qualitative in its outlook, and employing a not very highly specialized language. This is not to say that complex notions and arguments are the exclusive possession of him who employs a mathematical or logical notation. Far from it. Such a technique, once acquired, may become a potent weapon for saving thought and for grinding out results in purely mechanical fashion. Contrariwise, some most difficult and involved arguments may be developed without the aid of a single symbol. Still, when an argument is essentially mathematical, is fundamentally complex, and presents novel ideas, the task of the writer who would tell the story in simple language is not an enviable one.

The authors of the works under notice must be deemed to have succeeded in their task. The treatment is, in most instances, a little discursive in character, but that can scarcely be reckoned a fault, having regard to the audience to which the volumes may be supposed to appeal. They leave the reader with a clear picture of the subject-matter, and, while providing plenty of background, they do not in general overwhelm him with a mass of unessential detail.

This is not to assert that the volumes are completely free from error. On the contrary, there are, here and there, examples of unevenness of presentation and of obscurities of statement which may, occasionally, be positively misleading. The practice followed in some of the illustrations, of placing side by side examples of large-scale and of microscopic objects without the slightest indication of the magnification employed, is very much to be deprecated.

It is, perhaps, scarcely fair to single out for special mention one of a dozen good companions, but it is impossible to conclude this review without remarking on the admirable qualities of the volume on "Heredity and Variation".

The series is well produced and illustrated, and offers remarkably good fare at a very low cost.

N. F.
A. F.

Molecules and Morphogenesis

Order and Life

By Joseph Needham. (The Terry Lectures for 1935.) Pp. x+175. (Cambridge: At the University Press; New Haven, Conn.: Yale University Press, 1936.) 8*s*. 6*d*. net.

IN another context, Dr. Needham himself has likened the biochemist and the embryologist to the gangs drilling a tunnel from each end, and now just about to establish contact with one another. In fact, this contact may be said to have occurred, for knowledge of the chemical structure of protein molecules bids fair to throw light on the structure and properties of fibres (not excluding muscle); and the properties of liquid crystals can now be ascribed to certain living units.

Dr. Needham, whose researches entitle him to a place in the gangs of workers at both ends of the tunnel, has put forward a suggestion which may prove to be the turning point in the experimental attack on a problem of great topical interest and importance; namely, the morphogenetic fields, which he compares with the zone of influence which surrounds molecules possessed of the property of inducing orientation in neighbouring molecules. Cholesteric paracrystals have this property, and sterol-like substances are now known to be concerned in the morphogenetic activities of the 'organizer'.

The author's attitude to the philosophical position of biology is of great interest. Philosophers may find difficulty in accepting what they will probably believe to be Dr. Needham's attitude towards the Aristotelian distinction between matter and form. But Dr. Needham has done an inestimable service to 'natural philosophy' in emphasizing that the organizing relations in virtue of which organisms are more than the sums of their organs are legitimate objects for experimental analysis, and in showing that there is no haven for vitalism either in the indeterminacy principle of physical theory or in the mistaken notion that analysis of living organisms kills them and yields knowledge only of inorganic matter.

Dr. Needham pleads with logically irresistible eloquence for the recognition of the validity of a "biological level", and introduces to Western readers the often neglected writings of Marxist philosophers on this point. No doubt some biologists will discover that they have been thinking along similar lines. No biologist can afford not to read and ponder over this book.

G. R. DE BEER.

Mathematics for Technical Students

By Frederick G. W. Brown. Part 1 (First Year Course). Pp. x+215+xviii. 3*s*. Part 2 (Second Year Course). Pp. x+217–491+xxv. 3*s*. 6*d*. (London: Macmillan and Co., Ltd., 1936.)

It is to be hoped that all teachers of mathematics in technical schools and evening institutes will have the opportunity of seeing these two books; for they provide a preliminary two-year course in mathematics which is exactly what is wanted at the present time.

After a revision of the simple operations of arithmetic, the student is introduced to the notation of algebra and made to see the value of this new weapon, until, finally, he should be able to solve arithmetical problems by means of a simple equation. This is followed by a short informal course of theoretical geometry; time spent on this section will be amply rewarded in the later stages of the course.

The concluding chapters of Part 1 deal with applications of previous work to the area of simple rectilinear figures and circles and to the volume of bodies of uniform cross-section. Some teachers will no doubt prefer to take this work earlier in the course—and there is much to be said for this view; teachers will find no difficulty in doing this.

Part 2 is necessarily more formal in character than Part 1. The first three chapters deal with logarithms and their many applications, plenty of useful exercises being provided; simple equations in two unknowns, fractions, harder fractions and quadratic equations complete the work in algebra. The remaining chapters deal with numerical trigonometry, harder mensuration and graphs, and applications of Simpson's rule. This last chapter could serve as a link in an introduction to the calculus for those students who proceed further with mathematics.

Typical sets of examination papers and useful mathematical tables are provided at the end of the book.

Teachers in evening schools have many problems to meet: the minimum number of students to form a class, intermittent attendance, the weariness of students who have done a day's work and the difficulty of an adequate supply of text-books; but if evening school students could handle and use these two volumes, examiners would soon find a considerable improvement in elementary mathematics.

L. C.

A Text-Book of Physical Chemistry

By Sylvanus J. Smith. Pp. xii+355. (London: Macmillan and Co., Ltd., 1936.) 5*s*. 6*d*.

This book is intended primarily to provide a course of physical chemistry for students preparing for the Higher School Certificate Examinations in science, also for candidates for university open scholarships, and for the First Examination for medical degrees. Such students will find the book very useful. In its 345 pages of text, the author more than covers the field of physical chemistry required by these examinations.

The subject matter is generally brought right up to date, but the older theories are also given their fair place. The section on the structure of the atomic nucleus, however, should now include a mention of the modern theory of its constitution from protons and neutrons. The excellent chapters on catalysis and colloids touch on many important industrial applications. A good selection of examination questions is given at the end of each chapter, with answers to the numerical examples in the appendix. The text is illustrated throughout with clear and helpful diagrams. Fig. 87 cannot correctly be described as the "Bunsen-Roscoe Actinometer" since it shows a mercury meniscus used in contact with chlorine gas.

The treatment is neither too elementary nor too advanced, and seems to be just the right standard required by the examinations for which the book is written.

Graphical Solutions

By Prof. Charles O. Mackey. Pp. vii+130. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1936.) 12*s*. 6*d*. net.

Graphical and mechanical representations of practical equations are especially useful to the engineer, and this volume has been written to provide a systematic course in the subject. The first four chapters are devoted to stationary adjacent and sliding scales; network or intersection and alignment charts for equations in three variables and combinations of all these methods of solution. In the final chapter, the fitting of equations to experimental data is discussed. The treatment is quite elementary and involves only a working knowledge of logarithms, algebra and plane geometry, while a little calculus is required in the section on empirical equations. With the volume is provided a very clear reproduction of the logarithmic scales prepared by the late Prof. Lipka.

To those who have to deal with practical graphical computation, this book should prove very useful, instructive and interesting.

Sammlung chemischer und chemischtechnischer Vorträge

Begründet von F. B. Ahrens. Herausgegeben von Prof. Dr. R. Pummerer-Erlangen. Neue Folge Heft 33: Die Azoxyverbindungen: eine Monographie. Von Dr. Eugen Müller. Pp. 40. (Stuttgart: Ferdinand Enke, 1936.) 3.40 gold marks.

The mode of representing the structure of the important class of the azoxy-compounds has recently undergone a change, based originally on chemical evidence provided by Angeli, and confirmed by the isolation of optically active substances by Marvel and E. Müller. The new formulation is a consequence also of the physical properties of the substances. The present monograph sets out clearly and accurately the grounds for the present representation of the structure of the azoxy-compounds, with full references to the literature. It is a useful contribution to the literature on the organic chemistry of nitrogen.

Science in Development*

By the Right Hon. Lord Rutherford, O.M., F.R.S.

IN surveying the great tide of advance in the physical sciences during the past forty years, it is not always recognized how much the progress of discovery has been influenced, and indeed in many cases controlled, by the improvement of laboratory technique and by the development of new instruments and methods of measurement.

To appreciate the rapid changes which have occurred, it is probably simplest to contrast the laboratory equipment of to-day with that available at some well-defined epoch in the past. I choose for this purpose the year 1895, that turning point in the history of physics, which saw the discovery of X-rays, to be followed in quick succession by the discoveries of radioactivity and of the electron. This choice of year seems to me convenient as it marks a natural dividing line between the older and the newer physics.

First of all, I should like to refer to the great advantages to research in general that have followed from the invention of an efficient form of lead accumulator. Before the commercial manufacture of the accumulator, the experimenter had to rely on primary batteries for the supply of electric current in his investigations. The Daniell cell or corresponding battery was used for small currents—as, for example, in comparing resistances by the Wheatstone bridge. For the supply of currents of the order of an ampere or more, Grove's cells were often used, but these had only a working life of a few hours and had to be freshly prepared each day. When I first began some investigations on the magnetic properties of iron in 1893 at Canterbury College, Christchurch, New Zealand, I found it necessary to prepare each morning a battery of about a dozen Grove cells. This involved the cleaning and amalgamation of the zinc plates and adding the necessary acids. Fortunately, large platinum plates for the electrodes were available. I found this battery of low internal resistance a very convenient means of obtaining substantial and steady currents, but after several hours' work the battery showed obvious signs of exhaustion and accurate work with it was impossible.

In order to illustrate the provision for research forty years ago, I shall take as an example the Cavendish Laboratory, which was directed by Sir J. J. Thomson, who was then on the verge of beginning his famous experiments on the electrical conductivity in gases produced by X-rays and his investigations of the nature of the cathode rays. The equipment of the Cavendish Laboratory both for teaching and research was probably typical of the better European physical laboratories of that time. Largely due to the labours of the late Sir Richard Glazebrook and of Sir William Napier Shaw, a well-organized system of laboratory instruction had been arranged for students, and this was extended and elaborated through the years by that genius in the design of laboratory apparatus for teaching purposes, Dr. G. F. C. Searle.

While the provision for teaching and research was in general excellent in the older sciences of optics, heat, sound and properties of matter, in contrast with to-day the amount of electrical apparatus, particularly on the measuring side, was sparse and in some cases almost non-existent. Apart from reflecting galvanometers of the moving magnet and moving coil types and a tangent galvanometer, there was no portable instrument for measuring current except one very crude form of ammeter. The only portable method of measuring voltage was a rather ponderous Cardew voltmeter of the hot wire type, which was of very limited utility and accuracy. It was not until a few years later that those admirable instruments for measuring current and voltage designed by the late Mr. Edward Weston of the United States came into laboratory use. To-day, hundreds of measuring instruments of this or similar types are required in electrical research, and indeed a single experimenter may feel himself hardly used if a dozen of these instruments are not available, with appropriate wire rheostats to control the voltages and current.

Apparatus for work in electrostatics was more plentiful, including a number of types of quadrant electrometer, which, however, were usually both unreliable and capricious instruments. The quadrants were large and the needle unnecessarily heavy. The moving system was often supported by a silk fibre and the position of the needle controlled by a small magnet attached to it. A platinum wire was attached to the bottom of the needle and dipped in strong sulphuric acid, which formed the inner coating of a small glass condenser. In order to obtain a reasonable sensitivity, the needle and condenser required to be charged to a fairly high potential. This was done by charging the jar with

* From the twelfth annual Norman Lockyer Lecture of the British Science Guild, delivered on November 12.

a spark or two from an electrophorus or from a charged Leyden jar. Unless very special precautions were taken with the insulation, the charge on the condenser leaked away rapidly and the sensitivity of the electrometer varied markedly from hour to hour, while the zero of the needle was very unsteady. Under these conditions, it was difficult to make observations over any but a short period with any accuracy. Lord Kelvin, the pioneer in the construction of quadrant electrometers, had designed a more elaborate and more serviceable instrument in which the potential of the charge given to the needle could be brought to a definite value by the use of an attracted disk electrometer incorporated with the instrument. One of these electrometers, which was available in the Laboratory, was made after great effort to work satisfactorily by Prof. J. S. Townsend, and was used by him in his well-known researches on the electrification of gases and on the properties of ions in gases. This, I believe, was the first time this instrument, which was of moderate sensitivity, had been used in systematic researches of importance.

A great advance was made about 1900 when Dozalek designed a quadrant electrometer with a fine quartz suspension and a very light needle, which gave a good sensitivity when the needle was charged to the comparatively low potential of a few hundred volts.

In place of the quadrant electrometer, the tilted electroscope designed by C. T. R. Wilson in 1903 was often used. This had a low capacity and a voltage sensitivity comparable with an electrometer. Recently a very sensitive form of this instrument has been designed by H. Carmichael and used for experiments on the bursts of ionization produced by the cosmic rays. After the Great War, still more sensitive electrometers were designed; for example, a modified quadrant by Compton, and a binant electrometer of high sensitivity by Hofmann, while a robust and portable type of string electrometer of good sensitivity designed by Lindemann has proved very serviceable in many directions. At this stage, I must not omit to mention the extraordinary utility of a modified form of the gold leaf electroscope for measurement of ionization, particularly in the study of the radioactive bodies. This instrument, which had been used for detecting charge for a century or more, was developed into an accurate measuring instrument largely due to the modifications introduced by C. T. R. Wilson. In course of time the electroscope displaced the quadrant electrometer for measuring the periods of decay of radioactive bodies and for a study of the α-, β- and γ-rays.

The changes in forms of apparatus so far mentioned did not involve any essential new principle, but were rather the result of improvement in design to increase their sensitivity and reliability and to adapt the form of the instrument to meet the needs of investigators. To this period, however, belongs the development of an instrument which to my mind is the most original and wonderful in scientific history—I refer to the 'cloud' or 'expansion' chamber of C. T. R. Wilson. I had the good fortune to be present in 1895 in the Cavendish Laboratory when Wilson was examining the formation of water drops in damp dust-free air by sudden adiabatic expansion of the gas. When X-rays were discovered, Wilson at once showed that the ions produced by the X-rays in their passage through the gas acted as nuclei for the condensation of water upon them under certain conditions of supersaturation. A cloud of visible water drops was formed and in a sense each ion was rendered visible by the water drop formed round it.

The next important advance was made in 1912, when Wilson devised the modern type of expansion chamber and showed that the tracks of individual α-particles and fast electrons are rendered visible by the trail of water drops formed on the ions liberated by the passage of these flying particles through the gas. It was a wonderful advance to be able to see, so to speak, the details of the adventures of these particles in their flight through the gas. Anyone with imagination who has seen the beautiful stereoscopic photographs of the trails of swift α-particles, protons or electrons, cannot but marvel at the perfection of detail with which their short but strenuous lives are recorded. The cloud chamber has proved an invaluable aid to research in many directions and has become all-important in recent work on artificial transmutation. This instrument provides in a sense a final court of appeal in which the experimenter may place his trust. I cannot imagine anyone with the most vivid scientific imagination who could have predicted the possibility of an instrument endowed with such unique powers and potentialities.

High Vacua

Of all changes in laboratory apparatus and technique in the period under review, none has been more revolutionary in type or of more importance to the progress of science and industry in many directions than the improvements in methods of rapid production of high vacua. Vacuum research has a long history and has persistently engaged the attention of scientific men from the year 1643, when Torricelli, the assistant of Galileo, made the first mercury barometer. The first mechanical air pump was devised by von Guericke in 1650. It was a simple type of suction pump

with a well-fitting plunger and automatic leather valves, and was probably able to reduce the pressure of air in a sealed container to between 1/100 and 1/1,000 of an atmosphere.

While mechanical pumps were improved, no great advance in principle or practice of producing high vacua took place for nearly two hundred years. To be sure, many investigations were made, for example, by Hawksbee, to investigate the beautiful glow discharges observed when an electrical spark passed through a vessel containing gas at very low pressure. While mechanical pumps were often used for special purposes, the Torricelli principle was more popular and effective in producing a good vacuum.

The most important stage in the subsequent advance was the invention in 1855 of the mercury pump proper by Geissler, who used it for exhausting discharge tubes in order to illustrate the striking luminous effects which arise when the electric discharge from an induction coil is passed through the low-pressure gas contained in the tube. Such Geissler tubes were long used for illustrations in lectures, and replicas of them may still be seen to-day. The invention of the mercury pump gave the possibility of producing a really good vacuum by long-continued pumping. The advantage over the mechanical pump was due primarily to the elimination of the mechanical valve and the dead space. The mercury pump was used by Hittorf for studying the marked changes in the appearance of the electric discharge as the pressure of gas was decreased to the lowest value obtainable. He observed the conditions of production of the now well-known cathode rays and was, I think, the first experimenter to appreciate that, in order to maintain a permanently good vacuum in a sealed tube, it was necessary to 'degas' the walls of the tube and electrodes by frequent heating and long-continued bombardment by the electric discharge. In this way he produced, for the first time, a tube with so good a vacuum that an induction coil failed to produce any visible discharge through the highly rarefied gas.

The work of Hittorf was extended and improved upon by Sir William Crookes, who used a modified form of mercury pump invented by Sprengel in 1865, which could readily be made automatic in action. A number of modifications of Geissler's original pump were made from time to time, and of these the pump devised by Toepler in 1862 came into general use towards the end of the nineteenth century. When I first came to the Cavendish Laboratory in 1895, modified forms of Toepler pump, made by that skilled glassblower Mr. Everett, were in general use. One of these pumps was used by Sir J. J. Thomson in his famous experiments which proved the nature of the cathode rays. In those days, it was usual to employ a one- or two-cylinder Fleuss pump for preliminary pumping of the vessel to a pressure below 1 mm. This pump was a greatly improved form of the original mechanical air pump of von Guericke. The moving piston and working parts were covered with a layer of oil. The small quantity of air entrapped by the upward motion of the piston was forced with the oil through a spring valve. By these modifications, the efficiency of the pump in reaching a low pressure was much increased. Under good conditions a vacuum as low as 1/50 mm. could be obtained. It should be borne in mind that the production of a good cathode ray vacuum in a discharge tube in the old days was a lengthy and laborious process with the slow-acting Toepler or Sprengel pumps. Several hours pumping was required to produce a good vacuum by these methods, while to-day, with our fast diffusion pumps, a similar result can be obtained in a few minutes or even seconds. It is of interest to record that the X-ray tubes first used for radiographic purposes were all painfully exhausted by one of these early forms of mercury pump.

From the point of view of ease and simplicity in maintaining a good vacuum, the discovery of Sir James Dewar in 1904 that specially prepared charcoal was a strong absorbent of gases at low temperature has proved of great importance to science. The tube to be exhausted was connected with a side tube containing charcoal. After preliminary exhaustion with a mechanical air pump, the charcoal was immersed in liquid air, when the residual gases in the tube were rapidly absorbed by the charcoal and a high vacuum produced which could be maintained for hours. This method of producing a controllable degree of vacuum was widely used for many years in our laboratories. For example, this method was employed by Sir J. J. Thomson in his well-known experiments on the positive rays, and on account of its simplicity is still used by Aston in his investigations with the mass-spectrograph.

The last thirty years have seen great changes in our methods of rapid production of high vacua, and many new and ingenious types of fast pumps have been invented. This rapid development has been in large measure due to the remarkable powers of invention shown by Dr. Gaede, who has designed a whole series of pumps of great scientific and technical interest.

The first glass diffusion pump employing a stream of mercury vapour was described by him in 1915, and has been followed by a succession of designs of increasing efficiency. This pump, which has the advantage of containing no movable parts, can be constructed either of glass or metal, and a great variety of forms have been used,

particularly in the case of small glass pumps for ordinary laboratory use. Improvements in the design of the all-metal diffusion pump to ensure higher pumping speeds were early made by Langmuir in the United States and by Kaye in Great Britain. Although there are great varieties of these pumps both as regards size, form and construction, they all depend on the same general principle. The gas to be removed diffuses through a suitable aperture into a stream of hot mercury vapour which carries the gas away with it, the mercury vapour being afterwards condensed and the gas removed by a backing pump. The speed of exhaustion of these pumps is astoundingly fast, and theoretically there is no limit to the degree of vacuum that can be obtained. In general, a single-stage pump requires the pressure to be reduced by a fore pump from 1/10 to 1/100 mm. before the pump comes into action. Gaede has designed a 3-stage all-steel pump which begins to operate at a pressure of 20 mm. and has a high speed of exhaustion.

In the mercury diffusion pumps it is usual to employ a liquid air trap to prevent the back diffusion of the mercury vapour into the vessel to be exhausted. This is a disadvantage both from the point of view of economics and of efficiency in pumping, and has been got over by replacing mercury by a special oil which has a negligibly small vapour pressure at ordinary temperatures, so that liquid air is dispensed with. The first oil diffusion pump was constructed in Great Britain by Mr. C. R. Burch of the Metropolitan-Vickers Research Laboratory, using special oil obtained by molecular distillation. These pumps are very efficient and are very widely used, particularly for large sizes of pump where great volumes of gas have to be rapidly removed.

The invention and development of the diffusion pump has given to science a new and extraordinarily effective instrument for the rapid attainment of the highest degree of vacuum. Not only has its use greatly simplified investigations in very high vacua, but also it has made possible many new technical developments. With the aid of these fast pumps, we can maintain large vessels at such a low pressure, even when gases are pouring in through a small opening, that voltages of the order of 1 million volts can be applied without the passage of a discharge. This has made it possible to obtain streams of very fast particles, for example, protons and deuterons, which have proved so effective in studying the transmutation of the elements.

I have already mentioned incidentally some of the more fundamental discoveries that have resulted from a study of the electric discharge through rarefied gases ; for example, the production and nature of the cathode rays, the discovery of the X-rays and the development of new methods of analysis of the charged atoms and molecules produced in the discharge tube. The resolving power of this method of chemical analysis has been so improved by Aston that it has been found possible not only to show the isotopic constitution of many of the ordinary elements, but also to determine the relative masses of the atoms with high precision. The use of high vacua led to the investigation by O. W. Richardson of the copious emission of electrons from incandescent bodies—a discovery from which has originated many important industrial applications. In general, the study of processes in very high vacua has added much to our knowledge in many directions. The pioneer work of Langmuir on chemical reactions at very low pressures and on adsorption phenomena has opened a new and important field of inquiry which is still being developed. Much light has been thrown on the formation of monomolecular films on surfaces and their importance in catalytic reactions, and in general on the nature of chemical and physical forces which come into play. The use of molecular rays by Stern and Gerlach was only made possible by high vacuum technique.

I have so far only spoken of methods of producing high vacua, but in the course of this development not only have reliable methods been devised for measurements *in situ* of the residual pressure of the gas, but also great advances have been made in industrial laboratories in the technique of making metal seals with glass, for example, copper, steel and tungsten. This has made possible the production on a commercial scale of robust tubes of combined glass and metal such as are used for high-power rectifiers and oscillators. In addition, the industrial laboratories have been responsible for many improvements in technique. Many new kinds of glass have been produced and methods devised for graded glass joints, such as pyrex to soft glass and silica to pyrex. The high-frequency eddy current heater for degassing metal parts *in situ* has proved of great value, while the technique for degassing tubes, whether by heat or the electrical discharge or both together, has been highly developed. Special machines have been devised for rapid exhaustion and sealing of glass bulbs. The production of low vapour pressure oils and greases has made possible the efficient and economical oil diffusion pump and improved methods for air-tight joints.

In the development of high vacua, the mutual reaction between science and industry is illustrated in a striking way. The pioneer work of the physicist led to the development of methods of producing high vacua and to many new discoveries of the

properties of matter in rarefied gases. These new methods have been applied to industry in a great variety of ways, and in turn have provided the physicist not only with improved forms of apparatus but also with many new technical devices which have made possible still further progress in pure physics. For example, the production on a commercial scale of efficient amplifiers, thyratrons and rectifiers, has provided the physicist with new and powerful weapons for extending his investigations in many directions. These developments have made possible not only the production of streams of swift particles for work on transmutation, but also methods of automatic counting of the swift particles which result from the transformations. These new counting methods owe much to the ingenuity of Dr. Wynn-Williams.

On account of these great improvements in technique and methods, progress in our knowledge has been so accelerated in the last few years that it is not easy for the investigator to keep in close touch with the rapidity of advance of new knowledge.

There have also followed great improvements in the efficient production of X-rays, and I must not omit to mention the development by Coolidge of the hot cathode, highly exhausted X-ray tube, known by his name, which has proved so valuable both for scientific and medical purposes. I could give many other illustrations of the beneficial effects of this close mutual relation between the workers in our university and technical laboratories —a happy relation which cannot fail to be of good augury for the future.

J. L. Macadam: Father of Modern Road-Making

By Dr. R. Quarendon

THE centenary of the death of J. L. Macadam comes at a particularly fitting time, because the history of the roads is passing through a stage very similar to that which marked the years of Macadam's greatest activity. Then, as now, transport was being handicapped by the lack of modern highways, and the march of progress hindered by out-of-date conditions.

The roads were in many cases little better than they had been in the Middle Ages. Two hundred years of neglect, ignorance and prejudice had left them in an appalling state of disrepair. Journeys which now take hours lasted for days or even weeks, and were undertaken only after anxious consideration.

Parliament had done its best to suppress the wheeled vehicle, or to regulate it as a nuisance. Act after Act was passed restricting the loads to be carried, the number of horses per wagon, and the size and shape of the wheels. Excepting the 22,000 miles of turnpikes, the repair of the roads was in the hands of the parishes, who were empowered to conscript labour—known as 'statute labour'—whose services were given with the greatest unwillingness. The 1,100 turnpike trusts were run in many cases by ignorant and incompetent men who took the revenues but spent little on repairs.

Lacking engineering training, Macadam seems to have developed his method from first principles. It was at thirty years of age, after having gained a fortune as an agent for the sale of prizes in the American War of Independence, that he returned to Scotland to begin his experiments. As magistrate, deputy lieutenant and road trustee for Ayrshire, he was able to give considerable time to this work. His efforts met with the greatest opposition, in spite of the fact that it was his own money which was being spent on the investigation. The Scots people did not want a hard metalled road. They preferred to drive their cattle and geese to market over the soft earth roads which then prevailed.

For many years, Macadam was unable to test his ideas on a suitable scale. In 1798 he was appointed agent for revictualling the Navy in the western ports, and his duties afforded little time for road research. It was not until 1815, when he became surveyor-general of the Bristol roads, that the opportunity for which he had been waiting arrived.

The usual method of making a road in those days was to dig earth from ditches cut along the side, and to pile it in the middle, in the pious hope that the traffic would beat it into a hard surface. Sometimes gravel was thrown on top, but in wet weather the earth and gravel soon became churned into a pebbly mud. Although he was a pioneer of his day, all Macadam really did was to provide a durable, properly drained bed of road metal. He excavated the earth to a depth of 6–10 inches, according to the nature of the subsoil, and filled in the trench with layers of stone broken to one-inch cubes. The traffic

was allowed to consolidate the broken stone until it knit together to form a hard smooth surface impervious to water.

Macadam's methods differed from those of his contemporary Telford in two ways. He used no large blocks of stone as a foundation, because he maintained that a soft, elastic base which 'gave' a little would withstand heavy traffic much better. Neither would he have gravel or similar binding material in the surface layer, as Telford recommended.

Many roads which are nowadays described as 'macadam' are not macadam at all, according to the strict letter of the method described by the inventor of the process. They are laid with small material mixed with the larger pieces to act as a binder, a thing which Macadam absolutely forbade. His was a counsel of perfection, however, because unless the stones have the correct shape they will not bed down without admixture to form the regular mosaic characteristic of the true macadam.

Macadam's energy and persistence gradually bore fruit. The enormous improvement of the roads under his jurisdiction became generally known, and in 1823 he described his methods in evidence before a committee of the House of Commons. As a result, macadam replaced the granite causeways in many of London's important streets, in spite of the dismal predictions of people who opposed the change. Southey wrote that "macadamising the streets of London is likely to prove quackadamising", but that opinion was probably due more to his admiration for Telford than to any critical examination of the available facts.

Before recognition came to him, Macadam spent £5,000 out of his own pocket in developing his method, and travelled 30,000 miles to help officials and others who asked for his advice. The greatly increased speed of the coaches gives a striking proof of the soundness of his ideas, which made English roads the best in the world. Whereas the journey from London to Edinburgh used to take 14–16 days, the time had fallen by 1830 to 40 hours—a remarkable improvement. In recognition of his services, Parliament voted him £10,000, which he accepted, and he was offered a knighthood, which he declined. His son accepted the honour in his stead.

Macadam described his researches in his memoir: "A Practical Essay on the Scientific Repair and Preservation of Public Roads", published in 1819. Other works on the same subject appeared from his pen. He died on November 26, 1836, in his eighty-first year at Moffat, near Telford's birthplace, on one of his frequent visits to the scenes of his boyhood.

Although many of Macadam's roads remain, they can no longer compete with the concrete 'speedways' of the modern era. They belong to a quieter age, when the horse jogged leisurely along the country lanes, and the passengers had time to notice the honeysuckle in the hedgerows. Yet they were our roads for more than a century, and it will be many years before the man who made them is forgotten.

Obituary

Prof. W. A. Parks, F.R.S.

THE death occurred in Toronto, on October 3, of Prof. W. A. Parks, professor of geology in the University of Toronto. William Arthur Parks was born in Hamilton, Ontario, in 1868, and educated in Bowmanville High School and the University of Toronto. With his university he was to be associated for the rest of his life, and his career is a long list of ascending responsibilities. He graduated B.A. in 1892, became a 'fellow of geology' in the following year, and was in turn instructor, lecturer and, in 1905, associate professor. In 1913 he was appointed director of the newly constituted Royal Ontario Museum of Palæontology, an institution which has greatly developed under his guidance. From 1916 until 1922, Dr. Parks was professor of palæontology and in the latter year he was promoted to the full chair of geology.

With his large department and his museum ever increasing in importance, Prof. Parks was fully occupied, yet he found time to conduct expeditions in northern Ontario and to undertake research in various directions. He was particularly interested in American Stromatoporoidea and also published a series of papers on the geology and palæontology of the Toronto district. He was also interested in, and published a comprehensive account of, the building and ornamental stones of Canada.

In his later years, attracted by the rich material in his museum, Prof. Parks turned to vertebrate palæontology and described many new genera and species of highly interesting dinosaurs. Despite these numerous activities he found time for service on outside bodies. He was president of Section C (Geology) of the British Association at Southampton in 1925, president of the Royal Society of Canada, 1925–26, president of the Palæontological Society of America, 1926–27, and president of the Royal Canadian Institute, 1928–29. His talents were recognized in Great Britain by his election to the Royal Society in 1934.

For the last few years, Prof. Parks had patiently borne much serious illness, but his interest in his

science and in his newly and greatly extended museum was not diminished. His death is a great loss to Canadian geology, and the sympathy of all who knew his pleasant and kindly personality will go out to his widow and his son. W. E. S.

Mr. D. A. Jones

MR. DANIEL ANGELL JONES, formerly secretary and afterwards president of the British Bryological Society, who died at Bristol on October 6 in his seventy-sixth year, has long been a familiar figure among Welsh botanists. Whilst he was a schoolmaster at Harlech his assistance was often invoked by botanists interested in the flora of North Wales, especially of Merionethshire and Carnarvonshire. His keen eye and wonderful memory of detail, locality and habitat were well known to phanerogamic botanists, and in the detection of bryophytes and lichens he was unrivalled.

During the present century, the story of Mr. Jones's life is largely linked up with that of the British Bryological Society. In 1895, a number of bryological enthusiasts formed the Moss Exchange Club. The main purpose was the exchange of specimens, but supplementary to this there was a desire to extend the knowledge of the distribution of bryophytes in Great Britain, as nothing in regard to this had been published since the issue of the second edition of the London Catalogue of British Mosses in 1881. In 1907, Mr. Jones took charge as secretary of the beginner's section (Section II) and continued that work until 1922, when both sections became merged as the British Bryological Society. He became secretary of this and continued as such until the early part of this year, when he felt compelled to resign on account of ill-health. The knowledge of the vice-comital distribution of bryophytes increased rapidly, and this increase was greatly contributed to by Mr. Jones. The "Census Catalogues of British Hepatics" (1905) and of "Mosses" (1907) were followed by a second edition for "Hepatics" in 1913 and a third in 1926, and a second edition for "Mosses" in 1930.

During the Great War, Mr. Jones was a Government lecturer on agriculture in connexion with University College, Aberystwyth, for which the University of Wales bestowed on him the degree of M.Sc. in 1918. In 1925, he was elected an associate of the Linnean Society, of which he had previously been a fellow (1897–1912). He became vice-president of the British Bryological Society in 1933 and president in 1935.

Jones was born in Liverpool on July 14, 1861, was a schoolmaster at Machynlleth for about six years, then at Harlech until he retired in 1924. After ten months spent in the study of bryophytes and lichens on the Continent, chiefly on the Riviera, he lived four years at Cheltenham, and the last five years of his life were spent at Bristol. His sense of humour, good fellowship and almost uncanny power of detecting rare or strange plants, rendered his presence amongst bryologists or lichenologists delightful and stimulating. W. W.

Mr. Marius Maxwell

BY the untimely death at the age of forty-eight years of Marius Maxwell, which occurred on November 2 at Nice in an accident to an aeroplane which he was piloting, the British Museum (Natural History) and those interested in the study of natural history have lost a keen supporter.

Maxwell had lived a most adventurous life and the manner of his death will come as no surprise to those who knew him best. He was a very generous donor to the Natural History Museum, and many of the specimens which he collected in his early days in Java and northern India have found a permanent home in the National Collection. Chief amongst these may be mentioned the skull of the record Javan rhinoceros (*Rhinoceros sondaicus*) which carries a horn of $10\frac{3}{4}$ in., and two skulls of the pygmy hog (*Porcula salvanius*) from Bhutan. Amongst his East African donations premier place must be given to the mounted head of a magnificent bull elephant which carries exceptionally long and slender tusks.

In 1911 Maxwell first visited Kenya Colony on a hunting trip between Nakuru and Lake Baringo, when the vast accumulation of game which he found in that country so impressed him that he determined to return later on a photographic expedition. The opportunity to re-visit East Africa did not come for another ten years, when in 1921 he conducted an expedition to the Masai Province and took some wonderful photographs of elephants and giraffes. One of the elephant photographs shows an old bull standing in the attitude of alarm with its ears widely spread; this photograph was taken at a range of 8 yards. It was there that he secured the amazing series of photographs of three elephants sauntering in a forest clearing, when he walked out into full view of the animals and proceeded to take about a dozen snapshots quite at close quarters. The giraffe photographs were some of the first photographs of galloping giraffe to be taken from a pursuing car, and Mr. Maxwell estimated the speed of these animals, when fully extended, as 28–32 miles an hour.

After a short trip to India on business, Maxwell returned to Mombasa in the spring of 1922 and went on another photographic expedition, first to Lake Natron and around the Tanganyika border in the south, and secondly up in the Northern Frontier Province along the Northern Guaso Nyiro. In the latter locality he obtained some excellent photographs of buffalo, elephant and hippopotamus. One close-up of a buffalo is especially awe-inspiring, as it shows the animal debating in its mind whether to charge or not. The elephant photographs taken in the region of the Lorian Swamp and at Abbas Wen are some of the most remarkable records ever made of these animals; this is especially true of the group of advancing elephants which forms the frontispiece of Maxwell's monumental work entitled "Stalking Big Game with a Camera", published in 1924 by the Medici Society. This volume is very handsomely illustrated by a large number of photogravure reproductions of Maxwell's photographs, and will remain

for all time a standard work on the subject of East African big game. The volume contains an introduction by Sir Sidney Harmer, and in addition to the chapters on elephants, giraffes, rhinoceroses, buffaloes and hippopotamuses, also has an interesting appendix on the ancestry of the African elephant, and the relationship of primitive elephants to primitive man. The volume concludes with a chapter on some of Maxwell's experiences in hunting elephants in India. This *édition de luxe* was followed a year later by a somewhat smaller and cheaper volume containing the same text and illustrations.

Always seeking after new experiences, in 1925 Marius Maxwell visited the Birunga Mountains north-east of Lake Kivu, in the Eastern Belgian Congo, to study and photograph the Eastern gorilla. He was accompanied by Mr. J. H. Barnes, the well-known white hunter, who had been with him on his two previous trips in Kenya Colony. Although not having very great luck in photographing the gorilla itself, he took some very interesting photographs of the gorilla forests, of their sleeping platforms and of gorilla shelters. Further, he secured a unique snap-shot of a female gorilla carrying on her back a young one ; this, I think, is the only pictorial record of this method of juvenile transport in this species.

Maxwell had graduated at Zurich and took up the profession of engineering, specializing in the machinery concerned with the manufacture of cane-sugar, and he erected many sugar factories in India. Latterly, he had interested himself in coffee-farming, and lived on a large estate at Thika Bridge in Kenya Colony. He married in 1929 Miss Winifred Ramsay.

GUY DOLLMAN.

Lieut.-Colonel Robert Knowles, C.I.E.

IT is no exaggeration to say that tropical medicine has sustained a grievous loss through the early decease, on August 3 at fifty-two years of age, of Robert Knowles after a brave struggle with prolonged ill-health, aggravated by exceptionally hard work which a keen sense of duty would not allow him to relax.

After completing his medical studies at Cambridge and St. Mary's Hospital, Knowles took the first place at his entrance into the Indian Medical Service in 1908 in its palmiest days, and, after some years in military employ, obtained his first opportunities for research under favourable conditions at the Kasauli Institute. Here he began a happy and successful collaboration with his friend, H. W. Acton, and they made important contributions on the subject of snake venoms. Here he also commenced his fruitful work on protozoology in connexion with the halteridium. After the interruption caused by the Great War, when he was severely wounded in Mesopotamia, he took charge of the recently founded Pasteur Research Institute in the beautiful hill station of Assam at Shillong, where his energies and organizing ability found ample scope, and where he commenced his important investigations on kala-azar.

When Sir Leonard Rogers had to return home a few months before he had completed the organization of the Calcutta School of Tropical Medicine, he asked that Knowles should succeed him, and once more he was an outstanding success, and soon became professor of protozoology, with his friend Acton as professor of bacteriology, and during the next sixteen years his work there can only be described as most remarkable. His most outstanding discovery was the demonstration, with the aid of L. E. Napier and R. O. A. Smith, that the sand-fly, *Phlebotomus argentipes*, was the long sought-for carrier of the infection of kala-azar. Later he did valuable work on a parasite of monkey malaria called *Plasmodium knowlesi* after him.

Knowles was equally distinguished for his medico-literary work, and was a clear and prolific writer, his work on medical protozoology being of exceptional merit, and those with Acton on the dysenteries of India, and with S. White on malarial literature in India were of great value. First as assistant editor with Sir John Megaw, and later as editor of the *Indian Medical Gazette*, he raised its standard and contributed invaluable summaries of the advances during each year, at the compilation of which he was a master.

Knowles's short, thickset figure, abounding in energy and enthusiasm, combined with the unselfish and cheerful manner in which he always found time to help any of his colleagues, British or Indian, makes his early loss quite irreparable to his innumerable friends.

Dr. W. F. Sheppard

DR. W. F. SHEPPARD, late assistant secretary, Board of Education, died on October 12 in his seventy-third year. He went up to Trinity College, Cambridge, was Senior Wrangler in 1884 (Parts I and II) and was placed in Division I of Part III in 1885. He was elected a fellow of Trinity in 1887. For these particulars we are indebted to the obituary in *The Times*.

The name of Sheppard is well known to mathematical statisticians. In 1898 he published in the *Phil. Trans.* (A, **192**, 101) a memoir "On the Application of the Theory of Error to Cases of Normal Distribution and Normal Correlation", in which the theory is developed by very elegant geometrical methods. It was in this memoir that he gave the noteworthy theorem, that if a fourfold table is formed from a normal correlation table by division at the medians, the coefficient of correlation r is given by

$$r = \cos\left(1 - \frac{2n}{N}\right)\pi,$$

where n is the frequency in either of the positive quadrants.

Much of Dr. Sheppard's work, in the *Proceedings of the London Mathematical Society* and elsewhere, was concerned with the method of finite differences and its applications. By this method he derived the well-known 'Sheppard's corrections' for determining

more accurately the moments of a grouped frequency distribution (*Proc. Math. Soc.*, **29**, and *Biometrika*, **5**, 1907). For these, and for his tables of the ordinates and integral of the normal curve given in "Tables for Statisticians", his name is known to almost every student of the subject. But his work really covered a considerable range, and we may note, amongst others, papers "On the Statistical Rejection of Extreme Variations" (*Proc. Math. Soc.*, **31**), "On the Use of Auxiliary Curves in Statistics of Continuous Variation" (*J. Stat. Soc.*, **63**, 1900) and on "Graduation by Reduction of Mean Square Error" (*J. Inst. Actuaries*, **48**). Of recent years he does not seem to have written so much on statistical matters, but some time since he made a return to pure mathematics and published through the Oxford Press a small book "From Determinant to Tensor" (1923).

G. UDNY YULE.

News and Views

Nobel Prize for Chemistry: Prof. P. Debye

THE award of the Nobel Prize for chemistry for 1936 to Prof. P. Debye will give great pleasure to his friends everywhere. Debye's contributions to science have been many, and have covered a wide range of subjects, but they all have certain features characteristic of the man who made them. He combines, in a remarkable way, ability in mathematical analysis with a sturdy sense of physical realities, so that he is able to make bold approximations without invalidating the formulæ at which he arrives. His early training as an engineer, followed by his training in theoretical physics under Sommerfeld, must have contributed to this striking combination of qualities. They have been shown equally by his all-important work on specific heats, on dipole moments in gases, and on the theory of strong electrolytes. He has made notable contributions to X-ray analysis, in particular the 'powder-method', the theory of scattering of X-rays by molecules, and the effect of temperature on X-ray diffraction. He is a delightful and inspiring lecturer. All who know him have the double pleasure of seeing the award so appropriately bestowed, and of being able to congratulate a kindly and delightful friend. Prof. Debye received the Royal Society's Rumford Medal in 1930, and in 1933 was elected a foreign member of the Society.

Nobel Prize for Physics: Prof. Victor F. Hess

THE Nobel Prize for physics for 1936 is divided equally between Prof. Victor F. Hess of Innsbruck for his work on cosmic radiation and Dr. C. D. Anderson of Pasadena for his discovery of the positron. It was Prof. Hess's experiments in manned balloons in 1912 which first definitely proved the existence of penetrating rays which enter the earth's atmosphere from outside. This conclusion followed from the discovery that the ionization in a closed ionization chamber at a height of 4,000 metres was greater than at sea-level, and above this increased rapidly. Hess also showed that the ionization due to this new radiation decreased neither during the night nor during an eclipse of the sun, thus showing that the rays cannot come directly from the sun, so long, at any rate, as the rays travel in straight or nearly straight paths. It was this pioneering work of Hess which led to the view that the penetrating rays were really cosmic in origin. In more recent years, Prof. Hess, besides contributing much to the subject of atmospheric electricity, has paid especial attention to the study of the variation of the intensity of the cosmic rays with time. This work demands very accurate measurements over a period of years, since the variations are complicated and small in magnitude. From these and other similar investigations, a small daily variation has been established with certainty, and probably also a quite small variation with sidereal time of the order of 0·1 per cent. The existence of such an effect was predicted by Compton as a consequence of the assumption that the rays had their origin outside the Galactic System, and about the expected variation was found from the measurements of Hess and Steinmaurer. Prof. Hess's work on cosmic rays has extended over a period of more than twenty-five years, and it is with very great pleasure that all workers in this field now see this work receiving its due recognition.

Dr. C. D. Anderson

DR. ANDERSON'S discovery of the positive electron or positron arose also through the study of cosmic radiation. During an investigation of the properties of the rays by means of a cloud chamber in a strong magnetic field, Anderson found certain photographs which revealed the tracks of particles with about the same ionization, and so about the same mass, as electrons, but which were curved by the magnetic field in the direction corresponding to particles with a positive charge. This exceedingly important result was published in 1932 as a short communication to *Science*, in which Dr. Anderson wrote: "For the interpretation of these effects it seems necessary to call upon a positively charged particle having a mass comparable with that of an electron." Thus a new member was added to the select list of fundamental particles. Subsequent work has shown, not only that about half the cosmic ray particles are positrons, but that they are also often produced as one of the partners of pairs of positive and negative electrons, when gamma-rays of high energy are absorbed by matter. These positrons do not live long, as they readily combine with other negative electrons to form more radiation. The discovery of

the positron provided the final proof of the validity of Dirac's theory of the electron, for this theory requires the existence of just such a particle.

DR. ANDERSON has also contributed greatly to the study of cosmic radiation itself, particularly by his work on the energy spectrum of the rays and of their energy loss in passing through matter. In connexion with the latter, he has recently shown that electrons with energies at least up to 3×10^8 electron volts do suffer the large radiation energy losses which are predicted by theory. During the last year, Dr. Anderson took his apparatus to the top of Pike's Peak at an altitude of 4,300 metres, and there obtained a large number of cosmic ray photographs by the counter-controlled method. Among these are some of the finest shower photographs yet taken. It is interesting to note that Dr. Anderson's communication to *Science*, announcing the apparent existence of a positive electron, was only the fourth paper published by him. Dr. Anderson, who is only thirty-one years of age, must certainly be the youngest experimenter in recent decades to make a discovery of such first-class importance; and now he is also to be congratulated on being surely one of the youngest experimental physicists to receive a Nobel prize.

Edward Meyrick, F.R.S.

MR. EDWARD MEYRICK will reach the age of eighty-two years on November 24, and his many friends and correspondents all over the world will join with NATURE in good wishes and congratulations on his effective life's work. In 1927, when awarded the Captain Scott Memorial Medal by the South African Biological Society, for his study of South African Microlepidoptera, the president justly remarked that "Mr. Meyrick's is an example of what can be done by a single individual, unsupported, with no financial backing, but devoted to a task that fills his life". Meyrick is a Wiltshireman, still residing at Thornhanger, Marlborough. He was a boy at Marlborough College from 1868 until 1873, and a classical scholar of Trinity College, Cambridge. From 1877 until 1886 he was a schoolmaster at Sydney, Australia, and at Christchurch in New Zealand. He returned to Marlborough College as an assistant master in 1887 and continued there until his retirement in 1914. During the last fifteen years of that period, he was president of the Marlborough College Natural History Society, which has been an inspiration to so many young naturalists, many of them now men of distinction. Marlborough is indeed one of the most fortunate of schools, situated in the beautiful valley of the Kennet between Savernake Forest and the wide and open chalk downs of Wiltshire, with its varied fauna and flora. The country-side is famous for dykes, barrows and hill-forts, and the county contains Stonehenge, Avebury, Old Sarum and Silbury; while the British 'mount' of Marlborough stands within the historic grounds of the College, once a British fort, once a castle, once a mansion, once the "Castle Inn" with its memories of Pitt, now a school, and always famous.

THE duties of an assistant master at a public school are so arduous and exacting that it is rather rare for a schoolmaster to achieve the distinction of becoming a fellow of the Royal Society. Meyrick was elected in 1904, largely for his work on Australian Lepidoptera. About nine years later he published his "Handbook of British Lepidoptera" (Macmillan), and in 1927 "A Revised Handbook of British Lepidoptera" (Watkins and Doncaster). In these books Meyrick broke away from the older classification based on fugitive characteristics such as wing patterns and colours, and he depended largely, but not entirely, on the more permanent forms of the veins or neurations of the wings. He was familiar with the Microlepidoptera of South Africa, Australia and New Zealand, for he was a great traveller, and a student of the moths and butterflies of the whole world. His study of the insects of Australia and New Zealand caused him to reject the Wegener hypothesis that those regions, once united, had drifted a thousand miles apart. Meyrick had a large viewpoint as a naturalist, and the following have been termed, by Comstock, Meyrick's Laws, though perhaps laws is not quite the right word: "No new organ can be produced except as a modification of some previously existing structure." "A lost organ cannot be regained." "A rudimentary organ is rarely re-developed." Most of Meyrick's work will be permanent; other work has come and more will originate from the many pupils to whom he has handed on the lamp of wisdom and the torch of enthusiasm.

Dr. F. Simon

DR. F. SIMON, who has been appointed to succeed Prof. A. C. G. Egerton as reader in thermodynamics at Oxford (see p. 895), took his degree in Berlin in 1921. He was *Privatdozent* and extraordinary professor of physics there until 1931. From 1931 until 1933 he was director of the physical-chemical institute of the University of Breslau. He was in California for six months in 1932 as a visiting professor. During the last three years he has been working in the Clarendon Laboratory at Oxford on low temperature research, particularly on the production of very low temperatures by the magnetic cooling method, and on the properties of matter in the neighbourhood of the absolute zero.

J. L. Macadam (1756–1836)

THE centenary of the death of John Loudon Macadam, which occurs on November 26 (see p. 869), is a reminder of the debt we owe to that group of men who at a critical time in our industrial history were instrumental in making vast improvements in our means of transport. As one of this group, Macadam has a place beside Brindley, the Duke of Bridgewater, Telford, Rennie, Metcalf, Smeaton and others. Macadam was born in Ayr on September 23, 1756. He lost his father in 1770 and as a boy of fourteen years of age was sent to an uncle in New York. Thirteen years later he returned home comparatively well off, and settled down to the life of a country gentleman in his native country. It was as such

he began his experiments on road-making, which were eventually to bring him fame if not fortune. It is not a little extraordinary, however, that his main work was done after reaching the age of sixty years, when he was made surveyor-general of roads to the Bristol Turnpike Trust. He resigned this position when sixty-nine, and two years later Parliament appointed him Surveyor-General of Roads. This position he held until his death at Dumcrieff House, Moffat, on November 26, 1836. At one time it is said he had no fewer than three hundred surveyors working under him. The importance of his work was fittingly commemorated at Ayr on October 30 last, when a bronze tablet erected by the Institution of Municipal and County Engineers was unveiled by Mr. Hore-Belisha, the Minister for Transport, and a paper on "John Loudon Macadam, Roadmaker" was read by Mr. G. S. Barry, the County Surveyor, Ayrshire.

Memorial to the late Sir Walter Fletcher

ON November 11, the subscribers to the Sir Walter Fletcher Memorial Fund were invited by the Medical Research Council to view Miss Dora Clarke's portrait-bust of the late Sir Walter Morley Fletcher, secretary of the Council from 1914 until 1933. The ceremony was held at the National Institute for Medical Research, Hampstead, in the library of which the bust is to be placed permanently. Lord Balfour of Burleigh, chairman of the Council, presided. The chief speakers were Prof. G. M. Trevelyan and Sir Frederick Gowland Hopkins, the former dealing mainly with the personal aspect and the latter with Fletcher's scientific and administrative work. Sir Henry Dale, director of the Institute, then accepted custody of the bust. The total amount contributed to the Fund by more than five hundred separate subscribers is approximately £2,300. The remainder, after meeting the cost of the personal memorial, is being used for a Walter Fletcher Memorial Laboratory. This is being constructed at the Farm Laboratories of the National Institute at Mill Hill, and is to be used for research work in nutrition.

Grassland of Great Britain

AT a meeting of the Engineers Study Group on Economics held on November 10, Prof. R. G. Stapledon discussed methods of dealing with the problem of grassland in Great Britain. He exhibited a map of Wales, the result of a recent survey, and pointed out that there are only 16,000 acres of proper pastures (rye grass), although at least a third of the 153,000 acres under bracken is of high potential value. To make the best use of the 18,000,000 acres of rough hill grazing ground in Great Britain, Prof. Stapledon considers that it is necessary for the State to acquire and develop it. This, he believes, would be economically feasible over a period of 25–50 years, beginning at once with an area of not less than 200,000 acres. Agriculturally, the potentialities of the hill land not above the 150 ft. contour (in all, more than 14,500,000 acres) are enormous, at least 20 per cent of that area being amenable to radical improvement. Lowland grass could be used for drying and for wintering, and improved upland grass for summering, and the plough, oats and fatting crops everywhere. Roads and tracks should be constructed in connexion with land improvement and afforestation. Sir Richard Paget, who presided at the meeting, expressed his appreciation of the pioneer work of Prof. Stapledon, and Lord Northbourne, in opening the discussion, stressed the importance of preserving individual initiative.

Temples and Caste in Travancore

THE decision of the Maharajah of Travancore, announced by proclamation authorizing the opening of the temples controlled by the State to all Hindus, according to a Delhi dispatch in *The Times* of November 16, has been hailed by progressive opinion in India as "the greatest reform of Hinduism since Ramanuja's days". By this drastic action, which at once obliterates caste distinction in right of access to the sacred places of religion, and removes one of the most strongly resented marks of inferiority in the outcastes, the State of Travancore has opened a way to political unity which Hinduism at large would do well to accept as a guide and example. The exceptional position of the Rajah in relation to the State religion has endowed him with a power of initiative that was open to few others in India, and perhaps least of all to the British Raj; but whether the example of Travancore will be followed elsewhere will doubtless depend in no small degree upon the religious and political reaction to so serious an innovation. It is said that conservative opinion has already criticized the reform as rash and unsound, while maintaining that the views of Hinduism outside Travancore should have been considered—a claim, of which, in view of past events, it would be difficult to vindicate the political wisdom. On the other hand, the Nationalists and leading members of the Congress, with Mr. Gandhi, have hastened to congratulate the head of the State of Travancore on his decision.

Guide to Ancient Monuments

MR. ORMSBY-GORE'S promise on relinquishing office as First Commissioner of Works to complete the manuscript of that part of the official guide to ancient monuments then in hand, has now been redeemed by the publication of the volume covering East Anglia and the Midlands ("Illustrated Regional Guides to Ancient Monuments under the Ownership or Guardianship of H.M. Office of Works", vol. 3, East Anglia and Midlands. By the Right Hon. W. Ormsby-Gore. London: H.M. Stationery Office. Pp. 72. 1*s*. net). In method of treatment of both the prehistoric and the historic sections this volume follows the plan of its predecessors; but matter of general application in the various periods, which has been given in the earlier volumes, has been omitted. Although it may be agreed that nothing can make a stronger appeal to the historic imagination than Stonehenge and Avebury, which have already been described, the present volume in no other respect falls below those already issued in the importance and interest of the monuments which it includes. As

a source of information relating to the industries of neolithic man, Grime's Graves is without rival; while the circle of Arbor Low in Derbyshire, and the megalithic barrows of the Cotswolds each hold a place in British prehistory, of which the importance needs no emphasis. It may be noted, however, that the latter are counted the oldest monuments under the guardianship of the Office of Works. Verulamium, since Dr. Mortimer Wheeler's excavations, is unique both as a British and a Romano-British site. In historic periods the abbeys of Shropshire and the castles, such as Framlingham, stand out among medieval buildings; while Kirby Hall, Northants, is one of the most important of the large country houses of Elizabethan and Jacobean times. For the first time, historic buildings belonging to the Crown appear. These are the Tower, Hampton Court, Kensington Palace, and the Chapter House of Westminster. Of the various periods into which English prehistory and history fall, the Saxon alone does not appear among the historic monuments under protection.

Ethnology of the Far East

THE authorities of the Raffles Museum, Singapore, have added a new series, to be known as Series B, to the Museum Bulletin. The present publication, which will now become Series A, hitherto has been devoted almost entirely to communications of a biological character. The new series will be anthropological, and for some time to come will be devoted largely to publication of the results of a scheme of research in the prehistory of the Malay Peninsula, for which the Carnegie Corporation of New York has voted a subvention extending over a period of three years. In the first issue of the new series are three reports on recent excavations—the first in Kedah by Mr. H. D. Collings, the second in a cave in Bukit Christamani by Mr. M. F. W. Tweedie, and the third on kitchen middens at Guak Kepeh, Wellesley Province, by Dr. P. V. van Stein Callenfels. The most important, as well as the longest, communication is from Dr. van Stein Callenfels, who, in "The Melanesian Civilization of Eastern Asia", contributes a detailed analysis of the Hoabinian stone age culture, so called from the early culture first distinguished in Tonkin, which he traces throughout the East so far as observed from China and Japan to Celebes, and analyses into three stages, in which he sees evidence for contacts between a people of a palæolithic type of culture with another in a protoneolithic stage. In incorporating the new evidence obtained under the present scheme in his analysis, and at the same time making use of the evidence afforded by earlier excavations in the Malay Peninsula, notwithstanding their defects in method, Dr. van Stein Callenfels also turns to the discussion of the position of Wadjak man, to whom he is inclined to assign a date later than the Pleistocene, but to regard him as a very old representative of the Melanesoid culture.

The Consumption of Statistics

IN his inaugural address on November 18 as president of the Royal Statistical Society, Lord Kennet urged the necessity for a more effective consumption of statistics. He affirmed that statistics—in the broad sense of the collection and methodical arrangement of facts—provide the one indispensable food from which the organs of Government can derive the motive power for the right conduct of the business of governing the nation. Decisions made without adequate statistical study on questions of the magnitude and complexity with which modern Governments have to deal, are not in the least likely to be even approximately correct, and the resulting policies and measures would be little better than the medicine-man's sympathetic magic carried out by incantation. Without doubt, then, the Government ought to be the most substantial consumers of statistics. If the Government consumes statistics—and it undoubtedly does to some extent both consume and digest them—the results of Government action seem to show that the metabolism is defective. What part of the organism is at fault? Lord Kennet classified the effective organs of Government as the Press, the wireless, the Civil Service, the Cabinet, the House of Commons, the voters at election time, the local authorities. Which of these is to blame? The fault must be directly attributed to the executive government, but the blame lies fundamentally with their masters, the people, whose national predilection is for 'muddling through', and who believe that scientific study has little practical value. Theory and practice are in reality not opposed but complementary to one another, and the widespread belief to the contrary is responsible for much of the mental lethargy which makes our conduct of affairs what it is—too often a fortuitous muddle.

Coal Gas Research

AT the eighth Autumn Research Meeting of the Institution of Gas Engineers held in London on November 3–4, the papers showed current trends of thought in the gas industries. The thirty-ninth report of the Joint Research Committee of the Institution and the University of Leeds gave the first instalment of a study of the complete gasification of coal in oxygen-steam mixtures. Such a process, if successful, might make the industry less dependent on the choice of coal, and less would be required. At the same time it would have far-reaching consequences on the distributions of fuel. This report contained a study of the conditions within a fuel bed during gasification. Three papers dealt with the sulphur impurity in coal gas. Coal gas is the purest fuel in general use, but this very purity renders possible its use in flueless apparatus, and the small quantity of sulphur compounds present may become noticeable even if innocuous. The paper shows that the coal gas of the future may be purified of sulphur compounds to a degree hitherto unknown. The paper by H. Hollings on the formation and removal of gum in coal gas reveals the solution of a baffling problem which has arisen following the use of the practice of drying gas before distribution. Traces of unsaturated hydrocarbons—almost inconceivably minute—condense or polymerize to form gummy substances which may cause trouble in appliances. The solution of this puzzle is

a marked achievement of industrial chemical research. A. R. Bennett and H. Hartley described an instrument for measuring the radiation from heating appliances, which should be serviceable for other uses.

Air-Conditioned Flats

EATON HOUSE, Upper Grosvenor Street, London, W.1, has been converted into a building containing thirty luxury flats. They are equipped for electric cooking and refrigeration, and hot water is supplied from a central hot water plant in the basement. We learn from the *Electrician* of November 6 that each tenant has an air-conditioning plant completely under his own control. Both the temperature and humidity of the air can be adjusted by the tenant to any value he pleases. In each flat there is a condensing unit working in conjunction with an air-conditioner, consisting of a slow-speed fan and motor, heating coils, cooling and dehumidifying coils, air filter and humidifying spray for winter use. The air-conditioners are housed in cupboards in the kitchens of each flat and cleverly concealed. Each conditioner passes approximately 1,300 cub. ft. of air per minute. About twelve complete changes of air per hour are provided in the rooms. It is essential that the plants be practically inaudible as they are in operation twenty-four hours a day. This has been effected by mounting the units in pedestal anti-vibrators. The filtered fresh air enters through grilles in the walls, and as there is no need to open windows street noises, grime and dust can be kept out. A small wall panel in the hall of each flat carries the temperature and humidity control apparatus. It consists of a thermostat, humidistat and change-over rotary switch. An advantage of individual control is that if a flat be left empty, the entire plant can be switched off and thus save running costs. The equipment was designed and installed by York, Shipley, Ltd. of North Circular Road, London, N.W.2. For the electricity the tenants pay a small quarterly fixed charge and ½*d.* per unit.

Testing Switchgear

THE safety of every electricity supply system depends on its switchgear always being ready to operate. The main switches (circuit-breakers) must always be capable of making and breaking the current, and still remain fit for use. The development of the grid system has proved the necessity of being able to 'clear' a fault even when fed by enormous currents. For many years, the firms now constituting Associated Electrical Industries have had extensive experience of short-circuit tests made with generators having capacities up to 80,000 kilovolt amperes. In an article in *Electrical Industries* of October 14, a description is given of a testing station having a generator capable of giving 2,500,000 k.v.a. on short circuit. In order to meet the demand for more tests and for tests at higher powers, the companies interested combined to form a separate company known as the Switchgear Testing Co., Ltd., which now owns and operates the plant on their behalf. The testing station is situated at Trafford Park, Manchester. Ample space had to be provided to ensure personal safety, and, when 'testing to destruction', to avoid damage to property by explosion and fire. The station has three testing areas; two are covered over and used for testing up to 33 kv., and one is an open area, testing up to the grid voltage of 132 kv. The station has a complete equipment for measuring and recording phenomena. Its electromagnetic oscillograph has sixteen elements and is probably the only oscillograph of this kind in the world. It is satisfactory to know that these companies have taken a leading part in conjunction with other firms both in Great Britain and abroad in producing a standard specification for procedure in testing circuit breakers which is recognized internationally.

Marine Work in Ceylon

THE Administration Report of the Marine Biologist, Mr. A. H. Malpas, for 1935 (Part IV—Education, Science and Art (G), Marine Biology: published May 1936) shows that the inspection of the pearl banks again reveals an absence of sufficient spatfalls of both southern and northern paars to provide fisheries within the next three years, despite the presence of sexually mature oysters in sufficient quantity to repopulate the banks. Although conditions of the kind have always been attributed to adverse currents carrying away the free-swimming larvæ into deep water where they are lost, there seems to be some justification for the belief that hydrobiological conditions in the Gulf of Manaar are the more important factors in so far that adult pearl oysters can be stimulated to maximum spawning only under particular conditions of salinity and temperature, which are the exception, rather than the rule, and therefore the pelagic larvæ are not developed in sufficient numbers to produce spatfalls except when these conditions obtain. The scheme referred to in last year's report for the establishment of a Fisheries Research Station at Colombo combined with an aquarium has been modified, and the suggested aquarium available for the public abandoned, a more comprehensive scheme with experimental aquaria and provision for a fish hatchery on a fairly large scale being substituted. This will provide not only for facilities for investigating the bionomics of marine and freshwater animals of economic importance but also for experiments in hatching and rearing the more important freshwater food fishes.

The London School of Hygiene and Tropical Medicine

A REPORT by Sir Austen Chamberlain, chairman of the Court of Governors, giving a short account in non-technical terms of the work of the London School of Hygiene and Tropical Medicine (incorporating the Ross Institute) for the information of those who contribute to its maintenance, has been issued to subscribers. Commencing with a short history of the establishment of the London Tropical School in the hospital of the Seamen's Hospital Society at the Royal Albert Dock, its removal to Endsleigh Gardens, and finally its incorporation in the London

School of Hygiene in Keppel Street, Gower Street, the work of the School for the year ending July 31, 1936, is surveyed. The teaching and research work of the various departments are briefly summarized, as well as additions to, and organization of, the library and museum. The incorporation in the School of the Ross Institute of Tropical Hygiene, and the work this branch is doing, are also dealt with. The report is illustrated with a number of plates, and lists of subscribers and of research publications are included.

Work of the Building Research Board

AT the Building Exhibition, Olympia, 1936, an exhibit was arranged to give the public an opportunity of seeing the nature, methods and results of the investigations of the Building Research Board being carried on at Watford, at Teddington and at Princes Risborough. The D.S.I.R. has issued a descriptive pamphlet, "Building Research Exhibit—Olympia 1936" (Dept. of Scientific and Industrial Research, S.W.1), containing a short explanatory statement of the nature of the work being done in each section and briefly indicating the special features of the exhibit. One of these showed samples of lightweight aggregates with a chart of their physical properties and the methods of testing used. In another section their value for thermal insulation in building construction was demonstrated.

Genetics of the Pig

A MONOGRAPH by A. D. Buchanan Smith, O. J. Robison and D. M. Bryant dealing with this subject (Reprint from *Bibliogr. Genetica*, **12**. The Hague: M. Nijhoff) is a summary of all that is known of the genetics of pigs and will be very serviceable to the geneticist as well as the practical breeder. Beginning with the chromosome number and the inheritance of colour in wild and domestic breeds, it goes on to hair and skin characters, blood groups, disease resistance, mental traits, sterility, intersexuality, numerous abnormalities and defects, conformation, productive qualities and methods of improvement in different countries. Twenty-one photographs of different breeds of pig are followed by a bibliography of 28 pages and an index which makes the information readily available.

The *Zoological Record*

THIS essential instrument of zoological research, published under the auspices of the Zoological Society of London, still requires further financial support. The statement of the 'Record Fund' in the report of the Council of the Zoological Society for 1935 shows that the sums received from the contributing societies were just sufficient to meet the loss on vol. 71 for 1934, and that the continuation of the *Zoological Record* is made possible only by the support given to it by the Zoological and other contributing societies. The British Association Committee formed for the support of the *Record* proposes that an annual grant of £50 should be repeated in 1937.

Breeding of King Penguins at Edinburgh Zoological Park

IN 1919, probably the first king penguin bred in captivity was hatched and reared in the Scottish National Zoological Park in Edinburgh, and since that time the number has been added to almost annually. Last year two were reared, and at present there are four king penguin chicks, all hatched at about the same time late in the summer. The work of incubation and rearing the chick is shared by both parents, but the part taken by the mother is almost negligible, the father being responsible for about nine-tenths of the performance.

Wild Animals in Poland

IN the Eastern Carpathians, the *Quarterly Information Bulletin* (Krakow, 1936) states, there still exist about three hundred bears, of which four were killed in 1935. The elk herds now number more than a thousand individuals, their welfare having been aided by the disappearance of an epidemic from which the herds suffered in the previous year, and from a decision to stop the cutting of timber in the elk territories, with the result that the herds, formerly compelled to emigrate, were able to winter in their established districts.

Child Neurology Research

A SPECIAL committee is to be formed with a grant from the fund established by Colonel Michael Friedsam and under the direction of Dr. Bernard Sachs, of New York, to stimulate research in child neurology and allied subjects. The committee is to be composed of two neurologists besides Dr. Sachs, two pædiatrists, one orthopædic surgeon and two laymen. Further information can be obtained from Dr. Bernard Sachs, 116 West Fifty-ninth Street, New York.

Canadian Minerals

THE mineral wealth of Canada is fully reviewed in the annual publication of the Department of Mines ("The Canadian Mineral Industry in 1935." Ottawa. 25 cents). Metals and metallic ores, industrial minerals and fuel are each arranged alphabetically, and under each is a review of producing localities, production, trade and prospective producing localities. Much important information is thus given in a readily accessible form.

Presentations to two Cambridge Botanists

AN executive committee has recently been formed at the University of Cambridge with the view of approaching resident members of the University, past students of the Botany School, and other British and Dominion botanists for subscriptions to a fund for obtaining the portraits, in oils, of Sir Albert Seward, formerly professor of botany, and Dr. F. F. Blackman, formerly reader in botany in the University, both of whom have now retired, for presentation to them. The presentations are intended as a token of personal esteem and appreciation of the great services they have rendered both to botany and to the University. Cheques should be sent to Prof. F. T. Brooks, Botany School, Cambridge, and should be crossed "Portrait Fund".

Announcements

PROF. F. G. DONNAN, professor of chemistry in the University of London, and Sir Albert Seward, formerly professor of botany in the University of Cambridge, have been elected honorary fellows of the National Institute of Sciences of India.

THE next International Congress of Microbiology will be held in 1939 at Atlantic City, New Haven, U.S.A.

THE Medical Research Council has made the following awards: Senior Fellowships to Dr. Frederick Murgatroyd, lecturer in protozoology in the Liverpool School of Tropical Medicine; and Dr. Cecil Hackett, recently engaged in investigations in the Northern Territory of Australia. Dr. Murgatroyd will work in West Africa on the chemotherapeutic treatment of trypanosomiasis, and Dr. Hackett in East Africa on the pathology and clinical manifestations of yaws. Junior Fellowships have been awarded to Gilbert B. Ludlam, clinical assistant in the Sheffield Royal Hospital, and Joel N. Strauss, formerly house physician in the Hospital for Tropical Diseases, London. These are tenable for three years, during the first two of which the holders will undergo training in Great Britain in tropical medicine and in the use of research methods.

THE following appointments and promotions have recently been made in the Colonial Service: W. E. Lewis, to be assistant conservator of forests, Nyasaland; T. W. Summers, to be assistant conservator of forests, Nigeria; L. C. M. Wedderburn, to be assistant conservator of forests, Nigeria; J. E. Turnbull, to be veterinary officer, Tanganyika; T. Bell, to be assistant manager, Government Stock Farm and Agricultural Station, Acre, Palestine; T. A. des Iles, to be veterinary officer, Tobago; D. P. Le Jeune, to be engineer, Water Supply Section, Geological Survey, Nigeria; W. F. Gwilliam (inspector of plants and produce, Gold Coast), to be agricultural officer, Nigeria; R. G. M. Willan (formerly assistant conservator of forests, Nigeria), to be assistant conservator of forests, Nyasaland; G. W. Butcher (chief electrician, Electrical Department, Falkland Islands), to be broadcast officer, Gold Coast; R. W. Donkin (inspector of produce, Zanzibar), to be inspector of produce, Gold Coast.

A STATE-SUPPORTED office for industrial hygiene has been established in West Virginia. Its first concern will be the supervision of silicosis.

THE central offices of the International Council for the Exploration of the Sea have been removed to the Charlottenlund Castle. The new address, therefore, is Charlottenlund Slot, Charlottenlund, Denmark, or, Postbox 20, Charlottenlund, Denmark.

WE are informed that among the presidents of Associations forming the executive committee of the International Union of Geodesy and Geophysics (see NATURE, Oct. 10, p. 650), there should have been included the name of J. A. Fleming, president of the International Association of Terrestrial Magnetism and Electricity. Prof. la Cour, one of the secretaries of the Associations, is from Denmark, and is succeeded by A. H. R. Goldie (Great Britain).

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

A University demonstrator in mineralogy and petrology in the University of Cambridge—Dr. F. C. Phillips, Department of Mineralogy and Petrology, Downing Street, Cambridge (November 24).

A head of the Mining Department in the Whitwood Mining and Technical Institute—The Secretary, Education Offices, Castleford, York (November 28).

A scientific officer (electrical engineering or physics) in the Royal Aircraft Establishment, South Farnborough, Hants—The Chief Superintendent (Quote A.154.(a)) (November 28).

A research chemist in the Department of Clinical Investigations and Research in the Manchester Royal Infirmary—The Director (November 30).

A lecturer in biology in the London (Royal Free Hospital) School of Medicine for Women—The Warden, 8 Hunter Street, Brunswick Square, W.C.1 (December 4).

Chemists in the Department of the War Department Chemist—The Under-Secretary of State (C.5), The War Office, S.W.1 (December 5).

A temporary assistant (Grade III) in the Admiralty Chemical Pool for work on metals at an Admiralty establishment in Sheffield—The Secretary of the Admiralty (C.E. Branch), Whitehall, London, S.W.1 (quote No. *C.E.*7123/36) (December 11).

A principal of the Kadoorie Agricultural School, Tulkarm, Palestine—The Director of Recruitment (Colonial Service), 2 Richmond Terrace, Whitehall, London, S.W.1 (December 15).

A second assistant petroleum technologist to the Government of Trinidad and Tobago—The Director of Recruitment (Colonial Service), 2 Richmond Terrace, Whitehall, S.W.1 (December 17).

A professor of applied chemistry in the Andhra University, Waltair, South India—The High Commissioner for India, General Department, Iadin House, Aldwych, W.C.2 (December 20).

A professor of chemistry in University College, Southampton—The Registrar (January 1).

A University professor of mechanical engineering in Benares Hindu University—The Pro-Vice-Chancellor (January 15).

A scientific research fellow in Girton College, Cambridge—The Secretary (February 1).

An executive engineer for the Public Works Department of Sierra Leone—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (Quote M/4572).

Letters to the Editor

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

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 887.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Nature of the Excretion of Nitrogen Compounds from Legume Nodules

FURTHER to our earlier communications concerning the excretion of nitrogen compounds from the nodules of leguminous species, I wish to add the following: a distinct excretion occurs only in media capable of absorbing the excreted amino acids. In water cultures, whether plain or filled with glass beads, the excretion is quite negligible. Addition of cellulose to the liquid medium results in a clearly detectable excretion. A much more powerful excretion occurs, however, in media consisting of kaolin, sand or soil. These materials absorb the excreted amino acids to such an extent that their extraction from the medium with water is very tedious and difficult. On the basis of these observations, it seems that the distribution of the nitrogen compounds between the nodule and the external medium is determined by an equilibrium. The presence of absorbing materials shifts this equilibrium to the side of the medium, and causes the excretion to occur. On the other hand, the host plant also takes up nitrogenous matter from the nodules. The equilibrium is therefore a very complicated one, and the rate of excretion depends largely on the ability of the host plant to utilize the nitrogen compounds fixed and synthesized in the nodules. Our observation that the rate of excretion is the higher, the greater the quantity of sand, is in accordance with this view. We have shown earlier[1] that the air content of the medium influences largely the function of the nodule, although it apparently has no specific effect on excretion, as we assumed earlier.

Another fact which is likewise in accordance with the above view is that the rate of excretion seems to increase in associated cultures of inoculated legumes and some non-legumes capable of utilizing the excreted nitrogen compounds. In our sterile culture system in quartz sand, wheat and barley utilize the excreted diamino acid, but only very little aspartic acid. However, even under these conditions, for example, in associated cultures of peas and barley, the amount of nitrogen in the barley and in the sand is generally higher than the amount of nitrogen in sand in cultures of peas alone. This is shown in Table I.

TABLE I.

3-litre Woulff's bottles; 3·4 kgm. quartz sand; period of growth: May 2–June 9, 1932. Nitrogen-free nutrient solution. The sand contained initially 2·7 mgm. N per kgm. sand.

	Culture No.	Inoculation	Dry weight		(N mgm.)*			Total fixed N (mgm.)	Excreted N (% of total fixed N.)
			Peas	Barley	Peas	Barley	Sand		
Exp. 1. One pea + one barley in each flask	1	Strain H IV	1·462	1·791	41·8	31·6	89·0	162·4	74·3
	2	,,	2·048	1·660	55·8	21·7	77·4	154·9	64·0
	3	,,	1·382	1·432	42·6	24·4	93·9	160·9	73·5
	4	,,	2·400	0·655	60·7	13·0	67·6	141·3	57·0
	5	None; control	0·297	0·063	6·4	0·7	10·0	—	—
Exp. 2. Two peas in each flask	1	Strain H IV	2·564	—	74·5	—	79·4	153·9	51·6
	2	,,	4·644	—	130·1	—	87·2	217·3	40·1
	3	,,	5·788	—	138·9	—	91·3	230·2	39·7
	4	,,	5·225	—	123·4	—	96·7	220·1	44·0
	5	None; control	0·512	—	14·4	—	9·5	—	—

* All nitrogen values for the inoculated cultures are given after subtraction of the corresponding values for the uninoculated controls.

TABLE II.

Sown May 22, 1934; peas harvested August 4, potatoes September 5. Nitrogen-free nutrient solution.

	4 peas + 1 potato		8 peas + 1 potato		Control not inoculated; 4 peas + 1 potato	
	Dry weight (gm.)	N (mgm.)*	Dry weight (gm.)	N (mgm.)*	Dry weight (gm.)	N (mgm.)*
Pea crop	7·117	169·1	25·310	640·2	1·495	30·4
Potato crop, tops	13·832	330·3	17·510	396·9	2·957	53·9
,, tubers and roots	25·410	287·9	33·173	332·1	8·940	92·4
,, total	39·242	618·2	50·683	729·0	11·897	146·3
Nitrogen in the sand		90·1		115·5		66·6

* Controls not subtracted.

The excretion is particularly powerful in ordinary pot cultures of legumes and non-legumes, when other bacteria decompose aspartic acid and thus enable the non-legumes to utilize the entire quantity of excreted nitrogen. This is especially the case in cultures of peas and potatoes. The latter plant takes up enormous amounts of nitrogenous matter, and may deprive the pea of nitrogen to such an extent that its growth is seriously impaired. Table II shows that the injury to the pea is the greater the less the number of peas in the culture.

It will be seen that in a culture with four peas to one potato plant, the potato has received from the pea nodules about 3·5 times more nitrogen than the peas themselves. Nitrogen in the potato crop has thus increased by 471·9 mgm. and in peas by 138·7 mgm. (after subtraction of the controls). The pea nodules have thus fixed nitrogen mainly for the benefit of the potato, at the expense of the pea. In another pot experiment in which low-nitrogen loam soil was used as the medium, the potato obtained from the nodules ten times more nitrogen than the peas.

Oats, wheat or barley are not able to deprive the peas of nitrogen to a similar extent, although in associated cultures of even these grasses and peas the growth of the latter is impaired with decreasing ratio of peas to non-legumes. This observation, made by us some years ago, is easily explained on the basis of the above view concerning the nature of excretion.

The extent of nitrogen fixation by inoculated legumes is thus not determined solely by the amount of nitrogen taken up by the legumes but also by the amount of nitrogen which is excreted from the nodules. I therefore wish to propose the following terms for general use :

Total fixed nitrogen=Nitrogen given up by the nodules to the host plants and the medium.

Extent of excretion=amount of nitrogen excreted into the medium, as a percentage of the total fixed nitrogen.

In associated cultures the excreted nitrogen naturally also includes the amount of nitrogen received by the non-legumes from the nodules of the legumes.

Our experiments show that the extent of excretion varies greatly with different strains of the nodule organisms. Preliminary observations also seem to indicate that a relatively low nitrate fertilization lowers the excretion much more than the nitrogen fixation. Further work is needed to throw more light on this question.

Further to our earlier communications on the nature of the excreted N-compounds, it should be mentioned that the excreted aspartic acid is the *l*-form. Small amounts of fumaric acid could also be isolated from the extract. The excreted amino-nitrogen can be determined quantitatively, both by the van Slyke method and also with ninhydrine at *p*H 7. This obviates the necessity of concentrating the extract.

Our work on the excretion of the nitrogen compounds from the nodules and on associated cultures of legumes and non-legumes will be published in the *Journal of Agricultural Science*, while our investigations on the chemical nature of the excreted compounds will be described in the *Biochemical Journal*.

ARTTURI I. VIRTANEN.
Laboratory of the Foundation
for Chemical Research,
Helsingfors.
Oct. 13.

[1] Virtanen and v. Hausen, *J. Agric. Sci.*, ii, **25**, 278 (1935).

Identification of Vitamins by Molecular Distillation

WHEN oils containing vitamins are submitted to molecular distillation[1], the fractions removed as the temperature rises contain successively more vitamin until a maximum is reached, after which the potency falls rapidly to zero because all the vitamin has been eliminated. The elimination follows a simple law and the ideal *elimination curve* possesses a slightly skew shape which is easily recognizable. Deviations from the shape indicate imperfect conditions of distillation or the presence of more than one form of the vitamin. The maximum of the curve can be located with an accuracy of ± 2° C., and is as definite a characteristic as a boiling point, if less precise. Separate elimination curves can be detected for more than one material if the maxima are 5° C. apart. When two potent materials yield different maxima, it is proof that they are different substances. Coincident maxima provide only partial evidence that the substances are identical. When oils containing traces of many impurities are distilled, their maxima occur in a fixed order, and if one can be identified, the others may be recognized. This enables dyes, etc., to serve as distillation pilots. For example, when traces of Celanthrene Red 3B and dimethyl-amino-anthraquinone are distilled with an oil containing the free vitamins A and D, the reddest fraction is found to hold the most vitamin A, and the bluest, the most vitamin D. The elimination curves of the two vitamins correspond almost exactly with those of the dyes (Fig. 1).

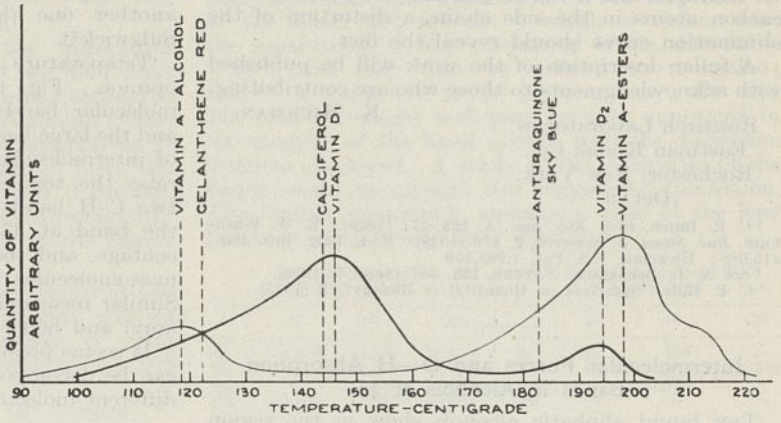

FIG. 1.

Elimination curves can be found more accurately if the distillation is made from an oil which yields a constant quantity of distillate for each equal increment of the absolute temperature. Such an oil can be made by esterifying glycerin with a mixture of fatty acids. By mixing various fish oils with this constant yield oil, it has been found that the vitamin A

in the cod liver and halibut liver oils exists almost entirely in the form of esters. The distortion of the curve shows that the esters are derived from most of the fatty acids present. A very small quantity of vitamin A alcohol is also found, the quantity increasing with the lower grades of oil. The vitamin D in cod liver oil yields a maximum halfway between the vitamin A alcohol and esters. The maximum is accompanied by a second high-boiling maximum which grows in relative size as the distillation is performed more quickly and carefully. Evidently vitamin D occurs partly free and partly as a mixture of esters, the esters surviving for only a few seconds at the temperature of distillation.

The maxima of free vitamin D and calciferol are found to coincide within 5° (Fig. 1). Nevertheless, when a mixture of the two is distilled, the maximum is not increased in height, but instead, two new maxima appear separated by 20°. Evidently calciferol and free vitamin D react, producing other antirachitic substances.

Recently, by studying some substituted di-aminoanthraquinones, it has been determined that the maxima are shifted about 5° C. for each additional carbon atom in the side chain. Calciferol is reported by Windaus *et al.*[2] to differ from vitamin D_3 by one carbon atom and one double bond in the side chain. It should be possible to settle the point by measurements of the elimination maxima; and this work is in progress.

The elimination method is being applied to the antirachitic vitamins in various fish oils; the distribution of the esters is found to differ greatly from one fish to another. Should there be more than one form[3] of the vitamin (in yellow fin tunny liver, for example) and if the second differs by one or more carbon atoms in the side chain, a distortion of the elimination curve should reveal the fact.

A fuller description of the work will be published with acknowledgments to those who are contributing.

K. HICKMAN.

Research Laboratories,
Eastman Kodak Co.,
Rochester, New York.
Oct. 9.

[1] C. R. Burch, *Proc. Roy. Soc.*, A, **123**, 271 (1929). E. W. Washburn, *Bur. Stand. J. Research*, **2**, 476 (1929). F. E. Carr, Brit. Pat., 415,088; Hickman, U.S. Pat. 1,995,559.
[2] See A. L. Bacharach, NATURE, **138**, 387 (Sept. 5, 1936).
[3] C. E. Bills, "Symposia on Quantitative Biology", **3** (1935).

Intermolecular Forces and O—H Absorption Bands in Alcohols at 3μ

THE liquid aliphatic alcohols show in the region of 3 μ two C–H bands, 2870–2890 cm.$^{-1}$ and 2950–2970 cm.$^{-1}$, and a very large and intense band at about 3350 cm.$^{-1}$, which is generally attributed to a fundamental O–H vibration. If we dilute to a very small concentration, we observe for ethyl alcohol in carbon tetrachloride that, at normal temperature, in passing from a concentration of 3·33 mol/lit. to 0·005 mol/lit. and keeping the product concentration by thickness constant, the C–H bands retain their intensity, whereas the large O–H band, which absorbed 90 per cent, has disappeared completely at a concentration of 0·02 mol/lit. A new narrow and well-defined band appears then at 3640 cm.$^{-1}$, and its intensity grows with dilution. The molar extinction coefficient passes from 4, for a concentration 0·05 mol/lit., to 15 for a concentration 0·005, instead of remaining constant. The results for alcohol in carbon disulphide are in complete agreement with those mentioned above.

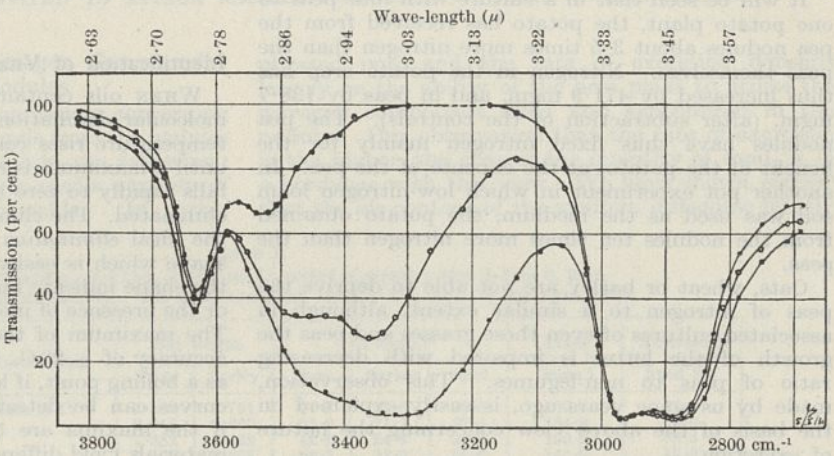

FIG. 1. Absorption of a 5 mm. layer of ethyl alcohol (0·1 mol/lit.) in carbon tetrachloride. Bottom curve, at 0° C.; middle curve, at 20° C.; top curve, at 70° C.

In our opinion, the band at 3640 cm.$^{-1}$ corresponds to the O–H vibration in the isolated alcohol molecule. With dilution the relative number of monomolecules grows, and this explains the increase in intensity of the band. This result is in agreement with the polarization measurements of C. P. Smyth, continued by K. L. Wolf, as well as his measurements of heat of mixing[1].

The large band which disappears with dilution is, on the contrary, due to intermolecular actions, for example, the hydrogen atom of one molecule vibrating with the oxygen atom belonging to another one (hydrogen bond, as interpreted by Sidgwick[2]).

Temperature effect measurements confirm our opinion. Fig. 1 shows that at 0° the O–H monomolecular band at 3640 cm.$^{-1}$ absorbs 56 per cent and the large band at 3350 cm.$^{-1}$ showing the influence of intermolecular forces absorbs 96 per cent. If we raise the temperature to 70°, the intensity of the two C–H bands remains exactly the same, whereas the band at 3350 cm.$^{-1}$ only absorbs a small percentage, and the intensity of the O–H band of the monomolecules increases and absorbs 64 per cent. Similar measurements on solutions of methyl, butyl, amyl and heptyl alcohols confirm this result.

It seems possible that the large band at 3350 cm.$^{-1}$ can be decomposed into two bands corresponding to different molecular aggregations (polymers).

J. ERRERA.
P. MOLLET.

University,
Brussels.
Oct. 5.

[1] C. P. Smyth, "Dielectric Constant and Molecular Structure" (New York, 1931). K. L. Wolf, *Trans. Far. Soc.*, Edinburgh Meeting 1936; in the press.
[2] N. V. Sidgwick, "The Electronic Theory of Valency" (1927).

Ultra-violet Luminescence of Sodium Chloride

SINCE the fluorescence and phosphorescence of sodium chloride are extremely weak in the ultra-violet, there have been few investigations of them until now[1]. Our measurements were carried out by a very sensitive photon counter. Samples of clear sodium chloride crystals were exposed to X-rays of 50 kv. and then irradiated by visible light for periods of a few seconds. Investigating the radiations of such crystals with the photon counter, we found a distinct ultra-violet phosphorescence which is remarkably changed if the crystal is plastically deformed.

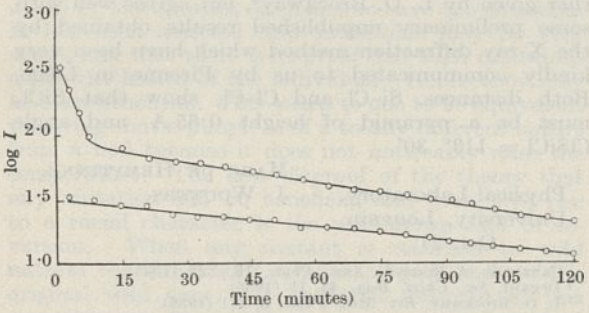

FIG. 1.

Fig. 1 shows the results. Curve I represents the decay of the intensity I of the ultra-violet phosphorescence of a sample of sodium chloride, which is perfectly free from deformation. Curve II shows the same for a crystal which was plastically deformed (bent) after irradiation with X-rays.

Comparing the two curves, it is evident that in the case of the bent crystal there are two monochromatic components in the ultra-violet phosphorescence of sodium chloride. One of these has a short half-life and is only present in deformed crystals while the other one (large half-life) is noticeable in all cases.

We have investigated the wave-length of these two components by means of a quartz monochromator. Component I has the wave-length $\lambda = 2350$ A.; while for component II, $\lambda = 2950$ A.

Comparing these results with the absorption measurements of Hilsch and Pohl[2] we find that component I ($\lambda = 2350$ A.) corresponds to a transition of the electron from the level of the F-centres (*Farb-Zentren*) to the ground-level, whereas component II ($\lambda = 2950$ A.) corresponds to a transition from the level of the F-centres to the level of the U-centres. It is interesting to find that the transition probability of component II is greatly dependent on the degree of deformation of the crystal.

Finally, we measured the excitation curve of the ultra-violet fluorescence of sodium chloride and we got more information about the origin of component II. The results of these investigations will be published later.

M. SCHEIN.
M. L. KATZ.

Physical Institute,
University,
Odessa.
Sept. 18.

[1] J. O. Perrine, *Phys. Rev.*, **22**, 48 (1923). W. Kudrjawzewa, *Z. Phys.*, **90**, 489 (1934). Otto Glaser and F. E. Beasley, *Phys. Rev.*, **47**, 570 (1935).

[2] R. Hilsch and R. Pohl, *Götting. Nach.*, **46**, 322 (1933); **52**, 406 (1933); **1**, 115 (1934).

Ultra-violet Band Systems of the Emitters GeCl and GeBr

THE available data for the band systems of diatomic halides of Group IV(b) elements are fragmentary and give conflicting indications of the nature of the ground states, for which either $^2\Sigma$ or $^2\Pi$ is theoretically possible, and the latter has been regarded as more probable[1]. We have recently made observations of band systems of GeCl and GeBr, which seem to clarify the situation considerably.

Through the kindness of Sir Gilbert Morgan and Dr. G. R. Davies, we have been able to use a quantity of their germanium and germanium dioxide for the preparation of the tetrachloride and tetrabromide. Heavy-current tube-discharges through the vapours of these compounds develop the desired band systems with sufficient intensity to be photographed in a quartz Littrow spectrograph (Hilger's E 1). Each system consists of bands degraded towards shorter wave-lengths, the band-heads being represented approximately by :

$$\text{GeCl}: \quad \nu = \begin{Bmatrix} 33{,}992{\cdot}2 \\ 33{,}017{\cdot}2 \end{Bmatrix} + (526{\cdot}6\,u' - 0{\cdot}3\,u'^2) - (408{\cdot}4\,u'' - 1{\cdot}6\,u''^2)$$

$$\text{GeBr}: \quad \nu = \begin{Bmatrix} 33{,}413{\cdot}4 \\ 32{,}263{\cdot}4 \end{Bmatrix} + (383{\cdot}7\,u' - 0{\cdot}7\,u'^2) - (296{\cdot}6\,u'' - 0{\cdot}9\,u''^2)$$

where $u' = v' + \frac{1}{2}$ and $u'' = v'' + \frac{1}{2}$.

The observed electronic separation in germanium chloride is, as would be expected, intermediate between those in the lowest states of SiCl[2] and SnCl[3,4] and smaller than that in GeBr. Analogy suggests that these two separations of 975 cm.$^{-1}$ and 1150 cm.$^{-1}$ occur in the lower (presumably the ground) states of GeCl and GeBr. The first of these emitters has the same number of electrons and nearly the same mass as SiBr, the lower electronic state of which is apparently single[5], while the second stands in the same relation to SnCl, the lowest state of which is known[4] to be $^2\Pi$. For each of these iso-electronic pairs certain similarities in the results of analysis of the band systems are to be expected, and are, in fact, observed, except in regard to the lack of electronic doubling in SiBr.

A possible explanation of the apparent anomaly in the lower state of SiBr may lie in the fact that the electronic separation to be expected is of the order 400–450 cm.$^{-1}$, which is rather near the separations of the vibrational levels, $424{\cdot}6u'' - 1{\cdot}3u''^2$, and may thus be difficult to recognize; and if it happened to lie between, say, 420 and 425 cm.$^{-1}$, it might well pass entirely unnoticed in the analysis of the band system with the dispersion hitherto employed. A study of the intensities of the bands seems to support this suggested explanation. The further apparently anomalous case of the lead halides[6,7] has already been discussed.

1. Electronic energy ν_e of upper state

	F	Cl	Br
Si	34,639	34,103	33,570
Ge	—	33,992	33,413
Sn	—	33,582	—
Pb	32,565	21,867	20,884

2. Electronic interval $\delta\nu_e$ in lower state

	F	Cl	Br
Si	161	208	—
Ge	—	975	1,150
Sn	—	2,360	—
Pb	—	—	—

3. Value of ω_e'

	F	Cl	Br
Si	1011·2	(698·7)	578·3
Ge	—	526·6	383·7
Sn	—	432·5	—
Pb	397·8	228·6	152·5

4. Value of ω_e''

	F	Cl	Br
Si	856·7	535·4	424·6
Ge	—	408·4	296·6
Sn	—	353·5	—
Pb	506·9	304·2	207·5

The above tables of data for this MX group show that the electronic separations $\delta\nu_e$ in the lower

states, the electronic energies ν_e of corresponding upper states, and the vibrational frequencies ω_e' and ω_e'', all have the expected trends as the mass of M or X is increased, namely, a slight decrease of ν_e, an increase in $\delta\nu_e$, and decreases of ω_e' and ω_e''.

L. A. BASHFORD.
Imperial College, H. V. A. BRISCOE.
London, S.W.7. W. JEVONS.
Oct. 22.

[1] R. K. Asundi and R. Samuel, *Proc. Ind. Acad. Sci.*, **3**, 346 (1936).
[2] W. Jevons, *Proc. Phys. Soc.*, **48**, 563 (1936).
[3] W. Jevons, *Proc. Roy. Soc.*, A, **110**, 365 (1926).
[4] W. F. C. Ferguson, *Phys. Rev.*, **32**, 607 (1929).
[5] E. Miescher, *Helv. Phys. Acta*, **8**, 587 (1935).
[6] G. D. Rochester, *Proc. Roy. Soc.*, A, **153**, 407 (1936).
[7] F. Morgan, *Phys. Rev.*, **49**, 47 (1936).

SINCE writing the foregoing letter, we have obtained evidence for the correctness of the explanation there suggested of the apparent lack of electronic doubling in the lower state of SiBr. Some time ago we obtained spectrograms in the Hilger E 1 instrument of a heavy-current tube-discharge through $SiBr_4$ vapour in order to see whether an alternative to Miescher's arrangement (*loc. cit.*) of the SiBr band-system was possible. Miescher's analysis was confirmed, but several of the band-heads were found to have a companion, about 4 cm.$^{-1}$ towards the red, which he did not record. The additional heads could not be included in Miescher's analysis or be explained as a Br isotope effect or be ignored. It now appears that they constitute a fragment (including $1 \rightarrow 0$, $0 \rightarrow 0$ and $0 \rightarrow 1$ band-heads) of the expected sub-system, and are accounted for by the smaller of the two independent coefficients in the following provisional formula for the whole system,

$$\nu = \left\{\begin{matrix}33{,}571{\cdot}2\\33{,}147{\cdot}2\end{matrix}\right\} + (574{\cdot}8u' - 4{\cdot}0u'^2) - (424{\cdot}7u'' - 1{\cdot}4u''^2).$$

Apart from the inclusion of this smaller coefficient, the formula differs only slightly from Miescher's. Comparison with other band systems of the same group of emitters suggests that the electronic separation of 424 cm.$^{-1}$ now observed belongs to the lower ($^2\Pi$) state. Thus the anomaly to which we referred disappears.

L. A. BASHFORD.
Oct. 30. H. V. A. BRISCOE.
W. JEVONS.

Geometrical Constitution of Silicichloroform

POLARIZATION measurements of Raman lines of chloroform made by Cabannes[1] and discussed by him show that this molecule has not a perfect pyramidal symmetry. On the other hand, recent electron diffraction measurements discussed by Degard[2] are not able to fix with precision the position of the carbon atom in the chloroform molecule. Is it so, also, for silicichloroform? To measure the state of polarization of the Raman lines of silicichloroform we employed the same method as that used by Cabannes. Optical parts of the instrument were made by the Société Belge d'Optique; we have to thank M. Cailler, director of that company, for his kindness. The spectrograph used was a Hilger E 443. The following results were obtained:

$HCCl_3$	ω:	261	758	365	667	1213	3019
	ϱ:	0·7	0·68	0·22	0·06	6/7	0·32
$HSiCl_3$	ω:	179	587	250	489	799	2258
	ϱ:	0·846	0·74	0·29	0·056	0·79	0·20

It appears that conclusions similar to those for chloroform apply in the case of silicichloroform. The number of Raman lines is in favour of a pyramidal structure of $SiCl_3$. Their classification compared with that of chloroform is given in the above table. The value of 0·846 and 0·740 given for 179 and 587 are greater than 0·7 and 0·68 for chloroform, showing that the $SiCl_3$ pyramid is more regular than the CCl_3 pyramid.

We have also examined silicichloroform by electron diffraction methods, using for this purpose a de Laszlo apparatus. We obtained the following results:

$$Si\text{–}Cl = 2{\cdot}05\ A. \quad Cl\text{–}Cl = 3{\cdot}39\ A.$$

The distance Cl–Cl is not quite in agreement with that given by L. O. Brockway[3], but agrees well with some preliminary unpublished results obtained by the X-ray diffraction method which have been very kindly communicated to us by Pirenne in Liège. Both distances, Si–Cl and Cl–Cl, show that $SiCl_3$ must be a pyramid of height 0·65 A. and angle $ClSiCl = 113° 30'$.

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Physical Laboratory, J. WOUTERS.
University, Louvain.
Oct. 21.

[1] Cabannes et Rousset, *Ann. Phys.*, **19**, 229 (1933).
[2] Degard, *Soc. Chim. Belg.*, **45**, 15 (1936).
[3] L. O. Brockway, *Rev. Mod. Phys.*, **8**, 231 (1936).

Natural Selection

IN NATURE of October 17, there appears a letter by my friend Prof. Hale Carpenter entitled "Insect Coloration and Natural Selection", written in answer to one of mine on natural selection published in these columns a few weeks previously. I maintained that "natural selection" was an "explanation" neither of mimicry nor of any other biological phenomenon whatever. Prof. Carpenter does not meet my arguments, but merely reiterates his conviction that natural selection is the only explanation which will enable us to account for mimicry.

I wish to restate my main argument more concisely and particularly. 'Natural selection', that is, the survival of the few amongst the many born, is a mere truism which we all accept. But 'natural selection' *as an explanation of evolution* implies the constant occurrence of random heritable variations in all directions, so that any conceivable demand of the environment may be met by some variation. In a word, it is the doctrine of evolution by pure chance.

Do such random heritable variations really occur? The experimental evidence entirely negatives this assumption. Ordinary fluctuating variations which can be graphically represented on a 'curve of error' are certainly not inherited. This has been proved by the 'pure line investigations' carried out by Johannsen on the bean, by Agar on the crustacean *Simocephalus* and by Jennings on the protozoan *Paramecium*. When the same results are reached by the examination of a flowering plant, a crustacean and a protist—organisms belonging to as diverse groups of living things as could be well imagined—it is surely just to conclude that these results express a universal law.

However, heritable deviations from the normal, formerly known as 'sports' but now as 'mutations', undoubtedly do crop up in the farmyard and in the cultivated field and garden. Can they furnish the material on which 'natural selection' can work so as to produce evolution? The answer from experiment is again decidedly no! Mutations have been produced by subjecting the eggs of insects to heat and

to X-rays. These agents kill a large number of eggs; some survive unhurt and a few are half-killed and give rise to mutations. Mohr, the greatest European authority on *Drosophila* work, arranged all the mutations observed in this insect on a scale which he compared to the colours of the spectrum: the slightest were at the red end and the most pronounced at the violet end. All produced a loss of viability and vigour which was proportionate to the extent of the mutation. That such weakened specimens could ever give rise to a new natural race is utterly incredible.

I am aware that desperate attempts have been made by the apostles of chance to save the situation. It has been asserted that mutations may be very small, and that there is no proof that such mutations affect the health of the individual. Hence they may be even beneficial. This seems to one to be equivalent to saying that a pimple is of a totally different nature from a boil because it does not noticeably raise the temperature. The best disproof of the theory that any mutation can be beneficial and even give rise to a racial character is the well-known fact of reversion. When any mutant is returned to wild natural conditions and *survives*, it goes back to the original wild type. A beautiful example of this reversion was furnished me by a very distinguished botanical colleague. The common flowering plant *Calceolaria* is a native of Mexico and produces bright yellow flowers. As all are aware, gorgeously coloured garden varieties of this flower are cultivated. My friend in visiting the hill stations of India saw these varieties in the gardens of the residents there: the plants had in many cases escaped on to the hill-sides and, in every case, had reverted to the wild *Calceolaria* and produced yellow flowers.

Thus the 'selectionist' is shut in between the jaws of a vice and deprived of the material for evolution. The only escape is by means of the heritability of long-continued acquired habit, which has now been amply demonstrated. That evolution, so far as structure is concerned, is an infinitely slow process was shown by Woltereck, when he demonstrated that 16,000 years has been required to convert the small Crustacea inhabiting the post-glacial lakes of Bavaria —not into new species—but into new varieties.

When, therefore, Prof. Carpenter asks how I account for the colours and shapes of the insect mimics, I reply that I do not attempt such a futile task in the present state of our knowledge. Only when we know in infinite detail the steps of the process by which the mimicking pattern has been produced can the task be profitably attempted. If Prof. Carpenter really wishes to know how the evolution of colour proceeded, let him go to the museum at Tring. There he will see trays containing hundreds of insects of the *same* species; different trays are taken from adjoining localities, and as one passes along them one sees the gradual change of colour with locality, until if one compares the end terms in the series one seems to be looking at two different species.

I shall conclude by giving one charming instance of "evolution by natural selection" supplied me by a friend and colleague on the staff of the Plymouth Marine Biological Station. The angler fish, as all marine biologists know, fishes for its prey by a flexible rod with a bait at the end. The rod is one of the dorsal spines: the bait a bit of glittering skin. But the angler is not an indiscriminate devourer of all that comes its way. When it sees a sea-bream approaching, it lays back its rod into a groove and makes no attempt to catch the fish, which has a row of hard dorsal spines and is a most unpleasant morsel to swallow. But when the angler sees a pollack, it erects the rod and dangles the bait so as to lure the fish within reach of its powerful jaws—for the pollack is a soft-spined fish. So we see how by a series of "beneficent mutations" hard spines have been gradually acquired by the sea-bream in order to protect it against the angler.

The only difficulties about this explanation are: (1) that hard spines are an original and primitive characteristic of teleostean fish and date back to the Mesozoic epoch, and are also characteristic of many families that never have any opportunity of coming into contact with an angler; (2) that the unprotected pollack are one of the most abundant species of fish, which exist and swarm in countless millions in all northern seas and are quite indifferent to the toll levied on their numbers by the angler.

Selectionist theories tested in the field wear a very different aspect from that which they exhibit in the study.

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Nov. 2.

Regeneration in Arachnida

IN view of the remarks made by Mr. T. H. Savory[1] on the failure of a harvestman (Opiliones) and of *Pholcus Phalangioides* (a spider) to regenerate lost limbs, the following observations appear relevant.

In 1932 and 1933 it was found that four males of the spider *Theridion ovatum* Cl. (*Phyllonethis lineata*) failed to regenerate front legs removed one and two days after the penultimate cast. Fourteen males failed to regenerate first legs and thirteen to regenerate lost palpi. In one male there was no regeneration at all of a palp lost in the anti-penultimate instar. With *Linyphia triangularis* Cl., four males failed to regenerate front legs and in one case second legs, but in only three cases were the results significant (the amputations being then made thirteen and fourteen days before the last moult). Eight males failed to regenerate palpi the femora of which were severed; two cases were significant. The palpi of two males were partly regenerated after amputation of the joint between femur and tibia; one specimen found without a palp in the penultimate instar developed an incomplete one after the last moult. These were all the experiments made.

Cases of non-regeneration in *Dolomedes* are recorded by Bonnet[2], who deals with the whole question of regeneration in great detail and points out that a limb is regenerated as a rule if the interval between the amputation and the following moult is not less than three quarters of the time separating the moults.

Savory states that failure to regenerate a leg "might be related to the contrast between the length of the limbs and the shortness of the cephalothorax, within which it would be impossible to develop a leg long enough to be useful when exposed by ecdysis". This would imply that the new limb is developed within the cephalothorax, whereas it was shown first by Blackwall[3] and most recently and conclusively by Bonnet[2] that the new limb is formed spirally within the remaining part of the old one, even if the coxa alone remains.

It is scarcely likely therefore that the relative size of cephalothorax and legs has much to do with the problem. Moreover the palpi which, especially in the male spider, are of the greatest use, are sometimes not replaced, and they are comparatively small compared with the cephalothorax.

G. H. LOCKET.

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Harrow.
Oct. 29.

[1] T. H. Savory, NATURE, **138**, 550 (1936).
[2] P. Bonnet, *Bull. Soc. d'Hist. Nat. Toulouse*, ii, **59**, 237–700 (1930).
[3] J. Blackwall, *Ann. Mag. Nat. Hist.*, **15**, 234 (1845).

The Common Stick Insect

SINCE 1910, we have bred a continuous supply of the common stick insect (*Carausius*). These are lodged in a glass rectangular case 18½ in. × 9 in. × 15½ in. fitted with a movable glass front. Two glass vases holding ivy leaves in water furnish food and moisture for the insects. The debris is removed from the case once a fortnight, when fresh food and water are supplied. The eggs which lie about in the debris are picked out and placed in a small box which is kept inside the cage, so that they are subject to the same temperature and moisture conditions as the adults. There is always a mixed population of insects in the cage, ranging from newly hatched individuals to one year old adults.

We found that during the very sunny months of the year, the excessive transpiration of the ivy leaves made the air in the chamber too damp and so favoured the growth of mould over debris and elsewhere. To afford more efficient ventilation, we removed the glass sliding door and replaced this by a piece of cotton veiling of 1/16 in. hexagonal mesh. This was not new material. It had been washed several times, but it was quite strong. The adults particularly made their way to the netting and clung to it.

On account of the exigencies of vacation in 1936, the stick insects had been left unattended for three weeks. At the end of that time, all the ivy had been consumed. Small holes were noted in the net when the food supplies were renewed. The netting was replaced. At the end of another three weeks, the food supplies were all eaten and the netting had been attacked more vigorously. On this occasion several holes were ½ in. in diameter, and the smaller holes ¼ in. in diameter were evenly disposed all over its area. Judging by the absence of fibrous material around these holes, it seems certain that the cellulose is eaten by the insects. (A specimen of the netting was kindly examined in the Textile Research Laboratory of Leeds and pronounced to be cellulose.) This experiment slightly modified was repeated, one isolated adult making a hole of diameter 1 in. The insects make no attempt to escape by these holes, whether or no because of anatomical impossibility we have not been able to decide.

Younger adults were then used for the experiment. They similarly attacked the material greedily.

Lastly, a piece of twill calico well washed was placed in front of the cage and the insects were given sufficient food. This also has been attacked, though as one would expect, the holes are smaller and are not produced so quickly.

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Nov. 1.

Raman Effect in Absolute Perchloric Acid

ACCORDING to recent views, hundred per cent liquid oxacids are pseudo-homogeneous substances, composed of covalent hydroxyl compounds partly associated by means of the unsaturated hydroxyl group. In a few cases, some of the acid molecules may act as proton acceptors, thus forming an acidium salt, accounting for the electroconductivity of the pure acid.

Thus in the case of pure perchloric acid, we have following equilibria :

$$2HOClO_3 \rightleftarrows (HOClO_3)_2 \rightleftarrows [(HO)_2ClO_2]^+ + [ClO_4]^-$$

If a little water be added, there is competition for protons between $HOClO_3$ and H_2O molecules, with water being successful, since it is a stronger acceptor than perchloric acid. In this way, a solid hydronium salt may be formed, the X-ray diffraction pattern of which is, according to Volmer[1], the same as that of ammonium perchlorate. If further water be added, it is used for the hydration of the hydronium and perchloric ions.

$$HOClO_3 + H_2O \rightarrow [H_3O]^+[ClO_4]^- \xrightarrow[H^+]{} [H(H_2O)_x]^+[ClO_4(H_2O)_y]^-$$

If this be true, the Raman spectrum of absolute perchloric acid must be quite different from that of perchloric acid in solution, and some information regarding the nature of the molecules and ions present may be obtained.

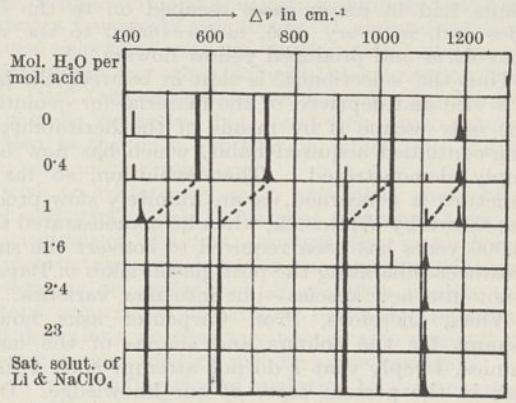

FIG. 1.

Fig. 1 represents the results of our examination of perchloric acid solutions : molten monohydrate (at 50° C.), pure perchloric acid and saturated solutions of lithium and sodium perchlorates. The figures clearly show that perchloric acid solutions up to 70 per cent (2·4 mols. of water) produce exactly the same Raman lines ($\Delta\nu = 450, 620, 922, 1110$ cm.$^{-1}$) as the salt solutions. The nature of the radical corresponding to these lines, which is the ClO_4^- ion, is consequently identical in both cases. When the concentration of perchloric acid becomes higher, all these lines diminish in intensity, while other new lines appear and increase in intensity. The spectrum of pure perchloric acid shows four main lines of frequency number 570, 730, 1026, 1190 cm.$^{-1}$, which have the same aspect and relative intensity as the corresponding lines of the ClO_4^- ion. Therefore, the structure of the perchloric acid molecule cannot be

very different from that of the perchloric ion, being a point-symmetrical one; only the binding forces are greater. Furthermore, the fact that the strongest line of the perchloric ion ($\Delta\nu = 922$ cm.$^{-1}$) persists even in the pure acid, suggests that the formation of an acidium salt is real, though the lines due to its cation are failing. In fact, the addition of a proton to the acid molecule changes but little the vibrating masses, and probably causes only a slight shift of some of the lines towards lower frequencies. The broadening and shifting of line 730 cm.$^{-1}$ is perhaps due to the disappearance of the complex cation.

In connexion with the presence of an acidium salt, the associated molecules give rise to a vibration of low frequency ($\Delta\nu = 422$ cm.$^{-1}$). Owing to the weakness of this line and to the great fluidity of pure perchloric acid, this association cannot be very strong. In presence of water, the association diminishes, while the acidium salt disappears. When both an acid and a water molecule are present, the following molecules and ions exist side by side:

$$(HOClO_3)_2,\ HOClO_3,\ ClO_4^-.$$

Consequently, the hydronium salt is not a homogeneous one. Even in solutions containing 1·6 H_2O molecules, there exist undissociated acid molecules. We think that this may be the case in solutions of perchloric acid of concentration higher than 72·3 per cent (2 mols. H_2O). The acid of constant boiling point would have therefore the composition $[H(H_2O)_2]^+[ClO_4]^-$.

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Oct. 21.

[1] *Lieb. Ann.*, **440**, 200 (1924).

Points from Foregoing Letters

EXPERIMENTS by Prof. A. I. Virtanen show that legume nodules excrete more nitrogen compounds in the presence of kaolin, sand or soil than in water cultures. The excretion is helped by the presence of other plants (barley, potatoes). The author considers that the distribution of the nitrogen compounds between the nodule and the external medium is determined by an equilibrium, and the removal of the compounds, either by adsorption on sand, etc., or their utilization by other plants, leads to further secretion. In certain circumstances, potatoes when grown with peas actually acquire more nitrogen compounds than the peas themselves.

Identification of vitamins present in oils by means of special vacuum ('molecular') distillation is reported by Dr. K. Hickman. The amount of vitamin distilled with the oil over a range of temperature follows a typical 'elimination' curve, and the presence of different vitamins or vitamin compounds can be detected by irregularities in the curve. With this method the author finds that vitamin A in cod liver and halibut liver oils exists almost entirely in the form of esters, while vitamin D (in cod liver oil) occurs partly free and partly as a mixture of esters.

Prof. J. Errera and Dr. P. Mollet bring forward evidence to show that the large absorption band at about 3350 cm.$^{-1}$ in liquid alcohols is not the fundamental O–H band of the isolated molecule, for it is strongly affected by intermolecular forces. The O–H band of the monomolecule appears in dilute solutions or at higher temperature at 3640 cm.$^{-1}$.

Curves showing the ultra-violet luminescence of crystals of sodium chloride, normal and deformed, which were exposed to X-rays and then irradiated by visible light, are submitted by Prof. M. Schein and M. L. Katz. The normal crystals emit ultra-violet light of wave-length 2350 A., while the deformed crystals give, in addition, ultra-violet light of wave-length 2950 A., but of shorter duration. The measurements were carried out by means of photon counters.

L. A. Bashford, Prof. H. V. A. Briscoe and Dr. W. Jevons announce the discovery and analysis of an ultra-violet band system of both GeCl and GeBr, and find that the lower (presumably the ground) states are electronic doublets (probably $^2\Pi$), separations of which are of the orders to be expected from analogy with diatomic halides of other Group IV(b) elements. A possible explanation of the non-detection of a similar doubling in the lower state of SiBr is suggested. In a subsequent letter the authors state that they have observed this doubling in new SiBr spectrograms.

Measurements of the polarization of the Raman spectrum lines of silicichloroform, $HSiCl_3$, carried out by Prof. M. de Hemptinne and J. Wouters, indicate that the pyramidal arrangement of the $SiCl_3$ group of atoms, though not perfect, is more regular than that of the CCl_3 group in chloroform.

Reverting to the controversy around natural selection, Prof. E. W. MacBride states that it cannot explain evolution because ordinary random variations are not inheritable. Further, he considers that mutations can never be beneficial, but lead to loss of viability and consequently cannot produce new races. Prof. MacBride sees the solution of the evolution problem in the heritability of long-continued acquired habit, which, he states, has been amply demonstrated.

G. H. Locket supplies additional instances of spiders failing to regenerate lost limbs and feelers. He refers to opinions of previous investigators concerning the factors which may influence regeneration or the lack of it.

Sister Carmela Hayes reports observations on the common stick insect (*Carausius*) which show that these insects eat cellulose (in the form of calico) even when sufficient food, in the form of ivy leaves, is available.

Diagrams showing the Raman spectra of perchloric acid, pure and in various aqueous dilutions, also of saturated solutions of lithium and sodium perchlorates, are given by R. Fonteyne. From the identity of the lines produced by the salt solutions and solutions of the free acid up to seventy per cent concentration, and their similarity with those of pure perchloric acid, the author concludes that the structure of the perchloric acid molecule cannot be very different from that of the perchloric ion. He considers that when both acid and water are present, then $(HOClO_3)_2$, $HOClO_3$ and ClO_4^- exist side by side.

Research Items

South Indian Blood Groups

A STUDY of the blood groups of a jungle tribe (Pre-Dravidian), the Panīyans of Wynad, has been made by Mr. A. Aiyappan of the Government Museum, Madras (*Man*, November). This tribe was selected as being more isolated and in a purer state than most other Pre-Dravidians. No great degree of admixture with them has taken place, owing to the sexual jealousy of the tribal code. Until recently they were very wild. The Australians, Veddahs and Panīyans, notwithstanding close resemblances, are differentiated by several anatomical characters, especially of the face. The Panīyan is infantile and prognathous, whereas the Veddah is orthognathous; and the supraciliary ridges of the Panīyan are less prominent than in either Australian or Veddah. Nothing is known of the blood-typing of the Veddahs, and comparison is therefore restricted to the Australians. Two hundred and fifty Panīyans from three different settlements were tested. The following results were obtained: *O*, 20 per cent; *A*, 62·4 per cent; *B*, 7·6 per cent; *AB*, 10 per cent. The Australian figures are: *O*, 57 per cent; *A*, 38·5 per cent; *B*, 3 per cent; and *AB*, 1·5 per cent. Thus though there is no close resemblance between the two sets of data, they agree in having a low percentage of *B*. Von Eickstedt makes an interesting suggestion that the Pre-Dravidians may be regarded as the Palæ-Europid type, and this the blood grouping supports. In a correlation table the Panīyans will be placed very near the Lapps and other peoples of western Europe. The Panīyans show a much lower percentage of *O* than the Australians; but Cleland, typing a sample of central Australians, found 38·1 per cent *O* and 61·9 per cent *A*. If further research confirmed this bigger series, we should be able to say that serologically the Australians and Panīyans are closely linked.

Pawnee Archæology

THE Pawnee Indians of Nebraska and Kansas, who formerly occupied permanent villages in the Platte and Loup Valleys and on the Republican in the present State of Nebraska, have been known to the white man since 1541, when they may have been visited by Coronado, and certainly since 1673, when Marquette, the French Jesuit, noted them in his map at some distance north of the Kansa. They were the most numerous and powerful of the tribes constituting the Caddoan linguistic stock, and one of the most important in the Plains area. The tribal organization consisted of four endogamous bands, each functioning as an independent unit, but with the principal chief of the 'Grand' band acting as spokesman for the whole on occasion. One band, the Skidi or "Wolf" Pawnee, seems to have had a different ancestry, or to have been an earlier offshoot from the parent stock, as this branch was less closely bound to the others. A persistent tradition places their original habitat in the south or south-west, while another associates them with stone-built houses, although in fact there is no evidence of a Pueblo connexion. Archæological remains, surprisingly rich and numerous, have been discovered at many of the village sites formerly occupied by the tribe. These, with the documentary history and traditions of the tribe, have been made the subject of detailed examination by Mr. Waldo Rudolph Wedel (Bull. 112, Bureau Amer. Ethnol.). The conclusion at which he arrives is that the material traits in Pawnee culture are drawn in large measure from the east and south-east. They formerly constituted part of the south-east Woodland culture area in its more western peripheral phase, retaining and disseminating many of the traits they acquired throughout the period of their northern residence, until Plains culture disappeared before the European contact.

Treatment of Cancer with an Enzyme Solution

BULLETINS will be issued from time to time by the Hendry-Connell Research Foundation, which will unite in one publication the laboratory and clinical aspects of medical research pursued there. In *Bulletin* No. 1, August, 1936 (Kingston, Ont., Canada), the results to date of the treatment of cases of cancer with a preparation named 'Ensol' are detailed. This is a solution of proteolytic enzymes obtained by digesting malignant tissue, removed at operation, with a pure culture of an anærobic bacillus, *C. histolyticum*. After six days growth, the mixture is centrifuged and filtered through a Berkefeld filter candle to remove organisms, the filtrate obtained constituting the 'Ensol'. Experimentally, when placed upon carcinoma tissue, it produces rapid lysis or solution of the cancer cells. This preparation is injected into the patient, and appears to have no harmful effect. Dr. H. C. Connell contributes papers on the clinical results of 'Ensol' therapy. Patients to the number of 382—cases of inoperable cancer or who refused surgical interference—were treated with 'Ensol' alone. Of these, 180 (47 per cent) ultimately died, 106 (27·7 per cent) appeared to be permanently benefited, and of the remainder most were relieved, and only 13 showed no benefit. Other papers in the *Bulletin* deal with the reactions of 'Ensol', and with the cultural characters of *Clostridium histolyticum*.

The Pine Shoot Moth

FORESTRY COMMISSION BULLETIN No. 16 (H.M. Stationery Office. 1*s*. net) on the pine shoot moth (*Evetria buoliana*) in England is of special significance in connexion with afforestation schemes where conifers are involved. The authors, the late Mr. C. C. Brooks and Mr. J. M. B. Brown, discuss the life-history and possible means of circumventing the ravages of this insect. During the past few years, the Forestry Commission's plantations in East Anglia have suffered severely from its ravages. An investigation of the pest was begun in August 1928 at the Imperial Forestry Institute, Oxford, most of the data being obtained from the Brecklands area. The larva destroys the leading buds or shoots, and unequal growth, or distortion, of the trees is a common effect of its activities. An encouraging factor in the situation is that the Corsican pine suffers notably less from this insect than the Scots pine, and its planting, under certain conditions, is advocated.

Helisoma corpulentum and its Relatives in Canada

THE freshwater mollusc *Planorbis corpulentus* Say, now known as *Helisoma*, is the subject of an extensive monograph by F. C. Baker (Canada Department of Mines, National Museum of Canada, Bulletin No. 79, Biological Series No. 21, 1936. Contributions from the Museum of Natural History, University of Illinois, No. 75). By studying a large number of specimens, it has been possible to clear up a great deal of confusion with regard to this mollusc, and it is shown that the species is a composite one embracing several varieties and at least one additional species, which have been previously referred to *corpulentum*. The large snails of the genus *Helisoma* divide into two well-defined groups, *corpulentum* and *trivolvis*, around which several species and races arrange themselves. In a previous paper (*Ecology*, **11**, 469; 1930) the author directed attention to the significant geographical distribution of certain species of freshwater molluscs in relation to the moraines of the last glacial invasion, the Wisconsin, when the country was greatly changed, many new species being evolved. The study of the helisomas of the *corpulentum-trivolvis* groups illustrates this well, and it is suggested that the parent stock of the large helisomas is probably the widely distributed *H. trivolvis* of the central and eastern part of the United States.

Bacterial Flora of Blow-fly Larvæ

WE have received from Dr. N. Balzam, ul. Nowolipki Nr. 21, m. 5, Warsaw, a short, preliminary communication on this subject. It appears that the larvæ of *Calliphora erythrocephala*, and also the young and older pupæ, contain numbers of bacteria—it is stated about two million per individual. In the course of metamorphosis they disappear from the larval alimentary canal and pass to the tissues of the nymph where they become localized, since they do not occur in the hæmolymph or the newly formed gut. On the last day of pupal development, rapid destruction of the bacteria takes place, and in the great majority of flies none is found several hours after hatching. Dr. Balzam supposes that a cellular or phagocytic activity explains the passage of the bacteria from the larval gut to the tissues of the nymph and their absence from the hæmolymph. The final result is that, owing to complete 'auto-sterilization', the young flies are free from bacteria, and, therefore, do not disseminate pathogenic germs derived from the larvæ. A full account of the work, it is stated, will appear in a coming issue of the *Annales de l'Institut Pasteur*.

Type Cultures of Micro-organisms

THE Medical Research Council has issued a fourth edition of the Catalogue of the National Collection of Type Cultures, maintained at the Lister Institute of Preventive Medicine, Chelsea Bridge Road, London, S.W.1. (*Special Rep. Series*, No. 214. London: H.M. Stationery Office. 2*s*. 6*d*. net). Five years have elapsed since the publication of the third edition of the Catalogue, and during this period a large number of species of bacteria and micro-fungi have been added to the Collection. In the present edition, the generic name *Bacillus* has been restricted to the spore-bearing rods, ærobic and anærobic. Most of the non-sporing rod-forms are listed under *Bacterium* except where well-recognized generic names are in common use, for example, the diphtheroids (*Corynebacterium*) and the organisms of undulant and abortus fevers (*Brucella*). The typhoid and para-typhoid bacilli and food-poisoning organisms are, however, placed under *Salmonella*, and the dysentery bacilli under *Bacterium*. It is pointed out that nomenclature is in a state of flux, and is now being considered by two or three committees. In respect of both bacteria and fungi, a number of synonyms is given for the convenience of those more familiar with the older systems of nomenclature. In addition to bacteria, yeasts, micro-fungi and *Actinomyces*, several strains of bacteriophage, and a few Protozoa and viruses are also stocked. Cultures may be obtained for a small fee on application to the Curator. In order to increase the services that may be rendered to microbiologists, it is requested that cultures be forwarded to the Curator, not only those of newly isolated species, but also fresh examples of types at present conserved in the Collection.

Role of Silicon in the Plant

A SERIES of papers upon this subject by A. Sreenivasan have recently appeared (*Proc. Indian Acad. Sci.*, **1**, **2** and **3**). The inquiry appears to have arisen out of the fact that the rice plant, which accumulates exceptionally large quantities of silicon in its ash, grows so satisfactorily under swamp conditions. This raised the question whether swamp conditions are particularly favourable for silicate supply and also raised anew the question as to the role of silicon in the plant. An extensive series of experiments with rice, grown both in swamp and dry soil conditions, showed that whilst both phosphate and silicate manurial treatments increase yield, silicate is particularly useful in raising the yield from manured arid soils to practically the same level as that in swamp soils. The conclusion is reached that the swamp conditions, therefore, are suited to the rice plants because thus large amounts of silica are supplied to the plant which would otherwise remain unavailable. The role of silicon still remains obscure; the author points out that its accumulation may be a secondary result of growth in swamp conditions which are otherwise favourable to the plant, for example, on account of the resultant presentation of nitrogen to the root system in ammoniacal form. The mode of entry of silicon into the plant also remains obscure; but this detailed examination has cleared up many points as to the behaviour of silicates in the soil, to which they contribute both an alkali and a silicate gel, and as to their significance in the manurial treatment of the rice crop.

Gravity Measurements in Sweden

PART 2 of vol. 25 of *Archives of Mathematics, Astronomy and Physics* of the Swedish Academy of Sciences contains two communications which show that progress is being made in the determination of the geophysics of Sweden. The first, by Drs. G. Ising and T. Eeg-Olofsson, gives an account of the measurements of the gravitational acceleration in the extreme south of the country by a modified form of the quartz fibre torsion method used by Threlfall in Sydney, forty years ago. The horizontal quartz fibre is supported at its ends by the lower forked end of a rod suspended like a pendulum from a support at its upper end. The centre of the fibre has attached to it one end of a small rod of quartz 1·6 cm. long, and the fibre is twisted until the rod is nearly horizontal, when a very small change of gravity makes a considerable change in the position of the free end observed by microscope. The torsional

constant of the fibre is kept constant by surrounding the apparatus with ice. The results show that the variations of gravity with latitude and height are nearly normal over chalk districts, but over the higher districts of Cambrian and Silurian rocks gravity exceeds the normal value by 0·04 or 0·05 C.G.S. units. The second communication, by Dr. G. S. Ljungdahl, on the magnetic anomalies, shows that they are much greater in Sweden than in France and that over the Baltic depression of 400 metres south-east of the island of Uto, the normal deviation of the compass to the west (about 5°) is reduced by 1°. The author hopes, as more results for gravity throughout Sweden become available, to trace further relations between regional anomalies of gravitation and the earth's magnetism.

Sound Insulation by Double Partitions

J. E. R. CONSTABLE, working in the National Physical Laboratory, has investigated the effect of introducing absorbent materials into the air space between light double partitions (*Proc. Phys. Soc.*, **48**, 690; 1936). Previous work had shown that the efficiency of a double partition for sound insulation was mainly dependent on the spacing between the panels. A calculation showed that the transmission would be considerably reduced by absorbing, inside the space between the panels, the sound which is reflected back and forth there. Experiments made by introducing acoustic felt into the space between double walls of thin iron or aluminium produced improvements in sound insulation which were in agreement with calculation and were of the order of 10 decibels.

Entropy of Deuterium Oxide

THE calorimetric entropy of ordinary water does not agree with entropies calculated from band spectrum and reaction data. An explanation recently given by Pauling assumes a random orientation of hydrogen bonds in the crystal. The entropy of deuterium oxide ('heavy water') shows a similar discrepancy (E. A. Long and J. D. Kemp, *J. Amer. Chem. Soc.*, **58**, 1829; 1936). The specimen had a density of 1·10781, corresponding with 99·92 atomic per cent, and a melting point of 276·92° K. The latent heat of fusion is 1,501 gm. cal. per mol. The calorimetric entropy of the liquid at 298·1° K. is 17·27 E.U.; the value which should be used in thermodynamical calculations is 0·806 E.U. higher on the basis of Pauling's theory. From the measured heat capacities and the known heat of sublimation, the calorimetric entropy of D_2O gas at 273·1° K. is 45·89 E.U. at 1 atm. pressure. The value from spectroscopic data is 46·66 E.U., giving a discrepancy of 0·77 E.U. between calorimetric and spectroscopic values. This is in good agreement with the theoretical value of 0·806, which is evidence for the correctness of Pauling's theory.

Indium

THE metal indium, belonging to Group III of the Periodic Table, has been very scarce. It is found in small amounts in certain zinc blendes, in zinc carbonate minerals, and in various ores of iron (including chalcopyrite, $Cu_2Fe_2S_4$), manganese and tin. It has also been found with cadmium and has been detected in all specimens of metallic tin examined by two investigators. F. M. Brewer and E. Baker (*J. Chem. Soc.*, 1286; 1936) now report that two rare tin minerals, cylindrite and franckeite, sulphides of lead, antimony and tin, have an indium content (0·1–1·0 per cent) much larger than any source yet reported. These minerals are confined to the Bolivian tin belt, where argentiferous thiostannates are found. Indium was also found in some silver minerals not containing tin. The same authors in a second paper (p. 1290) describe methods for the extraction of indium from cylindrite, chalcopyrite and metallic tin. Indium is coprecipitated with stannous sulphide. Since the boiling point of indium chloride is much higher than that of stannic chloride, they can be separated by distillation. Details of other methods are given.

High-Frequency Modulation of Ultra-Short Waves

THE development of television transmissions on ultra-short waves has necessitated the study of methods of modulating carrier waves of a few metres in length with modulation frequencies of the order of one megacycle per second. The usual methods of amplitude modulation employed for sound broadcasting at moderate carrier frequencies are not satisfactory, owing to the undesirable frequency modulation and vision distortion which accompany their use. Messrs. S. S. Banerjee and B. N. Singh, of the Physics Department, Benares Hindu University, state, in a communication addressed to the Editor, that they have recently been studying the use of short parallel-wire transmission lines in the modulation of ultra-short waves (wave-lengths 4–5 metres) by high frequencies of 1·5–3 megacycles per second. From the general equations applicable to such transmission lines, it can be shown that amplitude modulation free from frequency modulation is obtained when the length of the line is an integral multiple of a quarter of the length of the carrier wave. This condition, which is fairly critical, has been verified experimentally by the above investigators with the aid of a modified Lecher wire system previously adopted by Banerjee (*Phil. Mag.*, **19**, 787; 1935) in connexion with the measurement of the radiation resistance of transmission lines. At the high modulation frequency employed, the effects of the carrier wave and side bands are adequately separated on the Lecher wire system. The detailed results of these investigations will be published elsewhere shortly.

Colours of Globular Clusters

THE problem of the absorption of light in space, with the consequent 'reddening' effect of great distances, has been investigated by Stebbins and Whitford (*Astrophys. J.*, **84**, 132) through a study of globular clusters. They have used a photo-electric cell attached to the 100-inch telescope at Mount Wilson, and determined the colours of 68 clusters by means of the integrated light intensities of each cluster through filters transmitting light of effective wave-length 4340A. and 4670A. The colour excesses show a marked correlation with space absorption as deduced from the number of extra-galactic nebulæ in the field, and also with galactic latitude; being, of course, redder near the galactic equator where the absorption is greatest. The absorption was not found to be uniform, and the greatest measured colour-excess was + 0·82 mag., corresponding to a photographic space absorption of about 3 magnitudes. One effect of this absorption is that distances inferred from apparent magnitudes in clusters must be divided by four. When this correction is made, the diameter of our galaxy is found to be about 30,000 parsecs, which is of the same order as that of the Andromeda nebula.

Education for Rural Life

A JOINT session of Sections L (Educational Science) and M (Agriculture) was held on September 15 at the British Association meeting at Blackpool to discuss "Education for Rural Life". Papers were read by three representatives of each section.

Sir John Russell emphasized that education in rural areas must develop on lines different from that in towns. An important factor is the richer environment and greater body of natural experience open to the country child, but until recently there have been no enterprising teachers in rural areas to base their teaching on these facts. Local surroundings should be the basis of country education, and the syllabus of work done could accordingly be flexible and free. Realizing that the country child must live on and by the land, we should arrange that his education should be based directly on the life of the countryside. For this purpose, adequate land around rural schools is essential in order to provide for school gardening, playing fields and a school estate. School gardening was at one time a device to occupy the spare time of older boys; but now, in progressive areas, it has come to be the nucleus of the teaching in woodwork, drawing, composition and arithmetic: it has also attracted the interest of parents. Village surveys are being increasingly organized and have educated children in the history, geography and biology of their district. In the hands of good teachers who keep abreast of modern knowledge, education for rural life could be fuller, freer and less materialistic than the education ordinarily given in towns.

Mr. Henry Morris, director of education for Cambridgeshire, said that education for rural life must be independent of the great towns, the culture of which is largely commercialized. The solution, however, can not be found in a single village; but in groups of villages forming a region centred around a large village or small country town. Modern transport makes this easily possible. Even so, reorganization far more extensive than a Hadow reorganization of schools is required. The school buildings ought to house a senior school in the daytime and a community centre in the evening. Such a solution is provided in the village college, which focuses the social, cultural and artistic activities of the countryside in one centre, architecturally appropriate, where adults and children are freely educated. A village college can thus cater for drama, dancing, horticulture, public health and recreation and those communal activities in song and ceremony that enrich the corporate life. The planning of this college on a generous scale, with ample land and attractive buildings, requires foresight and experience. It needs considerable expenditure; but such expenditure would be socially beneficial in the highest degree, and above all, it would help us to make the fullest use of the leisure that applied science is making possible.

Prof. N. M. Comber dealt with the contribution of universities to education for rural life, and deprecated the brevity and elementary nature of the courses they provide in agriculture. Moreover, such courses emphasize practical and utilitarian matters; they should be broadened to include some study of cultural, social and recreational life of the countryside. The nation at large should endeavour to understand the significance and importance of the countryside, and some appreciation of rural life should be inculcated in the training courses for teachers.

Mr. T. S. Dymond referred to the influences on rural education of raising the school-leaving age. While many country schools are doing good work under the Hadow scheme of reorganization, large numbers fail to educate suitably the senior children. More individual work should be expected of them, more craft work should be introduced, particularly a variety of crafts such as carpentry, metal work, simple mechanics, dairying, fruit-bottling. In short, the education must be largely vocational. For those who are leaving school, some form of part-time continued education would be of great value, even if it took the form of young farmers' groups or women's institutes. Vocational work is valuable by cultivating the ability to acquire knowledge through experience, and thus stimulating self-reliance, initiative and a desire to learn.

Mr. G. W. Pierce, speaking as a village headmaster, claimed that the village school as it exists to-day is doomed. The new rural school will serve a wide area and will hold 220–280 children, but it must be located right in the countryside—the more rural the better. 8–10 acres of land are necessary in order to allow for ample playing fields and gardens. He deprecated the tendency of local education authorities to convey country children to the nearest town to be educated with town children; it is far better for town children to receive a rural education than for rural children to receive an urban education. The quality of the teaching staff is all important: the teachers must be interested in rural life, for a rural bias is essential in all subjects of the curriculum, particularly in arithmetic, gardening, science, handwork, cooking and geography. Practical work is of the first importance and should occupy at least half of the school hours. Further, it is educationally admirable that boys and girls should become interested in plant life and bird life.

Sir Arnold Wilson claimed that education for rural life involves in practice education for husbandry in all its branches. This implies that the teaching staff must be convinced believers in rural life. Agriculture is more vital to the nation than is generally realized: statistics show that agriculture offers very varied occupations and unrivalled scope for individual talent. Moreover, it is a healthy way of living. The passive idea of education is false; enthusiasm for doing should be inculcated. Germany shows a different outlook upon husbandry in every walk of life: there agricultural workers are being suitably trained, and country life is held in honour; there is no rigid distinction between school years and working years, and diplomas are awarded after suitable practical experience combined with a variety of instruction. The future of Great Britain depends on rural life, for it is in the country-side that food is produced, fresh air is abundant and a variety of occupations and experience is present. He believes that great help would be given in the enjoyment of the privileges of country life if the best part of education were given after the age of sixteen years.

Land Transport

IN his presidential address on October 15 to the Institute of Fuel (see NATURE, October 31, p. 752), Sir Philip Dawson dealt with the subject of transport on land. The end of the nineteenth century may be called the electrical age, but so far as Great Britain is concerned, since electrical power is mainly produced by steam, its application to traction only means the consumption of fuel transferred from the rolling vehicle to the power-house producing electricity. In countries where electricity can be produced by water-power, this agency may largely affect the total consumption of solid and liquid fuel. Hence the French call water-power *la houille blanche* (white coal). We are faced to-day with the fact that, despite the high efficiency in producing light, heat and power now obtained in the combustion of coal, the output of coal in Great Britain has diminished from 287 million tons in 1913 to 223 million tons in 1935.

In 1921, there were 269,000 horse-drawn vehicles on the roads; in 1934 there were only 23,000. There are now nearly 2,500,000 vehicles on the road propelled by internal combustion engines. The use of internal combustion engines burning heavy oil has been slowed down by the tax of 8*d*. per gallon imposed on Diesel oil. In Germany the use of this kind of engine is advancing rapidly. The risk of fire and explosion of heavy oil is much smaller than with petrol, and this would be a great advantage in time of war. Transport by road both for passengers and goods is rapidly increasing. This is due mainly to the increased facilities which the road offers both to the passenger and the trader. There were no less than 435,000 goods vehicles employed on the road last year. There are nearly twice as many people employed directly and indirectly in road transport as in railway transport. The motor-spirit and fuel-oil consumed last year exceeded two million tons, and increased by their taxation the revenue of the Government by forty million pounds. It is estimated that Germany will consume more than two million tons of light synthetic oil this year, more than half of which will be home-produced.

Much could be done in Great Britain to encourage the domestic supplies of petrol by the increased production of benzol by the gas and coke industries. Diesel-electric trains are coming into favour both in Germany and the United States. The great disadvantage of the steam locomotive as compared with Diesel and electric traction is that it consumes fuel when not actually performing useful work.

The electrification of railways, main line as well as suburban, is constantly increasing throughout the world. In Great Britain, the Southern Railway has made the greatest progress in this direction. All the electricity it uses for traction is supplied by the Grid from steam-operated power plants. Sir Philip quoted with approval the Weir report, which stated that electrification places in the hands of the traffic manager a new system which enables him to offer a more attractive transport proposition to the public and the characteristics of which are capable of extensive development. The adoption of electric haulage for metropolitan and suburban lines nearly always produces increased traffic. The additional cost of the increased train mileage has been much less than the increase in the revenue resulting therefrom. Even in countries where electricity is generated by steam, its largely increased use in industry and for haulage must bring about a decrease in the use of coal in consequence of the greater efficiency realized.

In conclusion, Sir Philip said that every effort must be made in Great Britain to utilize the thermal energy contained in coal for the production of all forms of power, so as no longer to have to rely on fuel imported from overseas, as we have to-day, for operating services which are vital to our national existence and commercial prosperity.

Maya Culture in the Highlands of Guatemala

THE Carnegie Institution of Washington, which under its Section of American Aboriginal History is conducting a comprehensive investigation of the anthropology of Central America, covering the archæology, history under Colonial administration, and physical characters and constitution, linguistics, and social conditions of the modern inhabitants, has undertaken a further investigation in the highland zone of Guatemala. Here a year of mound excavation has already made a substantial advance towards a settled chronological sequence in culture, which is one of the principal aims in present-day archæological research in Central America.

A mound in the neighbourhood of Guatemala city, to be known in future as "Haminaljuya", the "Hills of the Dead", is now being excavated by Dr. A. V. Kidder on behalf of the Institution and at the invitation of the distinguished archæologist, Dr. Antonio Villacorta, Minister of Public Education, and his son, Sr. Carlos Villacorta, director of the National Museum of Guatemala. This mound is one of a hundred situated within a restricted area of half a mile by one and a half miles. The area, as part of the highland region, is already characteristically known to archæologists as a source of material of the 'archaic' period, for which evidence is also forthcoming from other sites, such as the Valley of Mexico, and from the lowest levels of Uaxactun in the Province of Peten. Certain indications, however, had led Dr. S. K. Lothrop some years ago to infer that remains of a later period might occur in the area, perhaps even so late as the Maya Old Empire; and only last year Dr. Kidder himself, while pointing out that the highland region had served more as a highway for trade and migration than the lowland jungle country, suggested that its sites might be expected

to provide extremely valuable information as to the chronological interrelation of the various ancient cultures, particularly as it was probable that stratified remains would be discovered.

These prognostications, it is stated in a preliminary report on the first season's excavation of the mound issued by the Carnegie Institution (*Bull.*, 4, 6), have been strikingly verified. Even so far as operations have proceeded up to the present, it is evident that occupation of the mound was far more prolonged than had been thought probable. The mound presents resemblances to the third of the four sequent stages in the tentative classification of the culture of the lowland city of Uaxactun, the oldest site yet excavated in the Maya area. This would bring Kaminaljuya at least down to the Old Empire ; but finds from the site also present resemblances to those from Teotihuacan, the Toltec city in the Valley of Mexico.

Not only, then, does the evidence of the finds from Kaminaljuya reduce Dr. Lothrop's inference to proved fact, but it also has provided the stratified remains which Dr. Kidder desired. Quite apart, however, from their importance as evidence for cultural sequence, the finds are of an exceptional intrinsic interest. Not the least surprising result of the investigation was that after two pyramids superimposed upon a third had been revealed, still another was found beneath the third. Each of the outer three showed certain differences. The two outer pyramids, for example, rose to a surmounting platform by terraces, the third (reckoning here, as elsewhere, from the interior outward) showing three levels, whereas the second rises steeply in a single slope, and still carries a balustrade of twelve steep steps, while this feature in the third pyramid had been torn away when it was dismantled for the building of the fourth.

In examining the place of the stairway in the third pyramid, three tombs were brought to light ; and a fourth, still unexamined, was found under the staircase of the second pyramid. The burials in the three tombs, which have been opened, have produced a wealth of objects, personal ornaments in jade, crystal and other material, pottery, including some remarkable painted ware, obsidian spear-heads, and other funerary offerings, which when more carefully examined at leisure will certainly throw much new light on Maya art, burial customs and culture generally.

The tombs were great square pits, vertically sided, dug in the volcanic deposit, and measuring twelve feet square and twelve feet deep. Originally they were roofed with logs, which, when found, had rotted away and let down stones and earth on the contents. An interesting feature of these tombs is the arrangement of the body, which, with attendant circumstances, suggests the interment of a high priest or ruling chief. In the first tomb the personage interred had been placed in a sitting position in the centre of the floor. On three sides of the skeleton lay single human skulls and on the fourth the skull of a jaguar. In the second (Tomb III) the principal skeleton was that of a middle-aged male. The body had again been placed in the middle of the tomb in a sitting posture with the legs crossed. It had been loaded with ornaments, and at the side was a heap of pottery, in which were two human effigies in clay. At the feet of the skeleton lay the bones of a young woman and vessels for serving food, a milling stone for grinding corn, and other utensils. In a corner were the bones of a small dog. With the principal personage of the third tomb (Tomb II) were two others, possibly slaves. All were in the sitting position, facing south. This was in some ways the richest tomb of all and contained many unique pieces of pottery.

Dr. Kidder suggests in connexion with the burials, basing his opinion upon the evident character of the interment, that the custom of building pyramids superimposed one upon another may have been due to the custom of demolishing the pyramid, of which the deceased had charge at the time of his death, and preparatory to building another for his successor.

Developments in British Telegraph Services

IN a paper read to the Institution of Electrical Engineers on November 19 by L. H. Harris, E. H. Jolley and F. D. Morrell, details are given of many of the engineering developments which have taken place in the inland telegraph service of the British Isles during the last few years.

It is now clear to engineers that the use of underground cables solely for direct current telegraphy is wasteful and that modern developments in amplifiers and filters enable a direct current cable to carry many more circuits. In 1929, the international council (C.C.I.T.) standardized the speed of the teleprinter, and two years later the spacing of the carrier frequencies to be used for voice-frequency telegraph working was also standardized. In 1931 the Post Office installed and operated a London–Dundee 12-channel system, developed and manufactured in Great Britain, which met completely the requirements laid down by the C.C.I.T. A year later the London–Glasgow–Belfast 18-channel system was installed. The introduction of demand telephone trunk working created a shortage of trunk telephone circuits and it was decided to convert practically the whole of the inter-urban telegraph network to voice-frequency working. The telegraph cables thus thrown idle were used for telephone purposes. The number of voice-frequency telegraph channels has doubled during the last three years. The revolution in the methods used in telegraphy has been very thorough. By 1934 scarcely an item of traditional telegraph plant remained in the inland service.

Cable companies, news agencies and newspapers make considerable use of these circuits for speeds up to 100 words per minute. Voice-frequency channels are nearly always used, and even such important circuits as direct extensions of Atlantic cables are employed in this way. An increasing number of newspaper companies now rents telephone circuits on which they provide or rent equipment for alternative speech or pictures and multi-channel voice-frequency telegraphy.

The telex service, which gives the alternative of teleprinter working to speech over the telephone network, as distinct from a separate teleprinter exchange system, has also progressed. One of the latest developments of the private teleprinter services has been the introduction of broadcast systems. In these, facilities are provided and maintained, up to the limit of the number of machines at the central office, by which the renter can transmit simultaneously to any reasonable number of outstations. News agencies and police services are finding these methods very useful.

The 18 frequencies used by the carrier currents in the voice-frequency channels are the odd multiples of 60 cycles from 420 to 2,460. The currents are generated by a multi-frequency machine, driven by a motor fitted with a centrifugal governor which regulates the field current and controls the speed to within $\pm$ 0·25 per cent. Great progress has been made in standardizing 80 volts for all telegraphic purposes, and in eliminating the 24, 40 and 120 volts employed for local and main-line batteries when direct current was used. The maintenance of the voice-frequency network is carried out by the ordinary repeater-station staff, who rapidly have become familiar with the new methods. The average duration of interruptions of commercial circuits due to causes which can be attributed to the voice-frequency method do not exceed five minutes per week. In the case of private wire renters, they report faults directly by telephone using the voice-frequency terminal.

It has not been found necessary to make use of sub-audio (infra-acoustic) circuits in the British Isles, except for a few cases in which submarine cables are involved. The London–Jersey duplex teleprinter circuit is one of these cases. It is in series (composited) with the Channel Islands telephone circuit consisting of a single core unloaded submarine cable. Two duplex teleprinter circuits have been installed in the continuously loaded submarine telephone cable between Blackpool and Port Erin (Isle of Man). These circuits are noteworthy as they use only seven volts for transmission so as to avoid the risk of affecting the loading material used in the cable. Neglect of this gives rise to 'cross-talk' due to minute changes in the inductance.

The difficulties experienced at first in maintaining teleprinter speeds constant have been overcome. The difference in the speeds now seldom exceeds one per cent. The speed is checked by means of stroboscopes and synchroscopes. The latter instruments have been found to be much the more accurate. In the case of telephony, voice-frequency signalling methods and improvements in transmission technique have led to development in the direction of extending the automatic system to include the trunk circuits. This avoids the delays and costs of intermediate operating. Similarly in telegraphy, the elimination of probably 50 per cent of the operating transactions and delays would be possible by means of through automatic switching from the sending to the receiving office. The present voice-frequency network makes a framework for such a scheme which would have been quite impracticable under the old physical line conditions.

Telegraphy is now in a position to share in the rapid advances recently made in the telephone field. The teleprinter with its typewriter keyboard, the elimination of the distance factor by voice-frequency methods and the cheaper private wire telegraphic rentals should prove a boon to the commercial world.

Humboldt's Plan in 1836 for a World Magnetic Survey

EARLY in 1836 Alexander von Humboldt sent a letter to the Duke of Sussex, as president of the Royal Society, inviting the co-operation of the Society in the organization of a world magnetic survey. The letter was referred to Christie and Airy, whose report was read to the Royal Society on November 24, 1836. As von Humboldt's suggestions had a great influence on the steps afterwards taken, a few extracts from the report are given here :

"In this letter," said Christie and Airy, "M. de Humboldt developes a plan for the observation of the Phenomena of Terrestrial Magnetism worthy of the great and philosophic mind whence it has emanated and one from which may be anticipated the establishment of the theory of these phenomena. . . . The Baron de Humboldt and MM. Arago and H. Kupffer having, by the co-operation of many zealous observers, succeeded in establishing permanent magnetic stations extending from Paris to China, M. de Humboldt solicits, through His Royal Highness the President, the powerful influence of the Royal Society in extending the plan by the establishment of new stations. The plan which he proposes . . . is that magnetical observations, whether of the direction of the horizontal and inclined needles, or for the determination of the variations of the magnetic force, should be made simultaneously at all stations, at short intervals of time, for a certain number of hours and at fixed periods of the year precisely similar to the plan which has been recommended and adopted by Sir John Herschel with reference to observations of the barometer and thermometer." He also "considers that it deeply interests the advancement of mathematical and physical sciences that, under the auspices of His Royal Highness the President, the Royal Society should exert its influence in extending the line of simultaneous observations, and in establishing permanent magnetic stations in the tropical regions on both sides of the equator, in high southern latitudes and in Canada. . . . Should the proposition meet with their concurrence he begs that the Royal Society will enter into direct communication with the Royal Society of Göttingen, the Royal Institute of France and the Imperial Academy of Russia, to adopt the most proper measures to combine what is proposed to be established with what already exists".

After a full review of the subject, Christie and Airy went on to say, "By referring to M. de Humboldt's letter, it will be seen that the plan of observation so comprehensively conceived by him, has been most powerfully and liberally patronized by the Governments of France, of Prussia, of Hanover, of Denmark and of Russia ; indeed it is quite manifest that a plan so extensive in its nature must be far beyond the means of individuals, and even of scientific societies, unaided by the governments under which they flourish. . . . To suppose . . . that the Government of this, the first maritime and commercial nation of the globe, should hesitate to patronize such an undertaking . . . would imply that our Government is not alive either to the interests or to the scientific character of the country, and would show that we had little attended to the history, even in our own time, of scientific research, which has been so liberally promoted by the Government. . . . We therefore feel assured that, when

it shall have been represented to the Government that the plan of observation advocated by the Baron de Humboldt is eminently calculated to advance our knowledge of the laws which govern some of the most interesting phenomena in physical science . . . that the patronage to the undertaking which is so essential to its prosecution will be most readily accorded. . . ."

Educational Topics and Events

CAMBRIDGE.—M. Krook, research student of Gonville and Caius College, has been elected to an Isaac Newton studentship, and E. N. Rowland, of Gonville and Caius College, to an additional Isaac Newton studentship.

Prof. W. V. D. Hodge, Lowndean professor of astronomy and geometry, has been elected into a non-stipendiary fellowship at Pembroke College.

GLASGOW.—Dr. William Marshall Smart, chief assistant in the Observatory and lecturer in mathematics in the University of Cambridge, has been appointed regius professor of astronomy, in succession to Prof. Ludwig Becker, who has resigned.

Mr. Oliver Shewell Franks, fellow and prælector in philosophy of Queen's College, Oxford, has been elected to the chair of moral philosophy rendered vacant by the death of Prof. A. A. Bowman.

Dr. John Dougall has been appointed Gibson lecturer in the history of mathematics.

Sir Frederick Crombie Gardiner has given £10,000, and the trustees of his brother, the late Mr. William G. Gardiner, of Moraig, Stirling, have also allocated £10,000 to the University, towards the provision of a new Medical Institute to be erected in connexion with the Western Infirmary. This is to be known as the "Gardiner Medical Institute" and will be at the disposal of the regius professor of medicine for the purpose of teaching and research.

In a recent address to the General Council of the University, the new Principal, Sir Hector Hetherington, mentioned that during the last six years, whereas £130,000 has been received for scholarships, only £47,000 has been received for general expenditure on lands, buildings, equipment, etc. He pointed out that, at present, aid to the University is more important and beneficial than the provision of additional scholarships.

LONDON.—The following degrees have been conferred: D.Sc. in chemistry on E. E. Jelley, for published works on chemical microscopy and photographic chemistry; D.Sc. (engineering) on R. W. Bailey, for published works on creep and stress in metals, etc.

OXFORD.—Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research, has been appointed George Eastman visiting professor for the academic year 1937–38.

Prof. R. V. Southwell has been elected a member of Hebdomadal Council.

Lord Nuffield has been elected an honorary fellow of Pembroke College.

Dr. F. Simon, of Balliol College, has been appointed University reader in thermodynamics for five years from October 1.

It is proposed to confer the honorary degree of D.Sc. early next year on Dr. J. D. Pollock, chairman of the Metal Industries Company and of the British Oxygen Company, and a Carnegie Trustee.

SHEFFIELD.—Prof. F. C. Lea, formerly professor of mechanical engineering, and Prof. J. Husband, formerly professor of civil engineering, have been given the title of emeritus professor.

The following appointments have recently been made: Dr. K. Mellanby, Sorby fellow, as honorary lecturer in zoology; Mrs. H. Mellanby, as honorary research assistant in the Department of Zoology; Mr. J. E. Stanworth and Mr. F. R. Harris, as research fellows in the Department of Glass Technology.

Dr. J. C. Paisley has resigned his post of junior assistant bacteriologist.

A NUMBER of Commonwealth Research Fellowships, tenable by British subjects at certain American universities, are offered for award in 1937 by the Commonwealth Fund of New York. Twenty-four Ordinary Fellowships are offered to candidates living in Great Britain or Northern Ireland who are graduates of a university therein. Two Dominion Fellowships are available to British candidates living in a British Dominion or Colony who are graduates of a Colonial university. There are also five Service Fellowships tenable by British candidates holding appointments overseas under the British Government or a British Colonial Government, and three Home Civil Service Fellowships tenable by candidates holding appointments in the Home Civil Service. The Fellowships are tenable for two years, and are not open to women. Further information can be obtained from the Secretary, Commonwealth Fund Fellowships, 35 Portman Square, London, W.1.

"AN Educational Platform for 1936", formulated at Stanford University, California, last July by the Dean of the School of Education as a result of a conference held there on "Curriculum and Guidance", has been published in *School and Society* (Sept. 5). It is a fairly comprehensive reasoned statement of principles, aims and aspirations, and is valuable as an indication of some trends of thought in academic circles in the western States of America. The impact of the recent rapid advances in technological science on a society unprepared to readjust its institutions, which are consequently "jarred to their very foundations", calls for a concentration of effort on the part of educators to fit the younger generation and, so far as possible, the community at large, to take part in the social advances indispensable for the preservation of a democratic State. Hence the educational programme must stress the study of present conditions and the potentialities of the future, the study of the past being ancillary thereto, and the teacher's position shifting from that of merely transmitting information about things which have been done to one of dynamic influence in social evolution. Associated with this is the development of what is referred to as "the guidance service" to aid the student in defining his goals — vocational, social-civic, recreational and health. But guidance should imply more than mere counsel. The 'platform' envisages school education as an *apprenticeship* for worthy adult life, including the actual doing under supervision of things which constitute desirable living. This implies provision for participation in many varied activities outside courses of formal study. The last item in the proposals calls for a thorough-going broadening and raising of the standards of teacher-training institutions.

Societies and Academies

Edinburgh

Royal Society, November 2

E. B. BAILEY and W. J. MCCALLIEN: Perthshire tectonics; Schiehallion to Glen Lyon. E. M. Anderson's stratigraphy has been confirmed, with minor additions. The Dalradian boundary has been shown to be a slide affected by considerable overfolding. This overfolding has brought into one and the same district Dalradian with and without a Blair Atholl component. Other slides include the Schiehallion slide, as spectacular as any thrust in the North-West Highlands. Large-scale inversion is a commonplace in the district. Often the older Blair Atholl Series is found downfolded into the younger Perthshire Quartzite Series. The Loch Tay inversion extends fifteen miles across the strike. All the big recumbent folding and refolding is towards the south-east.

RALPH DENNELL: Feeding mechanism of *Apseudes talpa* and the evolution of the peracaridan feeding mechanisms. The almost hemispherical maxillipedal epipodite of *Apseudes talpa* closely enwraps the base of the second thoracic limb. A valvular flap, on its anterior border, lying outside a typical Malacostracan filter exit, enables the epipodite to draw a filter current from the filter chamber. The maxilla bears minute, but typical, filter setæ; but the maxillipedal brushing setæ are largely prevented from scraping them by a lower row of maxillary setæ. Fine food particles are retained mainly by the brushing setæ, and not by the filter setæ. The probable evolution of the feeding mechanisms of the Peracarida is described.

MABEL S. FRASER: The vascular supply to the follicle-bearing Ranunculaceæ. The main point emerging from this detailed study is the variation in the vascular supply to the carpellary whorl—a variation which is particularly marked in the acyclic group. In a single gynæcium there may be variation in the origin of the carpellary bundles and also in the number of traces entering each carpel. Thus no basic formula could be established for any one species. No evidence was found in support of the theory of carpel polymorphism as applied to this group. The tendency towards a basic five-trace supply to the carpel is noted, and the author is inclined to support the view expressed by Eames, that the primitive carpel was probably a palmate sporophyll, with a basic five-trace supply.

W. J. VAN STOCKUM: The gravitational field of a distribution of particles rotating about an axis of symmetry. The gravitational equations are considered in the interior of a rotating axially symmetric distribution of particles which are describing their paths without mutual interaction. The general solution of the equations is shown to depend upon an arbitrary solution of the equation

$$\frac{\delta^2 V}{\delta r^2} + \frac{\delta^2 V}{\delta z^2} - \frac{1}{r}\frac{\delta V}{\delta r} = 0.$$

As an example, the gravitational field of an infinite rotating cylinder is considered in detail.

T. M. MACROBERT: Some formulæ for the associated Legendre functions of the second kind, with corresponding formulæ for the Bessel functions. The generalized Bessel's integral is employed to evaluate a number of integrals and series involving Bessel functions regarded as functions of their orders. Corresponding results are also obtained for the Legendre functions of the second kind.

Paris

Academy of Sciences, October 26 (*C.R.*, **203**, 753–832).

ROBERT ESNAULT-PELTERIE: The extension of the principle of the limit law in dimensional analysis.

NIKOLA OBRECHKOFF: A theorem of Laguerre.

OTTOKAR BORŮVKA: Singular matrices. Admitting priority of Ed. Weyr.

SERGE BUCHEGUENNCE: The surfaces of Bianchi.

WERNER FENCHEL: Generalization of a theorem of Brunn and Minkowski concerning convex bodies.

JEAN DIEUDONNÉ: The zeros of derivatives of rational fractions.

PIERRE BOOS: The properties of symmetry of the integral curves of differential systems of the second order.

ROBERT D'ADHÉMAR: The moment of initial impulse and the inclination of the rifling grooves. The periods of virtual instability of projectiles.

RENÉ LUCAS: The specific heats of liquids and gases. By taking into account the existence of transversal waves, hitherto neglected, it is possible to develop a quantic theory of the specific heat of liquids analogous with that of solids.

JAMES BASSET and MAURICE DODÉ: The solubility of nitrogen in water at ultra-pressures up to 4,500 kgm./cm.^{2}. Starting with a certain pressure, about 300 kgm./cm.^{2}, the solubility of nitrogen in water diminishes as the pressure is increased. The possible effects of traces of oil derived from the compressor is discussed, and it is proposed to repeat the experiments with an apparatus excluding this possible source of error.

FÉLIX CERNUSCHI: The conservation of energy and Shankland's experiment. An argument that the results of Shankland, assumed to be exact, do not necessarily imply the abandonment of the law of conservation of energy.

PIERRE JACQUINOT and GASTON DUPOUY: New measurements of the variation of the deviations with the field in the Zeeman effect with mercury.

LÉON BLOCH, EUGÈNE BLOCH and PIERRE HERRENG: The absorption spectra of sulphur dioxide and of hydrogen sulphide in the Schumann region.

GEORGES BRUHAT and PIERRE GUÉNARD: Study of the circular dichroism of solutions of camphor in organic solvents. The solvents used were carbon tetrachloride, hexane, cyclohexane and benzene. The only effect of the change of solvent, in the absorption region, is a displacement as a whole, without appreciable modification, of the curves of dichroism and rotatory dispersion.

JOSEPH HRDLIČKA, MILOSLAV A. VALOUCH and LADISLAV ZACHOVAL: Contribution to the study of the Debye-Sears effect.

MAURICE CURIE and PIERRE PREISWERK: The activation of thulium by slow neutrons.

JOSEPH WIEMANN: The Raman effect and organic chemistry: the structure of the 'oses' and the Raman effect. Solutions of xylose, glucose, sorbose, arabinose, galactose, lævulose, rhamnose, and mannose were examined, and none of these gave a line corresponding with the C : O linkage, from which it would appear that none of these, in solution, has either an aldehydic or ketonic structure.

EMILE CARRIÈRE and RAYMOND LAUTIÉ: The formation of the molybdenum oxides Mo_3O_8 and Mo_2O_5.

MARTIN BATTEGAY and GERARD MANGENEY: The aldehydes of 1.nitro 2.methylanthraquinone.

J. A. GAUTIER: A new series of *N*.hydroxyalkoxyl-α-pyridones.

MARC TIFFENEAU and MLLE. J. GUTMAN: Molecular transformation in the cyclanic series. Isomerization of the epoxides derived from 1.benzyl 4.methyl 1.cyclohexene and 1.benzylidene 4.methyl cyclohexane.

JOSEPH HOCH: The action of organo-magnesium compounds on the ketoximes.

HENRI MOUREU and MAURICE DODÉ: Remarks concerning the mechanism of the formation of the monochlorhydrins of glycols. Studies on the kinetics of the reaction between water, chlorine and ethylene with formation of ethylene chlorhydrin. The results do not support the hypothesis that ethylene oxide is an intermediate product.

ALFRED MAILLARD: The proportion of deuterium in the light hydrocarbons from petrols of various sources of origin. The petrols have been burnt in an internal combustion motor and the water condensed from the escaping gases. The heavy hydrogen from natural hydrocarbons varies with the origin, and is about double that found in ordinary water.

JACQUES FROMAGET: The syntectonic origin of the conglomerates and limestone breccias of the north-west of Tonkin.

M. and MME. FERNAND MOREAU: The antagonism of some cations in cultures of *Saprolegnia*.

MLLE. MARIE THÉRÈSE GERTRUDE: The elaboration of carbon material by plants in aquatic media.

JEAN CHEYMOL: Results on the structure of verbenaloside. It is a lactone, and salts of the corresponding acid have been prepared. It is also a ketone and contains a methoxy group.

ROBERT WEILL: The cnidome of the cladonemides *Eleutheria dichotoma* and *Cladonema radiatum*; its cycle and interpretation.

JEAN BROUARDEL: Nuclear phenomena of conjugation in *Trichodina patellæ*.

PIERRE DRACH: Allometric growth and sexual dimorphism in the Brachyura.

ROGER HUSSON: The fauna of artificial subterranean cavities.

ALBERT VANDEL: The mode of distribution of the sexes in *Trichoniscus* (*Spiloniscus*) *provisorius* (2). Deuterogene females and monogene females.

CONSTANTIN LEVADITI, MLLE. RACHEL SCHOEN and LOUIS REINIÉ: The experimental reproduction of lymphogranulomatous conjunctivitis (disease of Nicolas and Favre) in the chimpanzee.

PAUL DURAND, PAUL GIROUD, EDOUARD LARRIVÉ and ANDRÉ MESTRALLET: The experimental transmission to man of "maladie des porchers".

Cracow

Polish Academy of Science and Letters, October 5.

W. SIERPINSKI: A theorem on definite functions in any infinite ensembles.

MLLE. H. PLAMITZER: Contribution to the method called *regula falsi*.

S. K. ZAREMBA: Contribution to the discrimination of the singular points of ordinary differential equations.

K. GUMINSKI: The luminescence of barrier anodes of aluminium. Study of the influence of the concentration of the electrolyte on the intensity of the luminescence of the anode, the distribution of the intensity in the spectrum of this emission in the case of an anode of pure aluminium, and the effect on this distribution of the addition of other metals to the aluminium.

K. DZIEWONSKI, L. STERNBACH and A. STRAUCHEN: The reactions of β-naphthylamine with thiourea.

J. SZAFLARSKI: The thermal conditions of the *Zmarzle Stawy* in the High Tatra.

W. FRIEDBERG: *Terebralia bidentata* = *Cerithium lignitarum* in the Miocene of Poland. Specimens of *C. lignitarum* collected near Zalesce (Volhynie), except that they are slightly smaller, correspond with *T. bidentata*.

J. ZACWILICHOWSKI: A new method of obtaining aberrant forms of Lepidoptera under the influence of chemical reagents. Changes of colour can be produced by injecting the chrysalids with suitable chemical reagents. The results may serve in the analysis of the genesis and causes of aberrations in the Lepidoptera.

J. GALLERA: A case of embryonic triplogenesis.

ST. ZARNECKI: The migrations of young sea trout from Dunajec to the sea.

Sydney

Royal Society of New South Wales, September 2.

C. A. SUSSMILCH: Evidence of a change of sea-level at Botany Bay. A borehole, drilled near Spring Street, Botany, some few years ago, passed through six successive beds of peat, five of which are below sea-level, the depth of the lowest being 87 ft. below sea-level. Afterwards a well was sunk to a depth of fifty feet, and at the bottom of this, which is 24 ft. below sea-level, a number of well-preserved tree stumps were found *in situ*. The peat beds have resulted from the accumulation of layers of terrestrial vegetation above sea-level, and their occurrence now below sea-level indicates a change of sea-level of a minimum amount of 87 ft. The presence of the tree stumps *in situ* supports this. The occurrence of six different beds of peat, separated from one another by beds of sand, suggests that the movement was an intermittent one, each bed of peat representing a pause in the movement. It is considered that the movement was a rising of sea-level, rather than a subsidence of the land.

W. M. HOLMAN: A study of phosphate solubility in certain New South Wales soils. Recently, Gaarder has used the solubility of the soil P_2O_5 at different *p*H values as a means of determining the nature of the combinations of P_2O_5 in the soil. The phosphate status of certain N.S.W. soils was examined by determining the solubility at different *p*H values within the *p*H range 1·5–8·5 of both native and added P_2O_5. In a black soil from Edgeroi, P_2O_5 is combined largely as basic calcium phosphate. Typical red soils from the western wheat districts are poor in respect to soluble P_2O_5, but have little capacity to remove P_2O_5 from solution. In certain red clay soils from Lismore, no P_2O_5 is soluble under the experimental conditions within the *p*H range 3–8. A large excess of sesquioxide colloids, chiefly hydrated Fe_2O_3, is responsible. When silicic acid colloid is added to these soils, the sesquioxides are deactivated and P_2O_5 is liberated.

Forthcoming Events

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

Monday, November 23

ROYAL GEOGRAPHICAL SOCIETY, at 5.30.—Geographical film on "The Mount Everest Expedition of 1936", by members of the Expedition.

Tuesday, November 24

ROYAL SOCIETY OF ARTS, at 4.30.—H. E. Laffer: "The Empire Wine Industry".

BRITISH SCHOOL OF ARCHÆOLOGY IN JERUSALEM, at 5.0—(in the Rooms of the Society of Antiquaries, Burlington House, W.1).—An open public meeting.

The Right Hon. W. Ormsby-Gore, M.P.: Address.

P. L. O. Guy: Description of the proposed archæological survey of Palestine.

CHADWICK PUBLIC LECTURE, at 5.15—(in the Great Hall. British Medical Association, Tavistock Square, W.C.1), —Sir Francis Fremantle: "The Doctor's Mandate in Parliament".*

Wednesday, November 25

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Prof. John Jewkes: "Social Policy and the Depressed Areas".*

ROYAL SOCIETY OF ARTS, at 8.—Lady Hart Dyke: "The Lullingstone Silk Farm".

Friday, November 27

ROYAL INSTITUTION, at 9.—Prof. Edward Mellanby, F.R.S.: "Recent Advances in the Treatment of Disease".

Saturday, November 28

NEWNHAM COLLEGE, CAMBRIDGE, at 5.—Lord Rutherford, F.R.S.: "Modern Alchemy" (Henry Sidgwick Memorial Lecture).

Official Publications Received

Great Britain and Ireland

Medical Research Council. Special Report Series, No. 216: Medical Uses of Radium; Summary of Reports from Research Centres for 1935. Pp. 38+5 plates. (London: H.M. Stationery Office.) 1*s.* net. [3010

The Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 2: The Influence of Chemical Composition of Butterfat on the Firmness of Butter. By J. Lyons. Pp. 19–38. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1*s.* [3110

Transactions of the Institution of Chemical Engineers. Vol. 13, 1935. Pp. v+235. (London: Institution of Chemical Engineers.) [211

Battersea Polytechnic. Report on the Work of the Session 1935–36 by the Principal, being the 43rd Annual Report presented to the Governing Body. Pp. 38. (London: Battersea Polytechnic.) [411

Proceedings of the Royal Irish Academy. Vol. 43, Section A, No. 4: Glow Discharges in Helium. By K. G. Emeleus, F. D. Greene and E. Montgomery. Pp. 35–47. 1*s.* Vol. 43, Section B, No. 5: Turbellaria of Ireland. By Rowland Southern. Pp. 43–72. 1*s.* Vol. 43, Section B, No. 6: Observations on the Structure of the Pulmonary Alveolar Wall in the Adult Rat, Guinea-Pig and Rabbit. By Stephen Shea. Pp. 73–81. 1*s.* (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) [611

North-East Coast Institution of Engineers and Shipbuilders. Catalogue of Parsons Exhibition, November 1936–January 1937, at the Municipal Museum of Science and Industry, Newcastle-upon-Tyne, in connexion with the first Parsons Memorial Lecture held 6th November 1936. Pp. viii+26. (Newcastle-upon-Tyne: North-East Coast Institution of Engineers and Shipbuilders.) 6*d.* [611

Hull Museum Publications. No. 188: Silver Roman Coins from South Ferriby, by B. H. St. J. O'Neil; and Bronze Roman Coins from South Ferriby, by J. W. E. Pearce. Pp. ii+22+10+3 plates. No. 189: Excavations at the Roman Town at Brough, E. Yorkshire, 1935. By Philip Corder and the Rev. Thomas Romans. Pp. 40. 1*s.* 2*d.* No. 190: Record of Additions. Edited by Thomas Sheppard. Pp. 20. (Hull: Hull Museum.) [611

International Tin Research and Development Council. Bulletin No. 4: Tin Plate and Tin Cans in the United States. Pp. 144. (London: International Tin Research and Development Council.) Free. [611

Royal Commission on the Private Manufacture of and Trading in Arms (1935–36). Report. (Cmd. 5292.) Pp. 101. (London: H.M. Stationery Office.) 1*s.* 6*d.* net. [611

Eton College Natural History Society. Seventh Annual Report, 1935–36. Pp. 47+10 plates. (Eton: Eton College.) To non-Members, 2*s.* 6*d.* [911

Other Countries

U.S. Department of the Interior: Office of Education. Bulletin, 1935, No. 2: Statistics of State School Systems, 1933–34; being Chapter 2 of the Biennial Survey of Education in the United States, 1932–34. Prepared by David T. Blose and W. S. Deffenbaugh. Pp. vi+111. (Washington, D.C.: Government Printing Office.) 10 cents. [211

Smithsonian Miscellaneous Collections. Vol. 95, No. 14: Morphology of the Insect Abdomen. Part 3: The Male Genitalia (including Arthropods other than Insects). By R. E. Snodgrass. (Publication 3396.) Pp. ii+96. Vol. 95, No. 18: Two Original Photographic Negatives of Abraham Lincoln. By Alexander Wetmore. (Publication 3400.) Pp. ii+2+4 plates. (Washington, D.C.: Smithsonian Institution.) [211

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 88. A Taxonomic and Distributional Study of some Diatoms from Siam and the Federated Malay States. By Ruth Patrick. Pp. 367–470+1 plate. The Amphibians and Reptiles of the Mexican Expedition of 1934. By Emmett Reid Dunn. Pp. 471–477. (Philadelphia: Academy of Natural Sciences.) [211

The Queen Victoria Memorial, Salisbury. Annual Report for the Year ended 31st March 1936. Pp. 16. (Salisbury: Rhodesian Printing and Publishing Co., Ltd.) [311

Proceedings of the United States National Museum. Vol. 84, No. 2998: Report on the Fishes collected by H. C. Raven in Lake Tanganyika in 1920. By George S. Myers. Pp. 16. (Washington, D.C.: Government Printing Office.) [311

Zweites Köppen-Heft der Annalen der Hydrographie und maritimen Meteorologie. Anlässlich des 90 Geburtstages von Wladimir Köppen. Herausgegeben von der Deutschen Seewarte in Hamburg. Pp. viii+94+8 plates. (Berlin: E. S. Mittler und Sohn.) [411

Kgl. Danske Videnskabernes Selskab. Biologiske Meddelelser, Bind 13, No. 3: Den kinesiske Uldhaandskrabbe (*Eriocheir sinensis* M.-Edw.) i Danmark. Af Ad. S. Jensen. Pp. 24+3 plates. (København: Levin and Munksgaard.) 1.50 kr. [511

University of California Publications in American Archæology and Ethnology. Vol. 34, No. 5: Myths of the Owens Valley Paiute. By Julian H. Steward. Pp. iii+355+440. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 75 cents; 3*s.* 3*d.* net. [511

University of Denver: Department of Anthropology. The Archæological Survey of the High Western Plains. Eighth Report: Pictographs and Petroglyphs of the High Western Plains. By E. B. Renaud. Pp. 47+25 plates. (Denver, Colo.: University of Denver.) [911

Smithsonian Miscellaneous Collections. Vol. 95, No. 17: A New Race of the Song Sparrow from the Appalachian Region. By Alexander Wetmore. (Publication 3399.) Pp. ii+3. (Washington, D.C.: Smithsonian Institution.) [911

U.S. Department of the Interior: Geological Survey. Bulletin 860-B: Geology and Fuel Resources of the Southern Part of the San Juan Basin, New Mexico. Part 2: The Mount Taylor Coal Field. By Charles B. Hunt. Pp. vi+31–80+plates 18–38. 1 dollar. Water-Supply Paper 770: Surface Water Supply of Hawaii, July 1, 1933, to June 30, 1934. Pp. 120. 20 cents. Water-Supply Paper 775: Records of Wells on the Snake River Plain, Southeastern Idaho. By Harold T. Stearns, Lynn Crandall and Willard G. Steward. Pp. 139. 20 cents. Professional Paper 185-I: Geomorphology of the North Flank of the Uinta Mountains. By Wilmot H. Bradley. (Shorter Contributions to General Geology, 1934–35.) Pp. iv+163–204+iv+plates 34–45. 45 cents. (Washington, D.C.: Government Printing Office.) [911

The Hanna Star Dome. By Dorothy A. Treat. (Pocket Natural History, No. 6: Astronomical Series, No. 1.) Pp. 48. 25 cents. Scientific Publications of the Cleveland Museum of Natural History. Vol. 6: The Composition and Dynamics of a Beech-Maple Climax Community. By Dr. Arthur B. Williams. Pp. 92. (Cleveland, Ohio: Cleveland Museum of Natural History.) [911

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 34: The Effect of raising the Middle Roller and some other Factors on the Yarn Strength of Sindhi Cotton. By Dr. Nazir Ahmad. Pp. ii+11. (Bombay: Indian Central Cotton Committee.) 8 annas. [911

Indian Forest Records (New Series). Vol. 2, No. 7: Entomological Investigations on the Spike Disease of Sandal, (29) Coreidæ and and Berytidæ (Hemipt.). By N. C. Chatterjee. Pp. ii+157–175. (Delhi: Manager of Publications.) 8 annas; 10*d.* [911

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 65: A Survey of the Sheep and Wool Industry in North-Eastern Asia, with Special Reference to Manchukuo, Korea and Japan. By Dr. I. Clunies Ross. Pp. 52. (Melbourne: Government Printer.) [911

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 88. Zoological Results of the George Vanderbilt African Expedition of 1934. Part 4: Notes on Four Gorillas from the Sanga River Region. By Harold J. Coolidge, Jr. Pp. 479–501+plates 12–13. Notes on Anacondas, with Descriptions of Two New Species. By Emmett R. Dunn and Roger Conant. Pp. 503–506+plate 14. Zoological Results of the George Vanderbilt African Expedition of 1934. Part 5: Dermaptera. By James A. G. Rehn. Pp. 507–526. (Philadelphia: Academy of Natural Sciences.) [911

Catalogues

Cambridge Easy to Read Thermometers. (Folder No. 25a.) Pp. 6. (London: Cambridge Instrument Co., Ltd.)

Philosophie. (Antiquariats-Catalog Nr. 708.) Pp. 232. (Leipzig: Gustav Foch G.m.b.H.)

Books on Astronomy and Mathematics. (New Series, No. 44.) Pp. 16. (London: Wheldon and Wesley, Ltd.)

A Catalogue of Books: Africa, Americana, Australasia; English History and Literature; Leaves from Manuscripts and Early Printed Books; Early Medicine and Surgery; Oriental; French, Spanish and Portuguese History and Literature; Early Science; and a Selection of Important New Books. (No. 526.) Pp. 116. (London: Bernard Quaritch, Ltd.)