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Coal, Iron, and World Peace.

THE subject of Sir Thomas Holland's brilliant and epigrammatic presidential address to the British Association Meeting at Johannesburg, which is printed in the Supplement to this issue of NATURE, is appropriate to the great and varied mineral wealth of South Africa. The address is not an account of the advance of science in the investigation of minerals or of the present stage of scientific opinion as to their genesis ; it deals with their political applications. Its aim is stated in the closing sentences : " Next year the Empire Congress of Mining and Metallurgy will meet in this city to discuss the proposition which I submitted to it at Montreal in 1927 ; and this address must be regarded, therefore, as an introduction to a movement which one hopes will supply the necessary data, and so facilitate a working agreement between the two great mineral powers that alone have the avowed desire and the ability to ensure the peace of the world."

Coal and iron ore are the dominant minerals, as their products are necessary both in industry and war, and their exceptional abundance on the opposite sides of the North Atlantic has, according to Sir Thomas Holland, established the existing political supremacy of the United States and north-western Europe. The distribution of these minerals he considers so remarkable that he suggests its use as a further argument in favour of Wegener's hypothesis of continental drift. His main thesis is that America and the British Empire, owing to their control of coal and iron ore, can, if they will, stop war by refusing to supply the products of those minerals to any belligerent power. He claims that the only two nations that could fight for long on their own resources are the British Empire and the United States, and if they refuse mineral products to countries that infringe the Kellogg Pact, no war could last long.

This view agrees with Mr. Foster Bain's classification of minerals into three groups—those sold by the ton, such as coal and iron, the lack of which, he remarks, would put any country " under bonds to keep the peace " ; pound-minerals, such as copper and lead, which can be stored in sufficient quantity to last through an ordinary war ; and ounce-minerals, such as gold and platinum, which can be smuggled during war into any country which has sufficient credit to purchase them. Mr. Foster Bain holds that no nation could maintain a long war under modern conditions without native supplies of iron.

The power of the United States and the British Empire to stop war by refusing iron to the combatants would, however, be restricted by the enormous quantities held by all developed countries. The need for food might prevent a blockaded country beating its ploughshares into swords, but it could probably obtain enough iron for military purposes by turning its scrap into swords and its rails and railings into gun barrels and armour plate. The largest supplies of European coal are in Germany and Silesia, and most countries have unlimited quantities of material which could be used as iron ore if required in war, though it could not be profitably smelted at peace-time prices.

Sir Thomas Holland recognises that some instrument is necessary to enforce the recent treaties against war ; and he believes that it could be found on the lines of the resolution submitted to the American Senate last February by Senator Capper, who proposed that the United States should refuse munitions to any nation that breaks the treaty for the renunciation of war. Sir Thomas Holland applauds that resolution, but proposes to modify its terms by substituting ‘ mineral products ’ for ‘ munitions ’.

Sir Thomas Holland's second main proposition is that the political dominance of the North Atlantic countries is assured by the poverty in iron ore and coal of the lands west of the Pacific. The belief that the bulk of the world's supplies of coal and iron are beside the North Atlantic has been repeatedly expressed in America in recent years. This conclusion was advanced by Dr. C. K. Leith in 1925, and published in “ Foreign Affairs ” (New York, 1926), and it has been supported, after an elaborate inquiry, by Foster Bain and other American experts. According to Leith and Foster Bain, the notion that China is one of the richest countries in the world in coal and iron is fiction based on the reports by von Richthofen. Later estimates have reduced the supposed quantities of Chinese coal and ironstone. American authors have also thrown doubt on the reported numbers of the Chinese people and denied China's claim to have the largest population in the world. But the older figures have been supported by later evidence ; and the same may happen regarding Chinese mineral resources.

The amount of coal and iron in China at present is utterly uncertain. The figures that were first put forward to replace von Richthofen's general statements were huge. Drake's estimate of the coal reserves of China was nearly 1,000,000 million tons ; Inouye of Japan reduced the amount to 40,000 million tons. Dr. V. K. Ting, however, supports Drake's total as being “ certainly of the right order of magnitude ”. The amount has been reduced to 23,000 million tons in the cautious calculations of the present Director of the Geological Survey of China, Dr. W. H. Wong, who naturally declines to include material in his returns without definite evidence. Further investigations may lead to the expansion of his figures, just as the British coal reserves have steadily grown, in spite of the heavy coal consumption, by the inclusion of previously unknown or incalculable reserves.

Some of the older statements as to the unlimited mineral wealth of China may have been due to Oriental exaggeration, and some recent estimates have been under-statements due to Western caution. The amount of coal in China is unquestionably enormous, and the western Pacific has far larger reserves of good iron ore than was recognised by some American estimates. Mr. Foster Bain, in a recent article, remarks that the supply of iron ores in Malaya and the East Indies is “ truly great, running into hundreds of millions of tons ”. It is true as regards China that Tegengren in his memoir on the Chinese iron ores (1923–4) estimates the known or probable reserves as only 950 million tons ; that amount is not so large as it looks, as the United States uses about 60 million tons a year. Nine-tenths of Tegengren's estimate consist of the ancient ores of Chihli and Fengtien ; the remaining tenth includes 83 million tons of contact ores, which in most continents form a small proportion of the supply, and 5 million tons of other ore. There are in other parts of China large supplies of iron ore which were not included, as neither the quality nor quantity is known. The estimates of the iron ore supplies of China are as unreliable as those of Africa by Rösler (1921), who credited Africa with only one-sixth of the quantity known in Europe. That figure indicated lack of information rather than lack of African iron ore.

Sir Thomas Holland is no doubt correct in his conclusion that the Western Pacific will not disturb the political supremacy of the North Atlantic within any time of practical moment ; but the predominance of the western world probably depends more on psychological factors than on the supplies of coal and iron ore. Sir Thomas Holland's address will arouse widespread interest, for it is illuminated by his gift of graphic phraseology, and its discussion will prepare for the consideration of this important problem at the Johannesburg meeting next summer of the Empire Mining and Metallurgical Congress.

Bateson and Mendelism.

Scientific Papers of William Bateson. Edited by R. C. Punnett. Vol. 1. Pp. viii + 452 + 7 plates. Vol. 2. Pp. viii + 503 + 29 plates. (Cambridge: At the University Press, 1928.) 42*s*. net each.

According to a statement in his biography, recently published, Bateson intended at some time to write the history of Mendelism. Interesting as such a review would have been, the result has, in effect, been accomplished by the publication of his scientific papers and public addresses; for we have here not only a record of English work covering the early days of Mendelism, but also a general summary of much of the work done elsewhere. These papers, taken in conjunction with Bateson's biography, tell nearly the whole story of the fateful years following the rediscovery of Mendel's work in 1900. Possibly, in retrospect, emphasis might now be differently placed, and much of the detail relegated to the background, but the vividness of the recital by those in the midst of the enthusiasm of verifying and expanding Mendel's work might be lost in a strictly historical review.

When the history of Mendelism comes to be written, there can be little doubt but that Bateson's insistence on the importance of Mendel's work will receive its just appreciation. Both in Great Britain and in the United States, he did much to direct the attention of the younger generation to the new discovery. Even Bateson's controversies went far towards overcoming the inertia and scepticism of those who had adopted an attitude towards the study of heredity that was inimical to Mendel's clear-cut exposition. While Bateson's advocacy speeded up the study of heredity along Mendelian lines, we of the English-speaking race should not forget that the real discovery of the significance of Mendel's work came from Holland, Germany, and Austria, and that the discovery was not so much due to a literary find as to confirmation of Mendel's laws from data almost identical with his. It is, of course, a moot point whether, even then, these data would have received the scientific interpretation which Mendel furnished, had not the later work led to the recovery of his paper before the newer results were interpreted. The inside story of the finding of Mendel's paper has, I believe, never been told in print, which is a pity, since it is an extraordinary circumstance that three investigators should have simultaneously found a paper that had been completely forgotten for thirty-five years.

Bateson's study of discontinuous variability during the decade preceding 1900 had led him to the conviction that this sort of variability provides the most fruitful material for the study of evolution. In this connexion it is not uninteresting to follow Bateson's procedure in trying to find a solution of the kind of discontinuity present in serial homology and kindred morphological series. It is clear from his vague comparisons with ripple marks, etc., that he had not himself at that time (1890) become free from the kind of speculation familiar to the old morphology, despite his attacks on the methods in general of that school.

Comparing Bateson's paper read before the Royal Horticultural Society in 1899, when Mendel's work was unknown to him, with one read before the same Society in 1900, when he had de Vries's paper before him, it is apparent that while at the earlier date the importance of discontinuous variation, the study of single characters and of their inheritance, is emphasised, the underlying principles are not suggested. It is well to remember, however, that it took Mendel himself nearly ten years before he had in hand the experimental proof that established his laws.

The immediate extension of Mendel's principles we owe in part to Bateson and Punnett and the Cambridge School, but equally I think to Cuénot's series of brief but convincing contributions (1902–3), that not only established the application of the same principle to animals, but also furnished interpretations of several new principles. These came at a critical moment and served to widen the field of work. Bateson's interpretation of his own experiments on animals furnished equally important evidence of the extension of Mendelian principles to the animal kingdom.

It is to be regretted, I think, that the materials in the Reports to the Evolution Committee from the Cambridge School are not included in these two volumes (the summaries are, however, included), even had it been necessary to omit some of the other papers to make way for these. To the student of genetics the data given in these reports will be looked upon as the most outstanding contribution to genetics made during the earlier years of Mendelism.

A survey of Bateson's later work, after he had taken charge of the John Innes Horticultural Institution, cannot be attempted in a brief review. It expanded, and kept on expanding. Many of the new problems that arose were still unsolved at the time of his death, but the results of his inspiration and enthusiasm still continue. Sometimes I have thought that his delight in new adventures distracted his attention from digging deep into the underlying principle of work already under way; yet, on the other hand, he pursued the evanescent 'rogues' to the very end, and 'sports' from root cuttings and 'chimæras' remained abiding problems.

Meanwhile work on the chromosome basis of heredity was coming more and more to the front, and its value in certain lines of research was everywhere becoming apparent. Bateson tried hard to give its proper due to this field of research, but it was only too apparent that it was distasteful to him and that he was, as he himself acknowledged, unfamiliar with first-hand information on cytology. He yielded for a moment after his last visit to America, but recanted, in part, in one of his latest papers. This has always been a source of regret to those of his friends 'over here' who had and have a high regard for his splendid abilities. An appreciation of the evidence and a little sympathy for these new lines of attack that were yielding promising results might, we thought, have simplified some of his perplexities.

From an early period Bateson's interest turned toward the study of variability in relation to species formation; and despite his sincere appreciation of the new openings presented by Mendel's discovery, he never succeeded in adjusting the results of the newer work on mutation and heredity to the historical problem of the evolution of species. He refused to minimise the importance of the older aspects of the problem, as many others have done, in the belief that after all they present a difficulty to those who insist on arbitrary definitions of species. Tradition had a powerful grasp on Bateson's mind, and he could not free himself from the supposed importance of some of the old difficulties connected with the origin of species. Systematists still follow their necessary methods of description, paying scant attention to genetic work; while geneticists are directing their main efforts towards solving other problems than the traditional problem of the infertility between species. Bateson stood firm in his contention that the outstanding question of genetics remains the species question.

The publication of these collected papers not only serves to perpetuate an important period in British biology, but also has made more accessible to students contributions that have been scattered in many journals, some of them difficult to obtain. The publisher and editor are to be congratulated on the accomplishment of a splendid memorial to an indomitable leader in the field of genetics.

T. H. Morgan.

A Seventeenth Century Water-Bailiff's Duties and Rights.

A Description of the High Stream of Arundel, the Heads and Risings thereof; the Sundry Kinds of Fishes therein in their several Haunts; the Fishermen, and their Care and Service in preserving the Fish in Roading Time; the Swans and Eyries, and other Fowl in their several Limits; the Water Bailiff of the aforesaid High Stream in Arundel Rape, his Fees, Dues, and Duties. Edited, with Introduction, Notes, Map, and Index, by Joseph Fowler. (Extra Publication, No. 1.) Pp. 71. (Littlehampton: Nature and Archæology Circle, The Museum, 1929.) 7*s.* 6*d.*

In this book we have a vast amount of antiquarian material that is of considerable local interest, and in so far as it touches on the rights and duties of a water-bailiff in mid-seventeenth century times, it will be of value to many whose interests lie beyond the bounds of West Sussex. Herein is printed in full a manuscript of which the first part is known only by two copies, which were made in 1899 for the Duke of Norfolk when defending his fishing rights, and the second part of which has been copied directly from the original. This was discovered after considerable search at Old Norfolk House, tied up with other manuscripts relating to wrecks upon the Sussex coast. The manuscript was known to Caraccieli (1766), Dallaway (1819), and Tierney (1834), but the first part of the original is still missing.

The river that we now know as the Arun is said to have been known of old as the High Stream in Arundell Rape, and in "middle times" as Alta Ripa; but by the Norman-English as Hault Rey. The water-bailiff who compiled the manuscript was one of considerable learning. He lived at Stopham, and his identity can only be conjectured, but the interesting suggestion is made that he may have been one of the Barttelott family. Apart from the fact that from the ancient style in which it is written, it is not always easy to understand what is exactly meant; it is replete with references to old customs, rights, and observances, and these are made increasingly valuable by the footnotes which have been made by the editor, which show a great amount of learning and research.

The natives of the county were called by the Saxons the Homelings, whilst those who came to dwell among them came to be known as the Comelings. With the modern popularity of Sussex, we fancy the Comelings are more in evidence than ever they were before. The author is sometimes severe on the antiquarians who write without full knowledge or inquiry into the subject of their writings, and it must be admitted that if writers in other parts of the country could have access to documents such as that which has been printed, even supposing them to be in existence, antiquarian knowledge would be greatly increased.

In tracing the course of what we call the Arun from its sources, the author mentions the various streams and rivulets which feed the river, and gives concise information as to the bridges, and does not fail to say who should repair them and who has failed in this duty. An interesting tradition is mentioned that the river entered the sea in former times near Lancing, " where Bramber River (Adur) then likewise vented itself ". This is a subject that deserves further inquiry, for it is not inherently improbable. Such a course would take the river to the rear of Littlehampton, of which the common and many of the houses are situated on the old beach, and it would leave between the river and the sea the same eastward-extending spit of beach such as we find at the mouths of other rivers on the south coast. A somewhat similar case is seen at Seaford, where the ancient spit of beach, at one time known as the Bemblands, lay between the Ouse and the sea, when that river turned eastward from what is now Newhaven.

We should like to make many references to points contained in this old manuscript. There is a short description of the various kinds of fish that are found in the river, and a touch of affection shown for these creatures by the water-bailiff, who during the " fence-month ", or close season, finds it his duty to take them under his care. His duties were to preserve the swans, fowl, and fish, and to watch over the fishermen's " weares, weare-gates, weeles, shutting-nets and other engins whatsoever that may any way entrap or deceave the fish at that time ". He was to see that the meshes of nets were properly sized, and if the rods of the weirs were above the customary size " hee is then to cutt and deface them ".

The second of August is stated to be " swann-hooking or swann-hopping-day ". This is a variant of ' swan-upping ', which is said in the O.E.D. to be the true form of the word, that is, the taking up of the swans or cygnets for the purpose of marking them. The water-bailiff had to decide between the claimants of the cygnets of swans that had wandered from their rightful owners' waters, and to see that the swan-marking was properly carried out, also to claim his dues on such occasions. There is a list of the marks pertaining to the various persons of rank who had the right of keeping swans. In this we have the word ' butted ' frequently, and a note by N. F. Ticehurst that this refers to the pinioning of a wing " by the removal of the part of the wing distal to the carpal joint ". The swan-marks included besides butting on a wing, one or more notches on the beak, slits on the web of a foot, round holes on the web, the cutting off of one or both ' heels ' (hind-toes), cutting off a claw, the burning of initials on the beak, and various combinations and permutations of them.

The powers of the bailiff to prevent the catching of immature fish and the prevention of pollution of the stream were extensive, and it would be of interest to know if they are still maintained. Unaccustomed or unlawful instruments were not to be used, and if discovered they were to be defaced, or cut in pieces, or taken away or repressed. He was to see that there was " no shooting with gunns uppon their waters by reason whereof the swanns and fowle are frayed out of their haunts, and many times killed, especially by shooting at night ".

The extracts that have been made will show that the book is one which will appeal to all lovers of Nature, although the manuscript was not written for that purpose. It will be of considerable value to owners of fishing and other rights elsewhere, whilst to antiquarians it will be a book to linger over and handle with affection. The folding map is of great service in tracing the feeders of the Arun, and the bridges and other spots referred to in the text.

The Colloid Chemistry of Protoplasm.

The Colloid Chemistry of Protoplasm. By Prof. L. V. Heilbrunn. (*Protoplasma-Monographien*, Vol. 1.) Pp. viii + 356. (Berlin: Gebrüder Borntraeger, 1928.) 19 gold marks.

THIS first in a new series of monographs is written by one editor of the series, Prof. L. V. Heilbrunn, and dedicated to the other, Prof. Weber, who has taken an active part in editing the new journal *Protoplasma*. This journal has certainly been very successful as a channel of publication for the stream of experimental records, comment, and criticism which are the visible evidence that the study of protoplasm has been taken up from many new points of view, often only now possible as the result of advances in other sciences, especially chemistry and physics. It has yet to be shown, however, that the very fluid and tentative generalisations in this field are ready to crystallise into monographs.

At the same time, the literature of this subject grows so rapidly, and has been so scattered, that a general presentation by one writer is very valuable. Fortunately, too, this literature is critically considered by Prof. Heilbrunn. Too often results are cited to-day without any consideration of the experimental technique by which they were obtained. As a result, a rational interpretation of protoplasmic processes is hindered as much by the effort to reconcile inaccurate and irrelevant data as by the experimental difficulties inherent in the subject.

The book is clearly, often even vividly, written, and the author lives up to his own advice: "We must cling to the facts which are broadly and generally true and leave the specific details to gods and encyclopædias." The author is more familiar with the zoological literature, but plants are by no means neglected. A constant attempt is made to link physical and chemical phenomena with morphological changes; this attitude is as valuable as it is rare.

Very few generalisations are probably yet ready for statement in this field. The most positive impression received from the perusal of the book is that the study of protoplasmic viscosity has proved a very fruitful line of attack. It will be a surprise to many biologists to read that the viscosity of protoplasm is often only a few times that of water. This conclusion must still be regarded as controversial, but the author seems to have a very strong case for his rejection of many figures which were more in accord with the prevalent impression of a very viscous 'slimy' substance. The changes in viscosity associated with the process of cell division are analysed. This association is now familiar to biologists, but morphology and colloid chemistry have still many joint problems in the phenomena of cell division.

There seems progress to report in the chapter upon the electric charge upon the protoplasm, where a clear distinction is drawn between the charge upon the surface layer and upon the colloid mass within the cell. When the action of acids and alkalis is considered, there seems little to show for much recent activity. Possibly the behaviour of iso-electric protein deserves more attention than it receives, as also the studies of Michaelis and others upon the permeability of protein-impregnated membranes in relation to hydrogen ion concentration. Certainly it is good to see attention directed to the lyotropic series when considering the action of salts. At one time Loeb's work upon the stoichiometric behaviour of proteins, with acids and bases, had thrust these phenomena too far into the background.

Many pages are given to a surface precipitation reaction, often exhibited by protoplasm when it escapes from the injured cell. Partly through its connexion with the presence of calcium, this reaction is brought into relation with the obscure phenomena of cytolysis and hæmolysis and with the clotting of blood. Cell division and vacuole phenomena are also considered mainly from the point of view raised in this tentative new interpretation of the surface precipitation reaction. The discussion is very stimulating and suggestive, but is of doubtful appropriateness in this monograph. Doubtless these chapters will appear in a more extended form, with full experimental protocol, in the pages of a journal like *Protoplasma*. We can only feel grateful that Prof. Heilbrunn has deferred the congenial task of detailed examination of these, as yet, mainly unpublished experiments long enough to permit the preparation of this more general monograph.

The botanist, by the way, will read with some surprise that "no one seems to have been especially interested in the process of vacuole formation" in the plant. Possibly the long controversy on the subject amongst French cytologists is regarded as too morphological in nature for consideration.

Our Bookshelf.

(1) *The Decline of the West.* By Oswald Spengler. Authorised translation with notes by Charles Francis Atkinson. Vol. 2: *Perspectives of World-History.* Pp. xi+507+xxxii. (London: George Allen and Unwin, Ltd., 1928.) 21*s.* net.

(2) *Kalki: or the Future of Civilisation.* By S. Radhakrishnan. (To-day and To-morrow Series.) Pp. 96. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1929.) 2*s.* 6*d.* net.

(3) *Nomades: essai sur l'âme juive.* Par Kadmi-Cohen. Pp. xii + 221. (Paris: Félix Alcan, 1929.) 12 francs.

(1) Those who are closely engaged in scientific work are too preoccupied to worry about the future of civilisation. Most of them, if they consider the subject at all, assume that, with science in the ascendant, the future is secure. The books before us, however, take a different view, and raise many important questions. Spengler's theory is well known, namely, that civilisations have their periods of growth, maturity, and decay, and that our European type of culture has passed the summit. Whether or no the reader can accept everything that he finds here will make little difference to the

fascination that the book will exercise upon him. Whatever else he may or may not be, Spengler is never dull: his generalisations, his handling of facts—many of them as unfamiliar as they are interesting—his *aperçus*, make his pages almost as entrancing, at least for the moment, as Gibbon's. Not that he has Gibbon's greatness—perhaps his keen and lively glance is more like Voltaire's. Students of science should read Spengler, if only as a moral discipline; he will suggest to their minds some profound doubts.

(2) Mr. Radhakrishnan's little book is, of course, of a much more limited scope, but it repays reading. His thesis is the familiar one that our ethical and religious development has not kept pace with the spate of scientific knowledge which has engulfed us all. He questions the too commonly held assumption that mechanical technique is equivalent to civilisation.

(3) M. Kadmi-Cohen's book on the Jewish soul is relevant to the subject dealt with in the other two volumes, since it is concerned with the problem of spiritual leadership for Europe. He holds that, much as Europe already owes to the Semitic genius, the debt is not yet complete. J. C. H.

Primitive Beliefs in the North-East of Scotland. By the Rev. J. M. McPherson. Pp. xii + 310. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1929.) 12*s.* 6*d.* net.

It is perhaps owing to the fact that north-east Scotland has been less well served by students that it does not figure so largely as the west in the literature of folklore and primitive belief. That this is not due to a lack of material is shown by the data which Mr. McPherson has collected and published in this book. As he points out, no systematic study of the folklore of this area has been made since the publication of "Notes on the Folklore of the North-East of Scotland", by Dr. Walter Gregor, nearly fifty years ago. Mr. McPherson has here collected and classified the large amount of material which has accumulated since that date, and in addition he himself has examined the ecclesiastical and burghal records which, while wishing to ignore superstitious practices, frequently were forced to note old ways and modes of thought and life in opposition to the views of the Church. Hence much valuable information upon such subjects as well-worship, tree, river and water spirits, fire festivals, and, above all, magic and witchcraft.

This latter subject claims a large share of the author's attention, and the whole of the second part of his book is devoted to the Black Art, which he examines exhaustively and in its various manifestations. It was in this area that some of the most famous of the Scottish witches were found—Isobel Goudie, for example. The actions of which they were accused were among the most primitive cited in all the witch trials. This is especially to be noted in connexion with fertility rites, in which both nudity and the use of urine are recorded. Control of the winds was a common prerogative of the witch, as might be expected in a country in which maritime activities play a large part. Belief in this ability continued until well into the nineteenth century. Although it has been possible to indicate only one or two points of interest in Mr. McPherson's collection, his book is a store of information on every side of old Scottish custom and belief.

Morphologie und Physiologie des Formwechsels der Moose auf genetischer Grundlage, II. (*Untersuchungen, ausgeführt mit Unterstützung der Notgemeinschaft der deutschen Wissenschaft zu Berlin und der Gesellschaft der Wissenschaften zu Göttingen.*) Von Fritz von Wettstein. (*Bibliotheca Genetica*, herausgegeben von Prof. Dr. E. Baur, Band 10.) Pp. iii + 216 + 10 Tafeln. (Leipzig: Gebrüder Borntraeger, 1928.) 48 gold marks.

This is the second part of Fritz von Wettstein's well-known experimental work on mosses, the first part having appeared in 1924. The present contribution deals largely with hybridisation between different species and genera of mosses, and with heteroploidy produced experimentally by Marchal's original method of wounding the sporophyte. By regeneration from a hybrid sporophyte, and subsequent hybridisation again, various unbalanced types can be obtained, in which the chromosomes may be regular multiples, but more sets will have been derived from one parent species than from the other. These are spoken of as heterogenomatic, homogenomatic forms being those derived from wounding successive generations of sporophytes in pure species, or from crosses giving a balance of chromosome sets. In a section on cell-size, a law for the increase of size accompanying various degrees and kinds of polyploidy is worked out.

Extensive comparative studies of the leaves, paraphyses, sex organs, capsules, stomata and cells in all the various kinds of polyploid hybrids form a basis for the analysis of the genetic effects of each chromosome set. This work has become sufficiently extensive to have wide bearings on various fundamental genetical problems; and mosses, in their structure and life-history, possess certain advantages which are not shared by flowering plants. R. R. G.

Handbuch der Vererbungswissenschaft. Herausgegeben von E. Baur und M. Hartmann. Band 1: *Die cytologischen Grundlagen der Vererbung.* Von Karl Bělař. Pp. iv + 412 + 2 Tafeln. (Berlin: Gebrüder Borntraeger, 1928.) 80 gold marks.

While the volume under notice is mainly devoted to the animal side of the cytological basis of inheritance, there is also a considerable amount of well-chosen evidence from plant material. Much of the evidence presented can be found in such works as Wilson's "Cell", but some of the recent developments have been more fully considered.

The earlier chapters deal with such topics as cytomorphology, cell and nuclear division, cell differentiation, fertilisation and parthenogenesis. In later chapters, considerable space is devoted to problems relating to chromosome reduction, individuality of the chromosomes, and the relation of the chromosomes to heredity. The last chapter asks the question whether formed cytoplasmic bodies such as mitochondria are bearers of hereditary characters, and, after considering the evidence almost entirely from the animal side, leaves the answer an open one.

References are made to the author's own experimental work on mitosis. Considerable space is taken up with a summary of recent developments in the genetics of *Drosophila*, and an account is also given of Wettstein's work on the production of polyploid mosses. The book will prove useful to those who wish to keep abreast with recent developments in this field.

Les méthodes nouvelles en analyse quantique (mécanique quantique, mécanique ondulatoire). Par Dr. Julien Pacotte. Pp. viii + 139. (Paris: Albert Blanchard, 1929.) 22 francs.

The object of this book is to give an account, from as many different aspects as possible, of the new methods in quantum mechanics. The first part, based on papers published before July 1926, contains six chapters. These deal with general quantum principles, Heisenberg's matrix mechanics and Dirac's numbers, de Broglie's waves, Schrödinger's wave mechanics, perturbations, and applications. The second part contains two chapters, which link up the new quantum mechanics with relativity and statistical mechanics.

The author's style makes the book easy and pleasant reading. He takes great care to point out that the different conceptions are not so much different theories as different aspects of the same theory. It is shown that Heisenberg's matrices suggest Schrödinger's work, and conversely. Perhaps some readers will consider that the space devoted to applications is too small. This section deals only with the harmonic oscillator and the hydrogen atom. At present the most successful parts of the new theory seem to be its applications, whereas the theoretical foundations are not as yet very secure, and have even been described as "a dodge, but a very good dodge".

H. T. H. P.

Fitness for Work. By Prof. T. H. Pear. Pp. 187. (London: University of London Press, Ltd., 1928.) 5*s*. net.

Prof. Pear has in this little book made an interesting study of fitness for work. He rightly remarks that far more books are written about unfitness. He analyses the aspects of successful achievement which force us to attribute to a worker capacities, abilities, or skills, and then the motives that lead a person to select, continue in, or change a particular work, and finally discusses some current conceptions of the function of work. Stupidity and laziness would almost seem to be out of place in a study of fitness, but the author presents some novel and provocative remarks on the two and shows their relation to such a theme. The final chapter on the question of the value of industrial skill opens up some very vital problems of modern industry. Two apparently opposite tendencies are clearly visible in the modern State: on one hand, there is an undoubted increase in the application of mechanism, with a corresponding diminution in the need for personal skill, but on the other, the very mechanism itself demands more people to adapt and adjust it, that is, to deal intelligently with mechanism, and modern organisations demand still greater skill on the part of those in authority.

Prof. Pear's book should appeal to a wide range of readers: his style is easy and not technical, so while the psychologist will find much to interest him, the general reader will find no terminological difficulty.

Kurzes Lehrbuch der Chemie in Natur und Wirtschaft. Von Prof. Carl Oppenheimer und Prof. Johann Matula. Zweite neubearbeitete Auflage. Band 1: *Allgemeine Chemie*, von Prof. Johann Matula; *Anorganische Chemie*, von Prof. Carl Oppenheimer. Pp. xiv + 566. 23 gold marks. Band 2: *Organische Chemie*, von Prof. Carl Oppenheimer. Pp. xiv + 471. 19 gold marks. (Leipzig: Georg Thieme, 1928.)

The authors have accomplished the considerable feat of giving a comprehensive delineation of present-day chemistry within the limits of little more than a thousand pages. The account is well proportioned and up-to-date. Particular emphasis has been laid upon the underlying principles of the science, and upon its relationships to biology and technology. The introductory section of 258 pages by Prof. Matula forms an admirable preparation for the succeeding systematic treatment of inorganic (pp. 294) and organic (pp. 453) chemistry by Prof. Oppenheimer. The work offers at a reasonable price a useful German text for advanced students, teachers, biological chemists, and all who are interested in the industrial applications of chemistry.

Matter, Electricity, Energy: the Principles of Modern Atomistics and Experimental Results of Atomic Investigation. By Prof. Walter Gerlach. Translated from the second German edition by Dr. Francis J. Fuchs. Pp. xii + 427. (London: Chapman and Hall, Ltd., 1928.) 30*s*. net.

This volume covers a wider field than is usual in a short treatise on atomic physics, and touches upon most of the important work done between about 1910 and 1926. It includes sections on atomic rays, superconductivity, conduction in crystals, spectrophotometry, and electrically and optically controlled chemical reactions, in addition to the more usual topics, and if it were well translated, would be invaluable both as an advanced text-book for honours classes in physics, and as a survey of the subject for research workers in other branches of experimental science. Dr. Fuchs has, however, failed to do justice to the original, and his translation can only be recommended as it stands with the warning that the reader must be prepared to be irritated by the many unusual expressions that he employs.

Letters to the Editor.

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

The Total Solar Eclipse at Iloilo on May 9.

The following is a preliminary note on the results of the eclipse expedition of Dr. K. H. Hartline, Mr. W. E. B. Lloyd, and myself. The preparations for the expedition were made at Johns Hopkins University, Baltimore, and were as complete and permanent as possible to reduce to the minimum the work that remained to be done in the eclipse camp. This was necessary owing to the fact that Dr. Hartline was unable actually to make the journey, and Mr. Lloyd and myself had only twelve days in which to put up the apparatus.

Our site was near Iloilo in the Philippines, in the grounds of the Normal School of La Paz, about a mile and a half north of the U.S. Naval Observatory party. Totality lasted 3 min. 42 sec.; but throughout, the sun was covered by a veil of high cirrus.

Ten panchromatic plates (H. & D. 2000, Imperial Dry Plate Company) were given exposures ranging from one to forty seconds with a 5-inch visual Alvan Clarke lens of 6-foot focus through a green Ilford 'Beta' filter transmitting λ4450-λ6950. The focus is good and the shorter exposures show much inner coronal detail. Longer exposures bring up streaky cirrus which confounds coronal detail; yet on these one can trace one streamer to three solar diameters from the limb.

Our intention was, if fine, to get extreme coronal extension by the use of these very rapid plates and the filter which would diminish the scattering of the light. In that the very considerable cloud veil thwarted us; but we feel that, under the conditions obtaining, had it not been for our filter, we should almost certainly have got the inner corona only.

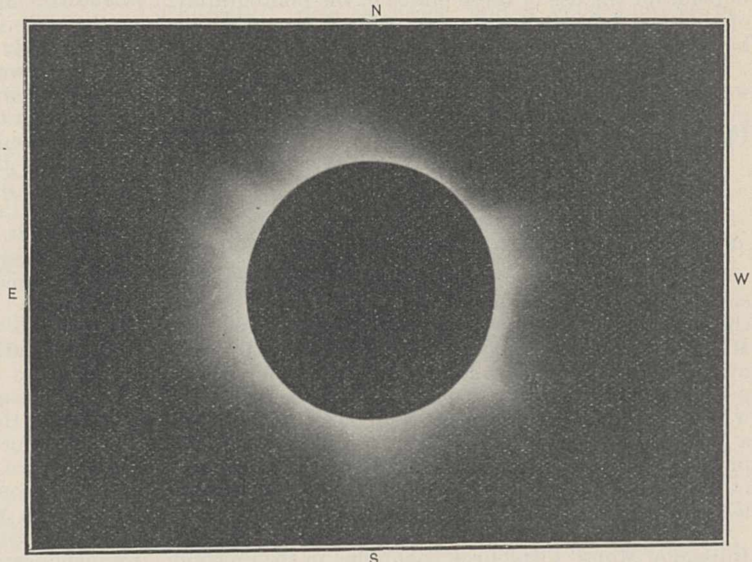

Fig. 1.—One second exposure. Panchromatic plate, 'Beta' filter. 5-in. Alvan Clarke lens, 6-ft. focus.

Using a neo-cyanin dyed plate and an infra-red filter, we gave a single exposure of about 200 sec. with a 3-inch rapid rectilinear lens of 24 inches focus (*F* 8). This plate-filter combination was sensitive between about λ7000 and λ9000 with a maximum at λ8500. On this plate the corona is completely confined to within half a diameter of the sun from its limb, is extremely intense—practically 'burnt out'—and has a very abrupt edge. We believe this effect to be far too marked to be attributed entirely to the steep intensity gradient of the photographic combination; but it will be necessary to decide this point on returning by measuring the plates with a micro-photometer, etc. Should the effect prove to be real, it will confirm the view that the light of the outer corona is entirely sunlight scattered by particles very small in comparison with the wave-length of light.

Another effect on this plate which will also require confirmation by measurement, etc., is an apparent filling-in on the infra-red plate of what on the panchromatic plates are wedge-shaped gaps in the corona extending in towards the limb. If this effect turns out to be real, it would suggest intervening screens of particles large enough to blot out visual rays but small enough to transmit those of the near infra-red.

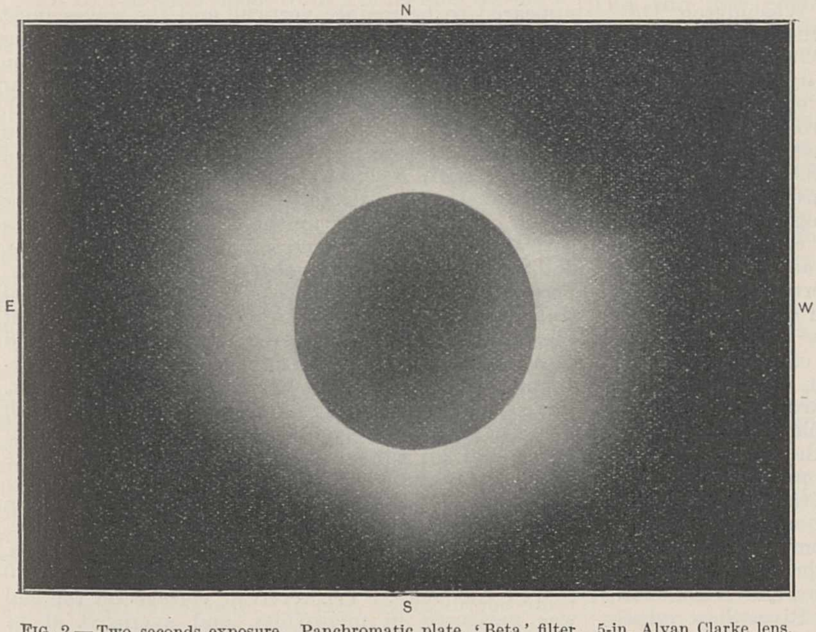

Fig. 2.—Two seconds exposure. Panchromatic plate, 'Beta' filter. 5-in. Alvan Clarke lens, 6-ft. focus.

Lastly, this infra-red plate is the only one on which no cloud appears; it has completely penetrated—or rather *ignored*—the intervening cirrus.

The cloud badly interfered with our attempt at infra-red spectroscopy—for which the *quantity* of light was all-important. In this a similar neo-cyanin plate was used with infra-red filter in conjunction with a concave objective grating (kindly lent by Prof. R. W. Wood), $2\frac{1}{2}$ in. × $3\frac{1}{2}$ in. aperture, 15,000 lines per inch and about 5-foot focus. On each of the two flash spectra obtained, only four emission arcs appear, three of which are the infra-red calcium triplet in the region around λ8500-λ8600. Unfortunately, owing to a displacement of the whole spectrum along the line of dispersion, due to a warping by the heat of the wooden tube and finder, the focus is poor. The fact, however, that these arcs appear at all under the conditions of the sky prevailing is hopeful for the use of these plates in the photography of the near infra-red during an eclipse, provided one has a clear sky.

In addition, two fairly successful colour pictures were made of the corona with the new Du Fay colour process film (kindly supplied by the Imperial Dry Plate Company).

REGINALD L. WATERFIELD.

Chicago, July 13.

Penetration of Rocks by Electromagnetic Waves.

DURING the month of June, research work has been carried out at the Mammoth Cave, Kentucky, under the joint auspices of the United States Bureau of Mines and the Geological Survey of Canada, by permission of both of which this communication is being published. The disputed question of the extent to which wireless waves will penetrate into the earth has a high scientific interest, and it bears directly on some practical modern methods of geophysical prospecting for underground conductors such as the sulphides of lead, iron, and copper.

Previous investigations have been made at the Bureau of Mines' Pittsburgh coal mine, in the Caribou Mine, Colorado, and in the Mount Royal Tunnel, Montreal. An account of the experiments may be found in *Technical Paper* 434, pp. 37-40, Bureau of Mines, Department of Commerce, Washington, D.C., and in the *Proceedings* of the Institute of Radio Engineers, Vol. 17, No. 2, Feb. 1929. References to the subject have also appeared in the columns of NATURE. All this work has been of a dubious character because of the presence of iron pipes and rails, and of copper conductors connected with electric lighting. There were three schools of thought; some claimed that the radiations came through the entrance, others that the waves passed through the rock, while the remainder considered that the effects were transmitted along wires, pipes, and rails. Probably all three paths are available, but certainly the Mount Royal experiments proved beyond question that the short waves of length 40 metres (7500 kilocycles) failed to enter the tunnel by any of these means for more than a few hundred feet. Longer waves, broadcasting upwards, were heard and measured throughout the entire three and a half miles of tunnel.

To settle the question, Mammoth Cave, Kentucky, was selected for experiments and it proved a fortunate choice. This cave has not been electrified for illumination, and the managers were good enough to remove telephone wires. There are no conductors whatever in the cave except here and there short lengths of iron hand rails. The exits are filled by and sealed with the waters of Echo River and the River Styx, which flow into Green River. A few years ago a new entrance was found and some electric wiring introduced; this is four miles away overland and eight miles away by cave. A careful survey was made both under and above ground so that corresponding points could be located and levels known. Most of the work was carried out above River Hall, with 300 feet of overburden, about 200 feet of Mammoth Cave limestone, capped by 100 feet of Cypress sandstone. The resistivities of these rocks *in situ* were ascertained by electrical prospecting to be of the order of 10,000-20,000 ohm-cm.

Broadcasting Wave-length.—The words and music from Louisville, Nashville, Cincinnati, were received on a No. 26 Portable Radiola superheterodyne six-tube set, and the bearing was taken with the small loop which is part of the apparatus. These signals were traced into the cave from the entrance and were lost at 500 ft. from the mouth, where the overburden is 150 ft. Yet under the Mammoth Dome, 1000 ft. in the cave, capped by an ascertained thickness of 75 ft., mostly sandstone, the signals were clear enough, and these were traced along a rather narrow tunnel for 300 ft., when the thickness was 150 ft.

On a later occasion, Messrs. Joyce, Barlow, and Kidd took a three-hundred-foot aerial and gave three turns of it round the loop, so as to form a close coupling, and led the other end to the ground. In this manner there was at night good audible broadcasting in River Hall 300 ft. below the ground and more than a thousand feet from the entrance, at a point approached by the famous tortuous passage well named the Corkscrew. Next night, signals and speech were also audible at Echo River, reputed to be 350 ft. underground. The conclusion is irresistible that waves from distant stations can be detected under 300 ft. of sandstone and limestone, waves which do not come through the entrance, and do not pass along conductors.

Long-wave Stations.—Code signals from about six stations (Long Island and others ?) were heard on a loop with a Model RE low-frequency receiving equipment, consisting of an antenna coupling unit, a radio frequency amplifier, a low-frequency receiver, and a tuned audio amplifier. These signals were clear enough to hear, but their intensities were hard to measure, partly owing to static. The wave-fronts appeared to be mainly vertical, and the waves must therefore have been travelling through rock rather than down from above. The reception was again at River Hall, 300 ft. below the surface plateau near the camping ground of the Mammoth Cave Hotel. The bearings of these signals obtained above and below ground were nearly identical. This picture of a wave, with its front mainly vertical, travelling through the rock, just as through the air, is rather novel. We could pick up these unidentified stations with three turns of wire on a four-foot-square frame, and we obtained bearings therewith.

Horizontal Wave Fronts.—A circular horizontal transmitting loop, 100 ft. in diameter, was placed on the ground, and the insulated wire could be tapped so as to give one to ten turns as required. A rectangular receiving coil of three turns 40 × 10 sq. ft. was placed on the floor of the cave at River Hall (300 ft. down). Currents of known magnitude of about half an ampere were introduced into a single turn of the loop, using a gasoline engine generator to excite an oscillator. The high-frequency loop current was modulated by applying a 500-cycle alternating current potential on the oscillator plates. The frequency was varied by steps of ten, from 20 to 110 kilocycles. The received voltage on the coil was measured in microvolts, and averaged about four, suggesting a flux of 10^{-9} lines per sq. cm. in the cave, due to half an ampere in the loop above ground. It was a most remarkable fact that the 20 and 30 kilocycle frequencies boomed out loudly compared with the 40-100 kilocycle frequencies. Measurements made above ground on the same frequencies showed no such emphasis, and there is a strong suggestion that these frequencies (20-30 kc.) pass with markedly less absorption through the rock. This question must stand over for a fuller investigation. The selectivity did not appear to be a function of the receiving instrument.

Audio Frequencies.—When 500-cycle frequency alternating current was impressed on the full ten turns of the 100-foot diameter circular loop, powerful signals were received with headphones both with and without a three-stage amplifier, using a 400 turn 3×2 sq. ft. rectangular coil, at depths of 100 ft. and of 300 ft. Of particular interest is the fact that detection was readily made without amplifier, in the Mammoth Dome, 900 ft. on an inclined line from the horizontal loop. We conclude that the electromagnetic effects of a 500-cycle frequency passed through 900 ft. of continuous rock. It is intended to publish a full report on these experiments in due course.

A. S. EVE.
D. A. KEYS.
F. W. LEE.

New Determination of the Curvature Radius of Space-time.

As communicated in a cablegram of April 10 (NATURE, April 20, p. 618), my statistical formula, concerning any two groups of stars 1, 2,

$$R^2 = \frac{c^2[\overline{(rv_r/v)_1^2} - \overline{(rv_r/v)_2^2}]}{\overline{v_1^2} - \overline{v_2^2}},$$

which is fully derived in a monograph on "The Size of the Universe", shortly to be issued by the Clarendon Press, Oxford, when applied to 29 Cepheids observed by R. E. Wilson of Albany, yielded for the radius R of de Sitterian space-time the value $3{\cdot}0 \times 10^{11}$; when applied to 35 stars of the O-type observed by J. S. Plaskett of Victoria, gave $R = 3{\cdot}2 \times 10^{11}$; and when applied to 246 stars taken from Young and Harper's list, $R = 3{\cdot}4 \times 10^{11}$ astronomical units. The latter batch of objects consisted of those of R. K. Young and W. Harper's "1105 Stars" (*Publ.* Domin. Astrophys. Observatory, Victoria, B.C., vol. 3, No. 1, Ottawa, 1924) numbered 500 to 1105, the distances of which, r, equal or exceed 50 parsecs, and the radial velocities of which are less than 100 km./sec. In the formula just quoted, c is the velocity of light, v_r the radial and v the resultant velocity, relative to the sun. (It may be noticed that in Young and Harper's memoir the radial velocities are corrected for the solar motion, but Prof. Young was kind enough to send me a complete list of the original velocities reduced, as usual, to the sun.)

Since the coincidence of these three R-values has seemed very encouraging, I have recently returned to the complete list of Young and Harper's stars, taking in also all those numbered 1 to 499, and, again, satisfying the conditions $r \geqq 50$ parsecs, $v < 100$ km./sec. This gave in all 460 stars, for which all data (r, v_r, μ, and therefore v_t and v) are available. Having divided this material into two groups of 230 stars each, ranging from $r = 50$ to 100 and from 100 to 1000 parsecs, and applied to these the above formula, I had the satisfaction of finding the said R-values corroborated excellently. In fact, the laborious computation, completed on July 11, gave for the nearer sub-group

$$\overline{s_1^2} = \overline{(rv_r/v)_1^2} = 2109 \text{ parsec}^2, \quad \overline{v_1^2} = 1754 \text{ km.}^2/\text{sec.}^2,$$

and for the more distant one

$$\overline{s_2^2} = 16{,}930, \quad \overline{v_2^2} = 2185,$$

where s_1, s_2 are, by the way, the actual distances of the several stars from their perihelia. Now, these values, substituted into my formula, give

$$R = 1{\cdot}76 \times 10^6 \text{ parsecs},$$

or $3{\cdot}63 \times 10^{11}$ astronomical units, or 5·74 million light years, in excellent agreement with the Cepheid and the O-stars results. In view of the numbers of the last group (460 stars), the latter value has by far the greater weight, and can be accepted with confidence, at least to two figures, as the actual value of the space-radius.

The complete list of data for the $29 + 35 + 460$ celestial objects will be found in "The Size of the Universe", now in proof, and a good number of details will be given sooner, in a paper announced for the next meeting (Aug. 26–29) of the American Astronomical Society at Ottawa.

Here it may still be added that the greatest possible distance apart of two points in elliptic (polar) space is $\frac{1}{2}\pi R$, and thus *nine million* light-years. In view of this, distances such as 140 million light years attributed by Shapley and Hubble to a group of fainter spiral nebulæ are entirely out of the question and (since my radius is stoutly supported by several hundred stars of a variety of kinds) must be subjected to a thorough revision. It seems that even the distances of the Magellanic Clouds, or at least that of the greater one, which of late served as a yardstick for several estimates, has been exaggerated. In fact, in a letter of Feb. 11, 1929, Prof. Shapley, kindly answering a number of my questions, says that the distances of the globular clusters are now being revised, and warns me that "the Large Magellanic Cloud will probably move in considerably when the present study of magnitudes and variable stars is completed". The latter warning was particularly agreeable to me, since I had just at that time derived the Cepheid value 3×10^{11}, which was some 15 times smaller than that obtained from the Magellanic Clouds (in conjunction with the clusters) in 1924. One can now confidently expect that when these objects, Clouds, and all "move in considerably closer, they will also confirm the radius of the order of 3×10^{11} a.u.".

I do not hesitate at any rate to assert that there are, in our world, no distances exceeding nine million light years, so that the present placing of Virgo (140 million) is utterly inadmissible.

The total volume of space being $\pi^2 R^3 = 54 \times 10^{18}$ cubic parsecs, there is ample room for some millions (but not 10^{16}, as Hubble imagines) galaxies comparable in size with our own Milky Way.

LUDWIK SILBERSTEIN.
Cinema Laboratories Corporation,
New York, July 19.

The Possibility of Observing an Emission Spectrum of the Calcium Substratum in the Galaxy.

IN a very interesting paper, "Physical Properties of a Gaseous Substratum in the Galaxy" (*Astrophys. Jour.*, **69**, p. 7; 1929), Gerasimovič and Struve have recently given strong evidence of a uniform gaseous medium of calcium in interstellar space. The absorption coefficient per parsec for the interstellar K line was found by them to be $3{\cdot}4 \times 10^{-4}$. If such a general calcium substratum exists, the question may arise: Is the density of this substratum strong enough to allow the emission spectrum of the Ca^+ atoms to be expected in the spectrum of the night sky?

The mechanism by which the emission spectrum would be produced must be analogous to that giving the spectra of diffuse nebulæ. We have thus two kinds of emission, partly resonance radiation or line absorption with subsequent emission by steps and partly photoelectric ionisation with subsequent recombinations. In the nebulæ the second mechanism is much more powerful than the first one (compare Zanstra, *Astrophys. Jour.*, **65**, p. 50; 1927), but in interstellar space the two mechanisms take about the same active part in producing the emission spectrum of the Ca^+ atoms.

To begin with the resonance radiation, for example, the K line, the problem of finding the energy density of the interstellar K line on our point in space is, when rigorously treated, rather difficult and leads to a complicated integral equation. The problem is, however, in several respects analogous to that of finding the energy density inside a star. Let us first consider a stellar system embedded in a calcium atmosphere of high density, or in other words, we consider the case when the absorption coefficient for the K line is much greater than $1/R$, R being the radius of the stellar system. As is obvious, the density of the interstellar K line must then be considerable, because the K frequency radiation emitted by the stars must work its way out from the stellar system. The absorption coefficient found by Struve and Gerasimovič is, however, of the same order of magnitude as $1/R$, and, as will be shown in the following, the interstellar K resonance line is not strong enough to be expected in the spectrum of the night sky.

For purposes of simplification, we will consider a stellar system of spherical shape with a radius of 5000 parsecs and with the sun in the centre. Further, we assume both the density of the interstellar starlight E_s and the density of the interstellar K frequency radiation E_k to be constant within the stellar system. The last assumptions are of course not justified if the radius of the stellar system is much greater than $1/\kappa$, where κ is the absorption coefficient, but in our case the assumptions will give a maximum value of the energy density of the interstellar K resonance line in the centre not very far from the truth. Supposing every K line absorption to be followed by K line emission, we derive easily the following expression:

$$E_k/E_s = e^{\kappa R} - 1.$$

With $R = 5000$ parsecs we find $E_k/E_s = 4{\cdot}5$. The energy density of the interstellar K line would accordingly be about 4·5 times stronger than the energy density of the integrated starlight of the same wavelength. Remembering, however, that most of the stars have a strong K absorption line, that the width of the interstellar K line is only about 0·3 A. (Struve and Gerasimovič, *loc. cit.*), and that only 30 per cent of the light from the night sky is due to the stars (Dufay, *Bull. de L'Observatoire de Lyon*, **10**, 9; 1928), we must admit the chances of finding the K resonance line in the faint spectrum of the night sky to be very small. The spectrum of the night sky has been carefully investigated by Dufay, who has kindly communicated to me that the image of the slit on the spectrum plates was never less than 0·04 mm. The dispersion was about 120 A. per mm., that is to say, the interstellar K line would in Dufay's spectrograph be diminished 16 times in comparison with the continuous spectrum of the starlight or 53 times in comparison with the continuous spectrum of the night sky. If there had been no K absorption line in the spectrum of the night sky, the interstellar K line would be superposed on the continuous spectrum and just strong enough to be detected, or about 0·1 magnitude stronger than the continuous spectrum. As, however, the K line is very strong in absorption in the spectrum of the night sky, there is no possibility of detecting the interstellar K emission line.

In the foregoing we assumed every K line absorption in space to be followed by K line emission. This is, of course, not true, as many of the quanta are split up into the diffuse doublet $1\delta - 1\pi$ and the forbidden transitions $1\sigma - 1\delta$. As to the latter doublet, the chances of detecting it in the spectrum of the night sky are, however, rather good. This doublet is not present in absorption in stellar spectra, and the interstellar absorption lines in the spectrum of the integrated starlight are, as is easily shown, more than filled by the resonance lines. As the forbidden doublet (λ7293·43 and λ7325·91) arises both by resonance and by emission by steps, the lines seem to be strong enough to be detected superposed on the continuous spectrum of the night sky. It may, however, be rather difficult to photograph the red part of the faint spectrum of the night sky, but it seems possible, and it would be of considerable interest if such an investigation were carried out.

As was mentioned above, an emission spectrum of the Ca^+ atoms may also arise by electron captures of Ca^{++} atoms. To get an idea of the strength of this process compared with the resonance radiation, I made a calculation for the K line with the following assumptions. The absorption coefficient at the head of the series was equalised with the absorption coefficient of the K line and was supposed to decrease as $1/\nu^2$ (Milne, *Phil. Mag.*, **47**, p. 209; 1924). Further, one capture out of ten was assumed to give rise to the K line. With the temperature and dilution factor for the integrated starlight beyond the series limit given by Struve and Gerasimovič, I found the intensity of the interstellar K line just equal to the intensity of the continuous spectrum of the starlight which corresponds to the temperature 7000° and the dilution factor $5{\cdot}5 \times 10^{-15}$. This mechanism of radiation seems thus to be of about the same power as the resonance radiation.

As a summary of the above, we may propose the forbidden doublet $1\sigma - 1\delta$ to be present in emission in the spectrum of the night sky. The H and K emission lines are, on the other hand, not to be expected. As to an eventual emission spectrum of Ca^{++} atoms, it seems not possible at the present time to make any statement. If emission lines due to interstellar calcium could be found in the spectrum of the night sky, they would give valuable information on the density of the calcium substratum and the size of the galactic system.

Yngve Öhman.
Observatory, Upsala,
June 25.

The Relative Masses of the Proton, Electron, and Helium Nucleus.

Theoretical considerations suggest that the square root of mass may be more interesting and important than mass itself in the case of the ultimate particles of matter. For in the modern theory of matter, electric charge is more fundamental than mass, and the dimensional formula for electric charge e is $M^{\frac{1}{2}}L^{\frac{3}{2}}T^{-1}$ in the electrostatic system. Thus e is proportional to $M^{\frac{1}{2}}$. This appears in more definite form if we adopt the classical point of view that the mass of the ultimate particles is entirely of electromagnetic origin. According to the theory of relativity, energy and mass are related by the well-known equation $E = mc^2$. But if the energy E is entirely electromagnetic, $E = \int \frac{1}{8\pi}(F^2 + H^2)dv$, where F and H are the electric and magnetic field intensities respectively. Thus m depends on the square of F and H, corresponding to the fact that it depends on the square of e. Carrying out this process yields the well-known formula

$$m = k\frac{e^2}{ac^2},$$

where m is the mass of a particle of charge e and radius a. The numerical quantity k (usually given as $\frac{2}{3}$) depends on the particular assumptions made concerning the distribution of charge. This idea of the importance of the square root of mass is of interest, we believe, in connexion with the following facts concerning the relative masses of the proton, electron, and helium nucleus.

If m and M are the masses of the electron and proton respectively, then $\rho = M/m$ is a pure number. Furthermore, on the basis of quantum theory one might expect a dimensionless quantity of such a fundamental character to possess integral properties, that is, it would be an integer, half integer, or the square of an integer, etc.

The value of ρ according to the "International Critical Tables" and the "Handbuch der Physik" (vol. 22, p. 81) is 1847. Birge, however, in a paper on the probable values of the general physical constants (to be published in the *Physical Review* Supplement) gives two values of $(\rho+1)$, one (ρ_1+1) obtained from spectroscopic data, and the other (ρ_2+1) from the value of e/m from the deflection experiments with cathode rays. The corresponding values of ρ are:

$$\rho_1 = 1838 \pm 1.$$
$$\rho_2 = 1847 \pm 2.$$

(The opinion has been expressed that ρ_1 and ρ_2 may be really different quantities.)

It is interesting to note that

$$\sqrt{\rho_2} = 42{\cdot}98.$$

This suggests that possibly

$$\rho = 43^2 = 1849, \qquad . \quad . \quad . \quad (1)$$

a value which is within the limits of error of ρ_2.

At first sight, 43 seems to possess no distinctive characteristics to qualify it for such an important position in the domain of atomic physics. But

$$43 = 1^2 + 2^2 + 2^2 + 3^2 + 3^2 + 4^2.$$

If we multiply the numbers on the right of the equality by two, we obtain the well-known sequence,

2, 8, 8, 18, 18, 32,

giving the lengths of the successive periods of the periodic table of the elements. This numerical relationship can be stated in terms of physics in the following words. The number 43 is half the atomic number of the inert gas of highest atomic number, namely, radium emanation.

It is, of course, impossible at the present time to say whether the integral relationship (1) is either exact or significant. But if it should turn out not to be exact, it might nevertheless be significant. The latter point is illustrated by the fact that the integral relationships between the atomic masses as determined by Aston and others are only approximate.

The helium nucleus is usually regarded not as an ultimate particle of matter, but as a structure of four protons and two electrons. Since the latter conception lacks experimental demonstration, it is not certain that it is correct. Perhaps the helium nucleus should be regarded as an ultimate particle just as the proton and electron. The facts seem to indicate that in some sense of the word the helium nucleus is at least 'more nearly ultimate' than the nuclei of the atoms of atomic number greater than two. In the first place, the alpha particle is the only positive particle emitted in naturally occurring radioactivity. Secondly, the experimental data as usually interpreted indicate that the alpha particle is the chief constituent of the nuclei of atomic number greater than two. Furthermore, the packing fractions demonstrate that, if helium is composed of four protons and two electrons, it is an extremely stable combination. Possibly this indicates that in the process of combination the protons and electrons have entirely or almost entirely lost their identity. This latter idea represents a fusion of the usual conception of the helium nucleus and the conception that it is an ultimate particle. (It is of course not impossible or improbable that in all nuclei the component particles have lost their identity.)

Let M_{He} and M be the masses of the helium nucleus and the proton respectively. If the helium nucleus is regarded as an ultimate particle, one might expect M_{He}/M to be the square of an integer just as ρ is. As a matter of fact, $M_{He}/M = \sim 2^2$.

This relationship can be formulated more precisely as follows. If m_H and m_{He} are the masses of the hydrogen and helium atoms respectively, then

$$\frac{m_{He}}{m_H} = \left(\frac{Z_{He}}{Z_H}\right)^2 \cdot \frac{1}{1+a}, \qquad . \quad . \quad . \quad (2)$$

where Z_H and Z_{He} are the atomic numbers of hydrogen and helium respectively, and a is the fine structure constant. Part of this relationship was pointed out by A. C. Lunn (*Phys. Rev.*, **20**, 1; 1922) before Aston's recent data were available. The value of a computed from Aston's data (*Proc. Roy. Soc.*, **115**, 510; 1927) by equation (2) is $0{\cdot}00724 \pm 25 \times 10^{-5}$, in excellent agreement with the spectroscopic value 0·00729.

In the quantum theory of the electron the mass enters as an arbitrary constant. Perhaps the facts presented here will be of value in constructing a better theory of the proton and electron, which will account for their masses, or at least their relative masses.

ENOS E. WITMER.

Randal Morgan Laboratory of Physics,
University of Pennsylvania,
Philadelphia, U.S.A.,
June 19.

Chromosome Numbers in the Agropyrons.

THE taxonomy of the Agropyrons is in a very unsatisfactory condition, and authorities differ widely in their classification of this genus. This undoubtedly is owing to the wide range of variability existing within the so-called species and also to the large number of intergrading types that occur between these species. The difficulty of classification extends to the seeds; analysts and seed merchants are unable to separate the desirable and undesirable forms with reasonable accuracy.

Since this genus contains a number of native and introduced hay grasses which are particularly well adapted to conditions in western Canada, it is a matter of considerable importance to clear up the foregoing difficulties. It was felt that a cytological study might assist greatly in overcoming some of the taxonomic problems and provide a valuable guide to plant-breeding work.

The plants examined were grown in the greenhouse during the winter of 1928–29. Artificial lighting for a part of the night enabled the work to be carried on in the winter months. Slides were prepared both from pollen mother cells and from root tips. Pollen mother cells proved to be more suitable, and most of the counts were taken from this material. The proper stage was quickly ascertained by Belling's aceto-carmine method. The florets were fixed in Carnoy's 6-3-1 solution for two minutes and then for twenty-four hours in Zenker's fluid. They were embedded in paraffin and sections 20 μ thick were cut. Newton's iodine-gentian-violet staining method (Huskins, C. L., *Jour. Gen.*, **18**, 315-364; 1927) was used with the above fixing agent. This gave a very brilliant stain, which seemed especially suited to differentiating overlapping chromosomes. In this respect it was preferred to Heidenhain's iron-alum hæmatoxylin, and it has also the advantage of being much quicker than Heidenhain's method. The foregoing method was used for the preparations shown in

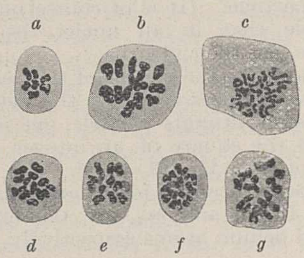

FIG. 1.

a, A. Griffithsii, 7 chromosomes; *b, A. Richardsonii*, 14 chromosomes; *c, A. Richardsonii*, root-tip, 28 chromosomes in the metaphase; *d, A. tenerum*, 14 chromosomes; *e, A. cristatum*, 14 chromosomes; *f, A. repens*, 21 chromosomes; *g, A. pungens*, 21 chromosomes. All but *c* show bivalent chromosomes in the metaphase of the heterotype.

Fig. 1, *a*, *d*, *e*, *f*, and *g*. The preparation shown in Fig. 1 *b* was made from a temporary mount prepared by Belling's aceto-carmine method, and this accounts for the swollen condition of the chromosomes. The root-tip preparation shown in Fig. 1 *c* was made from a slide prepared by using Bouin's fixing agent and Heidenhain's iron-alum hæmatoxylin stain.

On counting the chromosomes of the various species studied, they were found to fall into three groups with haploid numbers of 7, 14, and 21.

The groups are as follows:

A. Griffithsii . .	7 chromosomes.
A. Richardsonii . .	14 ,,
A. tenerum . . .	14 ,,
A. cristatum . . .	14 ,,
A. repens . . .	21 ,,
A. pungens . . .	21 ,,

The accompanying illustrations are camera lucida drawings from slides showing clear counts. A Zeiss 1·3 mm. apochromatic objective and ×20 ocular were used in all cases. This gave a magnification of 3200 on the original drawings.

Only typical members of the species were used in determining these counts, and their chromosome behaviour was fairly normal in all cases. Lagging of one or two chromosome pairs was frequently observed in the anaphase of the heterotype in the species *A. pungens* and *A. repens*, and to a less extent in *A. tenerum*. However, the chromosomes did not seem to lag sufficiently to allow any possibility of their being excluded from the daughter nuclei.

Some of the wild plants examined did not exhibit normal chromosome behaviour. A plant which appeared to be *A. tenerum*, with the exception of short awns, was found to be peculiar in this regard. In the anaphase of the heterotype, three and four pairs of chromosomes were found at the equatorial plate just beginning to separate. This resulted in the daughter cells being multinucleate and containing varying numbers of chromosomes. There appeared to be eighteen univalent chromosomes at this stage, and the resulting daughter cells contained from five to thirteen. The plant of course was sterile. This may indicate hybrid origin, and the possibility of natural hybridisation occurring in the field. This phase of the subject, however, will be dealt with more fully in a later paper.

The discovery of a chromosome series in the Agropyrons is of considerable scientific interest as well as of practical value. This is particularly true, since like series have been reported in wheat, oats, and barley, all having a basic chromosome number of 7, and forming groups with 7, 14, and 21 as the haploid numbers. In wheat and oats the varieties of greatest commercial value belong to the 21-chromosome group, while in barley the 7-chromosome group contains all of our commercial varieties. The Agropyrons are intermediate in this respect. *A. tenerum* and *A. cristatum*, our two most promising economic species in western Canada, fall in the 14-chromosome group.

F. H. PETO.

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Further Evidence of the Carbon Isotope, Mass 13.

A FEW days ago Dr. King and I announced the discovery of an isotope of carbon, mass 13, appearing in the λ4737 Swan band of neutral C_2. Since then, I have found this isotope in two additional sources, namely, in Hopfield's absorption spectrograms of carbon monoxide, and in King's furnace (emission) spectrogram of the λ3883 CN band.

Two years ago J. J. Hopfield and I presented to the American Physical Society (*Phys. Rev.*, **29**, 922; 1927) an analysis of the emission and absorption spectra of carbon monoxide, based on extensive experimental material obtained by Prof. Hopfield with his vacuum spectrograph. The most complete absorption system is the fourth positive group, in which we were able to measure the bands from 0-0 to 15-0 ($\lambda\lambda$1544-1199). These bands degrade to the red, and it was noted at the time that a faint second head appeared to the red of each main head, at a systematically increasing distance. We were not able, however, to fit these heads into the band system. I have now carefully measured these second heads and find that they agree quantitatively with $C^{13}-O^{16}$ as an assumed source. The heads can be measured with reasonable certainty in all the bands from 2-0 to 15-0, with the exception of two for which emission lines interfere. The calculated isotope shift, using reliable vibrational constants obtained by Prof. Hopfield and myself, varies from 0·072 mm. to 0·273 mm. (55 cm.$^{-1}$ to 316 cm.$^{-1}$). The arithmetical average *obs.-calc.* value is 0·0035 mm., and the algebraic average 0·0017 mm., in the sense that the observed shift is very slightly less than the calculated.

If the $C^{12}-O^{18}$ molecule is also present, its absorption bands should lie to the *red* of the $C^{13}-O^{16}$ band heads, by amounts varying from 0·006 mm. to 0·024 mm. It is thus impossible, with the present spectrograms, to separate the two isotopes. In all cases the observed $C^{13}-O^{16}$ head is wide enough to include a possible $C^{12}-O^{18}$ head. Thus the evidence is conclusive that $C^{13}-O^{16}$ is present, but is strictly neutral as to $C^{12}-O^{18}$.

The second source of information is King's furnace spectrogram of CN λ3883 (*Astrophys. Jour.*, **53**, 161; 1921). Dr. King kindly loaned me all his CN furnace spectrograms for my work on temperature and band spectra (*Astrophys. Jour.*, **55**, 273; 1922), and I still have this material. He directed attention (p. 162, loc. cit.) to a very faint series of doublets lying between λ3872 and λ3876. I measured these roughly, in connexion with my temperature work, but was unable to fit them into the band structure. I found, however, that two of the six doublets had been observed by Kayser and Runge in the arc spectrum. I now find that these six doublets are the isotope lines P_{56} to P_{61}, due to $C^{13}-N^{14}$. They have the same doublet separation as the main doublets, and lie just to the red, in each case. In calculating the vibrational shift I have used the constants based on Heurlinger's original analysis, as calculated by Kratzer (*Ann. d. Phys.*, **71**, 72; 1923). For the rotational shift I have used new constants determined by R. T. Birge and W. O. Smith, in an unpublished quantum analysis of this band. The calculated shift varies from 0·228 mm. to 0·451 mm. (0·877 cm.$^{-1}$ to 1·739 cm.$^{-1}$).

Although the isotope lines are very faint, they can under favourable mechanical conditions be measured with reasonable accuracy. Excluding P_{56}, which lies too close to its parent line to measure properly, the observed isotope shift averages 0·014 mm. greater than the calculated, with an average deviation from the mean of only 0·0033 mm. This indicates a small error in the vibrational constants, or an electronic shift of this magnitude (0·05 cm.$^{-1}$). The latter explanation seems the more reasonable. The calculated isotope lines based on either $C^{12}-N^{15}$ or $C^{12}-N^{16}$ lie far outside the limits of error. There are definitely no other isotope lines observable in this region of the band, so that one may conclude that if isotopes of nitrogen exist, they are much less abundant, compared to N^{14}, than is C^{13} compared to C^{12}.

Raymond T. Birge.

University of California, June 29.

Fossil Records of Mendelian Mutants.

With the help of Prof. A. E. Boycott and others, I have been engaged for the past ten years in collecting data for the study of the distribution of variations in natural populations. The species selected for study were the two common and very variable British land-snails, *Helix* (*Cepœa*) *nemoralis* L. and *H.* (*Cepœa*) *hortensis*, Müll. These snails normally occur in populous and well-defined colonies. In habit they are sedentary and apparently seldom move far from their birthplace. Most of the variations taken into consideration are those that affect the colour and banding of the shell. The classical experiments of Lang, and the wider, but as yet mainly unpublished, work of Mr. A. W. Stelfox, have shown that several of the colour and band forms are inherited on simple Mendelian lines. Both species are recorded fossil from the Red Crag of Butley (Pliocene) and subsequent strata, and *C. nemoralis* from the Miocene of France (A. E. Ellis, "British Snails", 1926). Mr. J. W. Taylor in his monograph of the land and freshwater Mollusca of the British Isles gives numerous records of the geological distribution, and says of *C. hortensis* that in a pleistocene deposit (Ightham, Kent) the five-banded and unbanded forms were about equally numerous. To-day, bandedness is known to be a simple recessive to unbandedness in both species. Mr. W. J. Wintle (*Proc. Malac. Soc.*, **16**, 171-8; 1925) reports that on Caldey Island, *C. nemoralis* is very common as a living snail and as a pleistocene and holocene fossil. He states that among the living snails the unbanded form seems rather more common than the banded forms but that the reverse is true of the pleistocene shells. In neither of these cases, however, are any figures quoted.

In the living colonies studied by me the various phenotypes, as might be expected, occur with very different frequency; and the frequencies of any one phenotype may show a significant difference in samples separated by only a few yards. But on the whole series of colonies, banded types, taken together, are more prevalent than the unbanded form. Fortunately, the banding of the shell is easily seen in fossil material; detailed data, therefore, of the frequency of the different types in fossil samples could be obtained and would be of considerable interest from the point of view of genetics and natural selection theory. I am very grateful to Mr. A. S. Kennard, who has kindly supplied me with the figures for three fair-sized samples, each containing both species, from deposits near Goodwood. The samples are dated "Early Iron Age" and "Neolithic"; among the *C. nemoralis* there are four types, and among the *C. hortensis* two types, that are known to be inherited in a simple Mendelian manner. In all three samples the banded types taken together are numerically superior to the unbanded shells and the frequencies of the different types are just such as might be found to-day.

I need scarcely say that I should welcome any further data, references to already published data, or fossil material bearing on this point. C. Diver.

40 Pembroke Square,
Kensington, W.8, July 17.

Mimicry.

Prof. MacBride's reply to my criticisms of his views on mimicry, which appeared in Nature of May 11, has just reached me. Before this letter reaches England others may have dealt with this, but I would ask indulgence for a few remarks.

(1) It is to be regretted that opponents of the explanation of mimicry by natural selection so frequently rely upon arguments which overlook recorded facts. Such an argument was noted in section 9 of my article, and now Prof. MacBride quotes Bergh as evidence that butterflies are not eaten by birds. I would refer him to the discussion of this subject in Chapter x. of "A Naturalist on Lake Victoria", and to the following readily accessible publications: *Trans. Ent. Soc. London*, Part 3, pp. 353-71, 1902; *Proc. Ent. Soc., London*, pp. xxxii-xliii, 1915; *Jour. Linn. Soc.*, Zoology, vol. 33, 1919.

(2) Prof. MacBride states that the school to which I apparently belong gives no explanation as to how variations originate, and that "the real problem for science is how 'what is there' came into existence". That is one problem: another is why only a certain proportion of what came into existence survives to be included among 'what is there'. It appears to me that it is with the latter problem that mimetists are primarily concerned, as opposed to the former, which is one for geneticists.

(3) Regarding the influence of food, Prof. MacBride suggests that the study of such factors is the only means of solving the problems of animal coloration.

I would ask him to consider again the last paragraph of section 3 of my article, and whether he would attribute the wonderful similarity in appearance between *Planema* and *Pseudacrœa* to a similar effect of widely different food-plants upon larvæ not at all closely related to each other? G. D. Hale Carpenter.

Entebbe, Uganda.

Statistics in Biological Research.

Away on holiday, I see in my copy of Nature of July 20, p. 93, a letter on this subject from the distinguished statistician who uses the *nom de plume* of 'Student'. I regret that from some inadvertency he should have dated his letter from the Galton Laboratory, University College, London, an address to which, however much we may regret it, he has no claim. I feel sure that he will recognise, on fuller consideration, that the task of a director of a laboratory would become impossible if anyone could use its address without first obtaining the permission of the director.

Karl Pearson.

The Bicentenary of Thomas Newcomen.

Among the vast number of ingenious inventors whose work is the heritage of to-day, a prominent place must be accorded to Thomas Newcomen, who invented the atmospheric steam engine. Newcomen died in London on Aug. 5, 1729, two hundred years ago. Steam power, which is now of universal application, drives our factories, propels our ships, transports our trains, and waters, drains and lights our cities, raises our minerals, ventilates our mines, irrigates our fields, and ministers to our needs in a thousand ways. If for certain purposes oil and gas have displaced steam, it should be remembered that the first airship, the first aeroplane, and the first self-propelled carriages were driven by steam, and the internal combustion engine itself owes much to the steam engine.

Newcomen's first engine, that near Dudley Castle, was erected in 1712. Fifty years later, similar engines were to be found all over Europe, and a hundred years after that the total horse-power of the steam engines of the world amounted to some twenty millions, while to-day this total runs into hundreds of millions. Whether we contemplate the crude constructions of Newcomen, the stately beam engines of a later day, the whirling high-speed engines which drove some of our first dynamos, or the magnificent machinery found in our ships and power houses to-day, we cannot but admire the skill, ingenuity, and resource which has given man so adaptable and so powerful a means of multiplying his efforts. The steam engine, indeed, has changed the character of our civilisation, and among all the hundreds of men who have applied their minds to the problem of steam power, none deserves recognition more than Thomas Newcomen.

"The engineer", it has been said, "pre-empts and conveys to society the benefits of the experiments and discoveries of the scientist. This contribution is vital; for he finds practical and economic obstacles that tax his ingenuity to the utmost; and the joy of solution, coupled with the satisfaction of achievement, is his reward. For success he needs all the knowledge the pure scientist has acquired and all the experience the man of practical arts has accumulated." This interdependence of abstract science and engineering progress is nowhere more clearly manifest than in the history of the steam engine. The engine of Newcomen was the outcome of the application of the physical discoveries of the seventeenth century; the greatest improvement in the engine during the eighteenth century was due to the discovery of the theory of latent heat by Black and Watt, while the appearance of Rankine's treatise on the steam engine in 1859, in which for the first time a sketch of the new science of thermodynamics was incorporated, marks another epoch in its progress.

The discussions of the present time on the properties of steam and the refined investigations on its pressure and temperature which are being made in a score of laboratories, have their seeds in the studies of the natural philosophers of Italy three hundred years ago, from which came the first thermometers and pressure gauges. Speaking of the applications of the forces of Nature to the promotion of human welfare, Simon Newcomb wrote: "The superficial observer who sees the oak but forgets the acorn, may tell us that the special qualities which have brought out such great results are expert scientific knowledge and rare ingenuity, directed to the application of the powers of steam and electricity. From this point of view the great inventors and the great captains of industry were the first agents in bringing about the modern era. But the more careful inquirer will see that the work of these men was possible only through a knowledge of the laws of Nature which had been gained by men whose work took precedence of theirs in logical order, and that success in invention has been measured by the completeness of such knowledge. While giving all due honour to the great inventors, let us remember that the first place is that of the great investigators, whose forceful intellects opened the way to secrets previously hidden from men." In doing honour to Newcomen, we therefore pay homage not only to a great inventor, but also to those students of science through whose work the steam engine became possible.

Of the Newcomen steam engine we know a great deal; of Newcomen's life very little. Born at Dartmouth and baptized in St. Saviour's Church on Feb. 28, 1663, he was the son of an Elias Newcomen and great-grandson of another Elias, who graduated at Cambridge in 1568–69, and for many years was rector of the pleasant parish of Stoke Fleming, near Dartmouth. Newcomen himself learned the trade of an ironmonger at Exeter, and afterwards had a business of his own in his native town. But no particulars from which we can form an estimate of his character have come down to us. His fellow-countryman, Thomas Savery, was his senior by about ten or a dozen years, and it was these two Devonshire worthies who first attempted to use fire and steam for pumping water for mines.

Savery's patent was obtained in 1698, and this included the plan of obtaining a vacuum by the condensation of steam. But prior to Savery's patent had come the invention of the barometer, the measurement of the pressure of the air, the invention of the air-pump, and the work of Torricelli, Pascal, and von Guericke had been succeeded by that of Boyle, Mariotte, and Hooke. Then, too, Huygens had made a piston descend by the weight of the atmosphere after he had obtained a vacuum beneath it by the explosion of gunpowder, and Denis Papin had afterwards suggested the use of steam instead of gunpowder.

This was the pregnant suggestion which was employed in very different ways by Savery and Newcomen—by the former unsuccessfully; by Newcomen with far-reaching effects. Newcomen's engine was like a gigantic balance. At one end of a great beam hung the pump rods ; at the other hung a piston working in a cylinder, the cylinder being closed at the bottom and open at the top. The action of the engine was simple in the extreme. The cylinder having been filled with steam from a boiler beneath it, a spray of water was admitted to condense the steam and to form a partial vacuum. When this had been accomplished, the atmospheric pressure caused the piston to descend, thus raising the pump rods.

After the erection of the Dudley Castle engine in 1712, others were set up in Cornwall, Flintshire, the Newcastle-upon-Tyne area, London, Königsberg, Cassel, Paris, and in Sweden. No patent was ever taken out by Newcomen, but Savery's patent was considered to cover Newcomen's plan. The method of working naturally resulted in a great expenditure of fuel—about 25 lb. per horse-power per hour—but engines of the type were made until the beginning of the nineteenth century, and one or two were at work within the last twenty years.

The first great improvement in the engine came with Watt's experiment with the Newcomen engine model, still preserved at the University of Glasgow, which led to the invention of the separate condenser in conjunction with an air pump, a system which, as is well known, is still used in all condensing engines.

For a very long time Newcomen's merits were but little recognised. The Dartmouth antiquary, Thomas Lidstone, in 1857, and again in 1873, advocated the erection of a memorial to him at Dartmouth, and the project was at last carried out in 1921, the memorial consisting of a block of Dartmoor granite on which is a bronze plate with a line drawing of Newcomen's engine and an inscription.

Some Problems of Cosmical Physics, Solved and Unsolved.[1]

By Lord RAYLEIGH, F.R.S.

THE NEBULAR AND AURORAL SPECTRA.

AFTER the first period of success in identifying the origin of the spectral lines of the sun and stars with terrestrial materials, certain outstanding cases remained which were obviously important, but in which the identification could not readily be made. The first of these cases to yield was that of helium, which was unravelled while some of the pioneers in astronomical spectroscopy were still active.

Kindred to the hypothesis of helium, so triumphantly vindicated by terrestrial experience, were the hypotheses of nebulium, geocoronium and coronium. The problems epitomised by the two former words have now been solved, though the solution has taken quite a different turn from what was expected by the older generation of astrophysicists.

In the nebulæ are spectrum lines which have never been observed terrestrially. These are not faint members of otherwise complex spectra, such, for example, as we have in nearly all remaining unidentified lines of the solar spectrum, but they stand out, bold and challenging, on a dark background, presenting a puzzle that was the more intriguing from its apparent simplicity. According to spectroscopic experience, now made precise and rational, simple spectra are due to light elements. This, taken with the fact that lines known to be due to hydrogen and helium accompanied the nebular lines, strongly suggested that they too were due to light elements of the class which terrestrially are known as permanent gases. But the fact remained that no one had succeeded in observing them in the laboratory, and as time went on the originally convenient resource of relegating them to an unknown element had become less convenient. For the scheme of the elements became definite, and there was no room in it for new light elements.

More systematic knowledge of spectra in general, and of the spectra of the light elements in particular, was wanted before the question could be resolved. The clue was afforded by the circumstance that important nebular lines occur in pairs, obviously associated by their closeness and their constant relative intensity in different nebulæ and in different parts of the same nebula.

It is found, then, that the frequency difference of the green pair of lines originally discovered by Huggins, and known as N_1 and N_2, is 193 waves per centimetre. I. S. Bowen, to whom we owe the final elucidation of this enigma, sought for an equal interval in the spectrum of doubly ionised oxygen which he was analysing, and found it in the interval between the low-lying levels designated as P_2 and P_1. The lines were attributed to intercombination between one singlet upper level and two lower levels belonging to a triplet, the third being excluded by the rule of inner quantum numbers. To fix the differences of the terms concerned, it was necessary to connect the singlet and triplet levels by an intercombination line observed in the laboratory spectrum of doubly ionised oxygen. This was done by A. Fowler, who, combining Bowen's laboratory data with his own, was able to get a fairly satisfactory check on the observed position of the nebular pair. Practically no doubt remains, in view of the fact that other less well-known nebular lines can be similarly explained as due to singly ionised nitrogen and singly ionised oxygen.

The identification of these lines was made by ignoring so far as convenient the rules of the quantum theory. These rules forbid certain lines which might occur according to the combination principle. When a state of excitation of the atom is such that it cannot directly pass to a lower state without breaking one of these rules, that state is called metastable ; and this is the case which we have in the nebular lines.

The next cosmical problem I wish to refer to is the long outstanding one of the green line of the

[1] From the presidential address to Section A (Mathematical and Physical Sciences) of the British Association, delivered at Cape Town on July 24.

aurora, which was first seen by A. J. Ångström at Upsala in 1868. In this case the enigmatic line is even more isolated than in the case of the nebulæ, since, except in the case of unusually bright auroras, one can see nothing else in the spectrum at all. An apparently exhaustive study of the spectra to be obtained from terrestrial gases by the combined efforts of very many experimenters gave no clue to its origin.

The clue was eventually found by McLennan, who was able to produce the line by heavy electric discharges in a mixture of oxygen and helium, or, better, oxygen and argon. Oxygen is essential, and there is now no doubt that the aurora line is an oxygen line. There is, however, yet more to be done, for we do not know how to get the green line alone or with only the negative nitrogen bands as we see it in the sky. In the artificial spectrum the ordinary oxygen lines and the lines of the inert gas, helium or argon as the case may be, are conspicuous.

The wave-length of the auroral line could not be foreseen or calculated from our present knowledge of the arc spectrum of oxygen. In this case we have only a single line to deal with, and are thus without the invaluable clue afforded in the case of the nebulæ by the frequency separations of a doublet or triplet. There is, however, no difficulty in finding a conjectural place for it in the scheme of the oxygen arc spectrum as given by Hund's theory.

McLennan, arguing from the fact that nitrogen bands do not appear in the spectrum of the night sky, which, however, shows the green line, takes the excitation potential as less than 11·5 volts. This condition excludes very many possibilities. Indeed, if we are to be bound by the selection rules, it excludes *all* the possibilities. So with the example of the nebulæ before him, McLennan waives these rules, and assigns the green line to a transition from one or other of the low-lying metastable states which the theory indicates.

The lowest state of all should be a triplet, and owing to the absence of companions to the green line this may very probably be excluded. If so, only one alternative remains, and the successful determination of the Zeeman effect carried out in McLennan's laboratory is in harmony with the choice so arrived at. An independent investigation by L. H. Sommer, published immediately afterwards, covered exactly the same ground, and led him to the same choice. For the auroral line we have the experimental production from oxygen, but not the numerical spectroscopic relation. For the nebular lines our position is exactly the reverse.

There are other features of the auroral spectrum which are still obscure. I will limit myself to discussion of one of them—the red line of the aurora. Red auroræ are comparatively rare, and when they do occur the distribution of colour presents very curious features. In some cases the ends of the streamers are tipped with red, while the greater part of the length is green. The only reddish aurora which I have been privileged to observe at my home in the south of England (May 14, 1921) was of a different character, the colour ranging rapidly through various shades of purple. The light was distributed in irregular patches high up near the zenith, though predominantly in the north. At the same time its position was highly unstable, and the general impression produced was reminiscent of high potential discharges in highly exhausted vacuum tubes. Vegard has described cases where the whole sky suddenly turned crimson. He has obtained good small-scale spectrograms of the red line, which give the position as λ6322. A determination by V. M. Slipher of the Lowell Observatory gave λ6320.

So far as can be judged from the evidence available, no pair of the low-lying levels of the oxygen arc scheme which McLennan has discussed in connexion with the aurora are suitably placed to yield this red line by combination. We naturally turn to the consideration of nitrogen spectra, which, as is well known, are represented in the blue and violet regions of the auroral spectrum.

I described in 1922 a spectrum in which one of the first positive bands of nitrogen, λ6323, was very much intensified relative to the neighbouring red bands, which ordinarily are of comparable brightness. This spectrum was produced by adding a large excess of helium to the nitrogen afterglow, and the source had a visual red colour dominated by this band. In describing this work it was suggested as a possibility that this was the origin of the red auroral line, and somewhat similar ideas have been revived by McLennan in his recent Bakerian lecture. But there are difficulties to be met. One of the most urgent problems in auroral work is an adequate wave-length determination of this red line from a large-scale spectrogram.

Excitation of Spectra.

We have discussed cosmical spectra so far chiefly from the point of view of the spectroscopist. It will now be of interest to consider the probable mode of excitation of some of them.

Let us consider first the polar aurora ; this, as is well known, is closely bound up with exceptional conditions of magnetic disturbance, and these in turn are conditioned by solar influence. As regards the nature of this influence, the theory of Birkeland, elaborated by Störmer, still holds the field. The sun is regarded by them as emitting localised streams of electrically charged particles from limited areas of its surface.

This theory in its original simplicity has required a good deal of patching, and it is difficult to feel much satisfaction with the special *ad hoc* hypotheses which have had to be introduced into it. A stream of particles with a charge of one sign only is open to the criticism that the stream will dissipate itself by electrostatic repulsion, and loses the hard outline which is one of the most essential features. Lindemann has proposed to get over the difficulty by making the stream neutral on the whole, still consisting, however, of charged particles of both signs. Here, however, we lose too much of the magnetic flexibility of the stream. Chapman proposes

(*Continued on p.* 199.)

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The International Relationship of Minerals.

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A FEW years ago, members of the British Association looked forward annually to a generalised statement of the results of their president's own research work in science. The rapid specialisation of science, with its consequent terminology, has, however, made it increasingly more difficult in recent years for any worker to express himself to his fellow-members.

Last year at Glasgow most of us expected that the hidden secrets of crystals would be revealed by one whose capacity for popular exposition accompanies a recognised power for extending the boundaries of science. Instead, Sir William Bragg released his store of accumulated thought on the relationship of science to craftsmanship in a way which gave each specialised worker an opportunity to adjust his sense of relativity and proportion.

If I attempted now to summarise my scattered ideas on the outstanding problems of micro-petrology, I might possibly find half-a-dozen members charitably disposed to listen, and of them perhaps one might partly agree with my theoretical speculations. We have indeed to admit that the science of petrology, which vitalised geological thought at the end of the last century, has since passed into the chrysalid stage, but, we hope, only to emerge as a more perfect imago in the near future.

Coincident with the excessive degree of specialisation which has developed with embarrassing rapidity within the present century, the problems of the Great War drew scientific workers from their laboratories and forced them to face problems of applied science of wider human interest; and the atmosphere of this great mining field—the Witwatersrand—stirs ideas of this wider sort—ideas concerning a field of human activity which, in recent years, has affected the course of civilised evolution more profoundly than seems to be recognised even by students of mineral economics. This must be my excuse for inviting you to consider the special ways in which the trend of mineral exploitation since the War has placed a new meaning on our international relationships.

With knowledge of the shortcomings which were felt during the War, in variety as well as quantity of metals, it was natural immediately after to review our resources, with the object in view of obtaining security for the future. But events have since developed rapidly, both in international relationships and in mineral technology. The evolution of metallurgy during the present century, and the developments in mining on which metallurgy depend, have placed new and rigid limitations on a nation's ability to undertake and maintain a war; consequently, the control of the mineral industries may be made an insurance for peace. Let us first consider briefly how these circumstances have arisen, how each country has passed from the stage of being self-contained in variety of essential products to the most recent of all developments, the change to large-scale production that has tended to the concentration of the mineral and metal industries in certain specially favoured regions which will hold the position of dominance for several generations to come.

BEGINNINGS OF CIVILISATION.

The names of Isis, Cybele, Demeter, and Ceres seem to suggest that the ancient theologians in different lands formed the same conception of those peculiar conditions in prehistoric times which made it likely that a woman—tied for long periods to the home-cave—rather than a man, was the one who first discovered the possibility of raising grain-crops by sowing seed. Whoever it was who first made this discovery was the one who diverted the evolution of man along an entirely new branch, and so laid the foundation on which our civilisation was afterwards built—the beginning of what Rousseau called " Le premier et plus respectable de tous les arts ".

Compared with this economic application of observational science, the later inventions, which seem so important to us—explosives, printing, the steam engine—were but minor incidents in the evolution of civilised activities. Previous uncertainty regarding the supply of the products of the chase, and the dangers which were necessarily attached to the collection of berries and edible roots in the jungle, became less important to the family-man when it was found possible to raise food-supplies nearer home. This discovery was thus not one of merely material advantage ; for it necessarily led to the idea of storage, and so opened up a new mental outlook for primitive man.

Then this new possession of field-crops—the acquisition of cultivated real-estate—created fresh cares and new anxieties, which contained the germ of future political problems. In addition to the previous dangers from nomadic hunters and predatory carnivora, new troubles arose from other enemies — herbivorous animals, birds, insects, droughts and floods.

The formation of village-groups for protection, and the development later of tribal communities, resulted necessarily in the radial extension of field 'claims'—what our modern politicians, with careless disregard for geometrical terminology, now call 'spheres of influence'—always dominated by the extending necessities of agriculture, the growing of crops for food, and then, with the scarcity of skins, for textile materials.

The mineralogist and the metallurgist were perhaps before the farmer among those earliest research workers in applied science ; but they were small folk, mere specialists in science. They have obtained a place of undue prominence in the minds of our modern students because of the adoption of their products for purposes of terminology in our conventional time-scale for those ages that preceded history. But this is due merely to the durability of implements as index 'fossils', and is in no sense a certain indication of their political and industrial importance.

Then afterwards, long afterwards—indeed, up to historically recent times—national boundaries became extended or were fought for, but still mainly because agricultural products in some form were a necessity for the maintenance of communal life. When British traders first went to India, for example, they extended their influence along the navigable rivers for the trade in vegetable products which were raised on the alluvial lands around ; and so British India, as we call it to-day to distinguish the administered areas from the residual native States, is now mainly agricultural. Even when the permanent settlement of Bengal was made in 1793, no one thought of reserving for the State the underlying coal which has since become so surprisingly important. It was the field, and the field only, that was considered to be of commercial and political importance.

Agricultural products, therefore, until recently dominated the political ambitions of national units. Whether, and to what extent, the possession and use of mineral resources may now modify that dominant spirit is the principal question to which I wish to invite attention.

In the evolution of man, as in the evolution of the animals that occupied the world before him, there are no sharply defined, world-wide period limits : the pre-agricultural Bushman still survives and lives the life of pre-agricultural man in the Union of South Africa. The recognition of agriculture as a leading inspiration for acquiring and holding territory has been modified occasionally by 'gold rushes' into lands previously unoccupied, but they have generally had a temporary, often a relatively small, importance. The 'gold fever' may be what our lighter species of newspaper calls 'dramatic', but a fever is a short item in the life of a healthy man ; heat-waves do not make climates. Possibly our school children are still told that Australia is noted for its goldfields, but the whole of the gold produced there since its discovery in 1851 is less in value than that of three years' output of Australian agriculture.

Even in South Africa, which produces half the world's supply of gold, the value of the metal is still less than that of the pastoral and agricultural products. It is true that gold and diamonds introduced temporary diversions in the political expansion of South Africa, but the dominant interests of the Union are still determined by the *boer-plaas* and the *weiveld*. The adventures of the Spanish *conquistadores* in the sixteenth century and of their enemies, the sea-roving Norse *buccaneers*, were inspired by stories of gold in El Dorado. Yet the whole of the South American output of gold, even under its modern development, is almost negligible beside the pastoral and agricultural products—wheat, maize, wool, tobacco, coffee, cocoa, sugar, meat, and hides. The total production of gold for the whole continent last year was worth no more than a hundredth part of the surplus of agricultural products which the Argentine alone could spare for export. Truly there is a substantial difference between the bait and the fish, between the sprat and the mackerel.

The discovery and colonisation of a continent are not the only ways in which the lure of gold has often brought results more valuable than the metal itself. The efforts of philosophers from the time of the Alexandrian Greeks in trying to transmute the base metals into gold resulted in accumulating the raw materials with which Paracelsus laid the foundations of a new chemistry.

Mineral Resources and the Industrial Revolution.

Metals, we know, have been used since early times for simple implements and weapons, but it was not until the industrial revolution in Great Britain that the mechanisation of industries led to any considerable development of our mineral resources, first slowly and with a limited range of products, then on a large scale and with an extended variety.

However, to distinguish clearly cause from effect is not always simple. We were told at school of the remarkable series of inventors who laid the foundation of the textile industries in the north of England, and of the timely invention of the steam engine; its application to mine pumping; the successive construction of the steamer and the locomotive; the production of gas from coal. But the close association of ore, fuel, and flux made it possible not only to improve machinery, but also to increase facilities for the transport of raw materials and their products. When Josiah Wedgwood obtained his inspiration from the remains of Greek art, then being unearthed from the ancient graves of Campania, he first turned to account the raw materials of his native county of Staffordshire, and then promoted canal and road construction to introduce the china clay from Cornwall.

It is obvious that the growth, if not with equal certainty the origin, of the industrial revolution was due to the close association of suitable minerals in England. It was because non-phosphoric ores were still available that, at a later stage, Bessemer was able to give that new impetus which increased the lead of the English steel-maker; and so, when Thomas and Gilchrist came still later, with their invention of a basic process applicable to pig-iron made from phosphoric ores, their invention fell on barren soil in Britain. The new process, however, found applications elsewhere, and, instead of adding to the stability of the English steel industry, it gave the United States the very tonic they required, whilst the industrialists of Germany—where political stability had by then been established—found the opportunity of developing the enormous phosphoric ore deposits of Alsace-Lorraine, which had been borrowed from France eight years before. So it was through the genius of Sidney Gilchrist Thomas and his cousin Percy Carlyle Gilchrist that Germany was enabled in 1914 to try the fortune of war.

For the first half-century after the industrial revolution, Great Britain was able to raise its own relatively small requirements of iron as well as of the other metals that consequently came into wider use—copper, zinc, lead, and tin. The rapid expansion in steel production which followed Bessemer's announcement of his invention at the Cheltenham meeting of the British Association in 1856 brought with it the necessity of going farther afield for the accessory ores and for further supplies of non-phosphoric iron ores.

The next important step in metallurgical advance came in 1888, when Sir Robert Hadfield produced his special manganese-steel; for this led to the production of other ferro-alloys, and so extended our requirements, in commercial quantities, of metals which were previously of interest mainly in the laboratory—vanadium, tungsten, molybdenum, aluminium, chromium, cobalt, and nickel. The adoption of alloys, especially the ferro-alloys, at the end of the last century opened up a new period in the newly established mineral era of the world's history; for, beside the increase in the quantity of the commoner base metals which were wanted for the growing industries of Great Britain, it was necessary now to look farther afield for supplies of those metals that had hitherto been regarded as rare in quantity and nominal in value.

The country in which the industrial revolution originated and gathered momentum, because of the close association of a few base metals, could no longer live on its own raw materials, and never again will do so. Even in peace time Great Britain alone consumes twice as much copper and just as much lead as the whole Empire produces. Meanwhile, developments had occurred elsewhere, notably in Germany and in the United States, where the Thomas-Gilchrist process also had stimulated expansion. Thus, by the beginning of the twentieth century, the industrial activities of the world had entered a new phase, which was characterised, if not yet dominated, by the necessity for minerals to maintain the expanding arts of peace.

From this time on, no nation could be self-contained; a new era of international dependence was inaugurated, but the extent and the significance of the change were not consciously realised by our public leaders until 1914, when it was found that the developments of peace had fundamentally changed the requirements for war. Indeed, not even the German General Staff, with all its methodical thoroughness, had formed what the tacticians call a true " appreciation of the situation ". Two illustrations of short-sightedness on both sides are sufficient for the present argument. Up to the outbreak of war, although the wolfram deposits of South Burma were worked almost entirely by British companies, the whole of the mineral went to Germany for the manufacture of the metal, tungsten, which was an essential constituent of high-speed tool steel. Sheffield still occupied a leading place in the production of this variety of steel, but was dependent on Germany for the metal, which the Germans obtained mainly from British ore.

Under the compulsion of necessity, and without consideration of commercial cost, we succeeded before the middle of 1915 in making tungsten, whilst Germany, failing to obtain an early and favourable decision in war, used up her stocks of imported ore and turned to the Norwegian molybdenum for a substitute, until this move again was partly countered by our purchase of the Norwegian output. Germany then found that she wanted ten times more nickel than Central Europe could produce; so she imported her supplies from the Scandinavian countries, and they, being neutral, obtained nickel from another neutral country, where the Canadian ores—the world's main source—had hitherto chiefly been smelted and refined. We thus realised, not only our dependence on other lands for the essential raw minerals, but also we had the mortification of finding that, through our own previous shortcomings in the metallurgical industries, we were compelled to face lethal munitions made of metal obtained from our own ores.

The political boundaries of the nations, originally delimited on considerations dominantly agricultural in origin, have now no natural relation to the distribution of their minerals, which are nevertheless essential for the maintenance of industries in peace time as well as for the requirements of defence. This circumstance, as I hope to show in the sequel, gives a special meaning to measures recently designed on supplementary lines in Europe and America for the maintenance of international peace, measures which, as I also hope to show, can succeed only if the facts of mineral distribution become recognised as a controlling feature in future international dealings.

Localisation of Mineral Exploitation.

If minerals are essential for the maintenance of our new civilisation, they are, according to the testimony of archæology and history, worth fighting for; and if, according to the bad habits which we have inherited from our Tertiary ancestors, they are worth fighting for, their effective control under our reformed ideas of civilisation should be made an insurance for peace. In so attempting to correlate the facts of mineral distribution with questions of public policy, there is no danger of introducing matters controversial; everyone must agree on two things, namely, our desire and even hope for international peace, and consequently the necessity of surveying the mineral situation as developments in technological science change the configuration of the economic world.

Since the industrial revolution in Great Britain, the increase of mechanisation and consequent consumption of metals has been accelerated with each decade. It is not necessary to quote the statistical returns available for estimating the rate of this acceleration, for it can be expressed in a single sentence which justifies the serious consideration of every political economist: during the first quarter of this present century alone, the world has exploited and consumed more of its mineral resources than in all its previous history, back to the time when eolithic man first shaped a flint to increase his efficiency as a hunter.

To save you from the narcotic effect of statistical statements, I will limit myself to one illustration of this generalised statement; for this special example not only illustrates the rate of general acceleration in exploitation, but also introduces an important subsidiary question, namely, the way in which activity is becoming pronounced, if not substantially limited, to a group of special areas. In the year 1870 the United States produced 69,000 tons of steel; in 1880, $1\frac{1}{4}$ million tons; in 1890, $4\frac{1}{4}$ millions; in 1900, 10 millions; and in 1928, 45 millions.

Figures like these raise questions regarding the future which would take us beyond our present thesis. For the present we can assume with fair confidence that, taking the world as a whole, the depletion of natural stores is not yet alarming, although the rate of acceleration, by reason of its local variation, forces into prominence some international problems which will influence, and if effectively tackled will facilitate, the efforts to stabilise conditions of international relations.

I have elsewhere[1] made estimates of the quantities of metals stored in that part of the outer film of the earth's crust which may be regarded as reasonably accessible to the miner. The actual figures in billions of tons convey no precise mental impression to us, and need not be quoted here, but certain of the outstanding conclusions have a bearing on our present line of argument.

The first feature of surprising interest to the man

[1] Presidential address, Institution of Mining and Metallurgy, *Trans.*, vol. 34, p. lvii, 1925.

in the street is perhaps the relative abundance of those metals with which he is familiar in the arts—copper, lead, tin, zinc, and nickel. Nickel, in spite of its price and limited use, is twice as abundant as copper, five times as abundant as zinc, ten times as abundant as lead, and from fifty to one hundred times as abundant as tin. There are, indeed, among the so-called rare metals some which are distinctly more abundant than lead, although this is the cheapest of the lot in price, and is consumed at the rate of more than a million tons a year.

So one gets at once an indication of two important features. First, the miner works only those deposits in which the metal is concentrated sufficiently to make their exploitation a profitable business; and secondly, the metalliferous ores vary greatly in the completeness with which they have been concentrated in special places to form workable ore-deposits. Nickel-ore, for example, occurs under conditions which conspicuously hinder its freedom of local concentration; and consequently the wide distribution of the metal and its relative abundance bring little comfort to those who are anxious about their supplies of a metal which jumps suddenly into importance with every rumour of war. We are safe in predicting that we shall never recover for use in the arts any fraction of our total supplies of nickel as large as we shall of most of the others which have been mentioned. Indeed, nickel stands apart from the others; for, whilst it is important in peace time and is dangerously important during war, under the present state of mining and metallurgical practice the deposits in the world worth working for nickel can be numbered on the fingers of one hand, and nine-tenths of our supplies come from a single district in Canada.

Before discussing more precisely the significance of this and similar facts on the question of international relationships, let us consider for a moment the nature of our exploitation methods. Our reference to nickel shows that the metalliferous ores vary in their degrees of concentration, and, therefore, in their suitability for working; but, as the result of estimates made for a few common metals, we shall not be far from the average in assuming that we shall never recover more than about one-millionth of the total that lies within workable distance from the surface of our accessible dry land. Another conclusion, based on a similar group of calculations, shows that our greatest total tonnages are not contained in the rich deposits, but in those of low grade.

It follows, therefore, that every advance in metallurgical science and in mining technology that makes it possible to work our low-grade ores adds appreciably to the actuarial value of civilisation; for our mineral resources can be worked once, and once only, in the history of the world; and when our supplies of metalliferous ores approach exhaustion, civilisation such as we have now developed during the last century must come to an end. When a miner raises a supply of ore in concentrated form for the metallurgist, he damages, and so places beyond reach for ever, far larger quantities of residual ore than he makes available for use. When a metallurgist takes over the product of the miner and separates the refined metal for use in the arts, he also incurs serious losses, although not to the same extent. There are thus before both the miner and the metallurgist opportunities for extending the actuarial value of civilisation; and because the cost of labour is the principal constituent in the total bill, and has recently swamped contemporaneous advances in technology, the gradual elimination of manual labour by mechanisation is obviously the most profitable line of research.

Mechanisation carries with it in general a tendency to limit operations to the larger deposits, with the concurrent neglect of those propositions which are widely scattered over the earth, and, though individually small, represent in the aggregate a serious section of our limited resources. So our operations in mining, with the family of industries dependent on minerals, tend more and more to be restricted to a few special regions, where work can be done on a large scale.

The Mineral Age and International Relationships.

With this thumb-nail sketch of the way in which the new mineral era is developing, we are free to examine more closely the influence which this change in the configuration of the industrial world is likely to have on international relationships.

In the first place, it becomes obvious that no single country, not even the United States, is self-contained, whether for the requirements of peace or for the necessities of war. Not even the more scattered sections of the earth that are politically united to form the British Empire contain the full variety of those minerals that are the essential raw materials of our established activities.[2] Between

[2] For purposes of reference I give a list of minerals, showing how the resources of the British Empire, so far as our present information goes, can be relied on. This list has been kindly revised by Mr. T. Crook of the Imperial Institute.

1. *Those for which the world now depends mainly on the Empire*:—Asbestos, china clay, chromite, diamonds, gold, mica, monazite, nickel, and strontium.

2. *Those of which we have enough and to spare*:—Arsenic, cadmium, cobalt, coal, fluorspar, fuller's earth, graphite, gypsum, lead, manganese, salt, silver, tin, and zinc.

3. *Those in which we could be self-contained if necessary*:—Bauxite, barium minerals, felspar, iron ore, magnesite, molybdenum, platinum, talc, tungsten, and vanadium.

4. *Those for which we are now dependent on outside sources*:—Antimony,

them these two—the British Empire and the United States—produce more than two-thirds of the 2000 million tons of mineral that the world now consumes annually. Each of them has more than it wants of some minerals ; but, in order to obtain its own requirements at economic rates, each finds it necessary to sell its surplus output to other nations. Each produces less than it wants of some minerals, and so must obtain supplies from other nations to keep its industries alive. Each of them is practically devoid of a few but not always the same minerals, which, though relatively small in quantity, are none the less essential links in the chain of industrial operations. Even if these two could 'pool' their resources, they would still be compelled to obtain from other nations the residual few. For it is important to remember that, unlike organic substance, it is not possible to make synthetic metals, and it never will be ; it is not even possible to make artificial substitutes for many essential minerals that are used as such and not merely for their metallic constituents. There is no other mineral and no artificial substance, for example, that can combine the qualities which give to the mineral mica its position of importance in the arts—its fissility in thin sheets, its transparency to light and opacity to heat rays, its stability at high temperatures, its toughness and the degree of its insulating properties. There will never be a synthetic mica.

Thus the international exchange of minerals is an inevitable consequence of our new civilisation ; and the cry for freedom of movement, for the 'open door' and for equal opportunity for development, comes into conflict with the unqualified formula of 'self-determination'. Whatever may have been possible before the industrial revolution, when the mineral industry merely contributed to the simple wants of agriculture, when most national units were self-contained, the formula of 'self-determination' has come too late in the world's history to do good without a more than consequent amount of harm. We cannot even live now without the free interchange of our minerals for those of other nations ; in the name of civilisation we dare not go to war.

There is one more group of fundamental data to recall before we are in a position to point the practical lessons which follow from the newly established and prospective mineral situation. I have already referred to the way in which economic considerations tend, through large-scale production, to restrict operations to a limited number of specially favoured areas. There was a time within my memory when the primitive *lohar*, a survival of the aboriginal inhabitants of India, could be found in every province, nearly every district. He collected the granular mineral from the weathered outcrops of relatively lean iron-ore bodies, and, by using charcoal as a fuel, turned out blooms of malleable iron in a miniature clay furnace, using a pair of goatskins to produce the necessary blast. These primitive workers also produced small ingots of steel by the carbonisation of wrought iron in clay crucibles many centuries before the same process made Sheffield famous.

With the large-scale production of steel in western countries, attended by the opening of the Suez Canal, cheaper transport by steamers and the spread of railways from the coast of India, the *lohar* has been exterminated from all but the most remote parts of the country. His history is similar to that of other workers ; the small ore-bodies that he used are of no interest to the modern iron-master, and one result therefore of the modern movement is the neglect of a large fraction of our total resources. We are discussing, however, what is actually happening, not what we think should be a less wasteful course of evolution ; natural evolution, like 'trial and error' methods, is always wasteful.

Primitive workers in various lands have opened up to relatively shallow depths but small deposits of other ores, and in eastern countries especially, where forms of civilisation extend far back into history, the numerous and widespread 'old workings' have given rise to travellers' impressions of great mineral wealth. But low-grade deposits that the ancient miner could not utilise are now opened up by mechanical methods on a large scale ; and, on the other hand, what satisfied the primitive metallurgist in abundance would be of little use to the modern furnace.

We have now to re-value the tales of travellers, which have had a dangerous influence on those who have directed the course of international competition ; we have to strike out of consideration the integers of the primitive worker to whom a great tonnage would form a mere decimal point in the modern unit ; we have to realise that our mid-Victorian standards of metal production are gone for ever, and that the comforting after-War formula of 'back to normal' is merely a hypnotic drug to conceal the uncomfortable, one might say regrettable, dynamic conditions which have since developed at a speed that is not sufficiently recognised within our Empire.

It is now misleading to speak of the wide distribution of minerals within a country as we could

bismuth, borates, copper, petroleum, phosphates, potash, pyrites, quicksilver, sulphur, and radium.

A corresponding list for the United States was prepared in 1925 by a committee under the chairmanship of Prof. C. K. Leith, and published under the joint authority of the two Mining and Metallurgical Institutions in New York.

have done some fifteen years ago ; we must now rule out the smaller deposits, and so form a new picture composed of those concentrations that are on a scale sufficient to support modern metallurgical units.

For this reason it is necessary to review afresh the resources of the undeveloped Far East, which has for many years been regarded as a menace to western industrial dominance. The vague general notion that mineral deposits are evenly distributed throughout the earth's crust has fed the impression that the development of China, which is much larger than the United States, may yet shift the centre of industrial gravity when her great population becomes awakened and organised by western technical science.

It is true that the people of the East are rapidly adopting the methods and using the mechanical facilities of western nations—railways, telegraphs, power factories, steel ships, and other metal-consuming devices ; but the critical investigations made by mining geologists, especially since the War, tend, with a striking degree of unanimity, towards recognising the remarkable circumstance that China, as well as other countries of the Far East, is deficient in those essential deposits of minerals on which our mechanised form of civilisation is based.[3]

When China was still an unknown land, it was possible for after-dinner speakers to impress non-critical hearers by talk of the 'yellow peril' and the 'challenge of Asia' ; but these expressions have been used without thought of the circumstance that natural resources in minerals now set a rigid limit to power, whether industrial or military. We have known for some time of the natural limitations of India, of Japan, and of smaller political units in the East ; but until very recently we have had insufficiently precise data for estimating the quantitative value of the terms 'vast' and 'unlimited' which have been so often applied to China. Assuming that China may yet become a homogeneous national unit, or even assuming that her resources may become developed by Japanese energy, there is very little doubt now that, as an industrial area, the country is deficient in those minerals that form the essential basework of the modern form that civilisation has definitely taken.

The obvious limit in development, as defined by local natural resources, can be extended only to a limited degree by the importation of raw materials from other areas ; for a country can buy metals only by the exchange of other products ; its buying powers are limited by its selling powers. Abundant cheap labour, assisted by a semi-tropical climate, can produce an exportable surplus of foodstuffs only in limited parts of the Far East ; even the so-called luxury products, which to our early navigators formed the inspiration of what we call geographical research, are now obtained elsewhere, and some are being replaced by artificial products evolved from the chemical laboratory.

Dominance of the Western World.

Exploratory work by mining geologists tends more and more to show that the essential mineral products are far from evenly distributed over the land areas of the world. Western Europe and North America have an undue share of those deposits that can be worked on a large scale, and it is the large-scale movement that marks the specialised character of the new industrialism. Anglo-Saxon character would have found limited scope for its energy but for the fact that nine-tenths of the coal, two-thirds of the copper, and as much as 98 per cent of the iron-ore consumed by the world come from the countries that border the North Atlantic. Dr. Wegener might like to add this fact to the data on which he has based his theory of drifting continental fragments.

The industrial revolution, which began in Great Britain, has always been recognised as a dominant phase in western civilisation, but it is now assuming a new character. It spread first to the western countries of Europe, and developed there because of the favourable conditions of mineral resources, but the force of the movement faded out towards the Slavic east and the Latin south ; the mechanical industries of Italy are based on imported scrap. When the new industries became transplanted west of the Atlantic, the natural conditions which originally favoured Great Britain were found to be reproduced on a larger scale.

Thus in these two main areas, separated by the Atlantic Ocean, a family of industries based on mineral resources has arisen to dominate the world ; for no similar area, so far as our geological information tends to show, seems to combine the essential features in any other part of the world. Other parts of the world will continue to supply minor accessories ; and the isolated basic industries associated with coal and iron will supply local needs on a relatively small scale. But political control, which follows industrial dominance, must lie with the countries that border the North Atlantic.

It is only in this region that there is any approach to the state of being self-contained. Yet since the War there has arisen, first in Europe and then by

[3] A comprehensive study of this question, with bibliography, has recently been published by a competent and judicial authority, H. Foster Bain: "Ores and Industry in the Far East", 1927.

imitation in Asia, a degree of national exclusiveness more pronounced than any which marked international relations before 1914. Each small political unit has become vaguely conscious of the value of minerals, and has shown a tendency to conserve its resources for national exploitation on the assumption that they add appreciably to military security.

There is, however, no such thing now as equality of nations in mineral resources; 'self-determination' and the 'closed door' are misleading guides to the smaller nations. Political control may hamper, but cannot stem, the current of the new industrialisation; commercial and industrial integrations are stretching across political boundary-lines; and the demand for the interchange of mineral products will be satisfied in spite of fiscal barriers.

It would have been a shock to our members if, before the War, political problems were discussed from the presidential chair, and party politics may always be inconsistent with the mental products of culture. But the results of science and technology now limit the effects of national ambitions, and therefore dominate the international political atmosphere for good or evil. One is justified always in suggesting non-controversial measures that tend to good; and this it is proposed to do very briefly as the direct suggestion of the new configuration of the mining and metallurgical world.

The League of Nations has accomplished a large measure of international understanding in questions of social value; its influence in forestalling possible causes of war has raised new hopes; but fortunately, so far, it has not been compelled to use any such instrument of force as a blockade, and any such measure that clashed with the vital economic considerations of first-class powers would probably cause stresses well beyond its elastic limits. The more recent and simpler pact of Paris associated with the name of Mr. F. B. Kellogg wants equally an ultimate instrument for its practical enforcement.

It was with this ultimate object in mind that the outline of my argument was drafted after the Glasgow meeting last year; but I am glad to find that my views have since been expressed independently. Senator Capper, of Kansas, in February last submitted a resolution to the American legislature recognising this shortcoming of the simple treaty, and proposing to supplement its moral obligations by a corollary which, if passed, will empower the government on behalf of the United States to refuse munitions to any nation that breaks the multilateral treaty for the renunciation of war.

Senator Capper's resolution, however, still leaves unsolved a residual problem of practical importance. Those of us who had the painful duty of deciding between civil and military necessities in the Great War, know well that there is now but little real difference between the materials required to maintain an army on a war footing and those that are essential to the necessary activities of the civilian population; *materials* essential for one purpose can be converted to *articles* required for the other. Thus if Senator Capper's resolution be adopted by those who have signed the Kellogg Treaty, either sympathy for the civil population would be stirred, or the armies would be still supplied with many essential munitions: the definition of 'conditional contraband' would still remain as a cause for international friction.

A formula, still simpler but equally effective, is indicated by this review of the new situation arising from the essential use of minerals. It is suggested, therefore, as an amendment to Senator Capper's resolution, that the simple words "mineral products" be substituted for "arms, munitions, implements of war or other articles for use in war".

The only two nations that can fight for long on their own natural resources are the British Empire and the United States. If they agree in refusing to export mineral products to those countries that infringe the Kellogg pact, no war can last very long. As our friends across the Atlantic have recently learnt, it is easier to stop exports than to prevent imports: the Customs' officer is more effective, less expensive, and far less dangerous than a blockading fleet.

The confederation of American States has the advantage of forming a compact geographical unit, without inter-State fiscal barriers to hamper the interchange of mineral products. The British Empire, in the words of Principal Nicholas Murray Butler, "has passed by natural and splendid evolution into the British Commonwealth of Nations"; it is composed of geographically scattered and independent political units, among which freedom of interchange, with due regard to local interests, can be effected safely only by more complete knowledge of our resources. Next year the Empire Congress of Mining and Metallurgy will meet in this city to discuss the proposition which I submitted to it at Montreal in 1927; and this address must be regarded, therefore, as an introduction to a movement which one hopes will supply the necessary data, and so facilitate a working agreement between the two great mineral powers that alone have the avowed desire and the ability to ensure the peace of the world.

Summaries of Addresses of Presidents of Sections.[1]

Geology in Colonial Development.

Sir Albert Kitson, who is the Director of the Gold Coast Geological Survey, in his presidential address to Section C (Geology), discusses "The Utility of Geological Surveys to Colonies and Protectorates of the British Empire". Geological surveys are now in full operation and doing valuable work in Nigeria, the Gold Coast, and Sierra Leone in West Africa; in Uganda, Nyasaland, the Anglo-Egyptian Sudan, and the Mandated Territory of Tanganyika in Central and East Africa; and in the Federated Malay States. Many other colonies have had temporary surveys.

After discussing in detail the functions and methods of such surveys, Sir Albert shows that special assistance may be given to various other departments, such as those devoted to agriculture, forestry, water supply, and public works, the latter involving problems of hydro-electric power and sanitation as well as materials of construction and foundations. Some of the practical results achieved by existing surveys have been of great material value. The coal field of Southern Nigeria, discovered in 1909, has so far yielded two and a half million tons of coal, the total net profit to Government being £452,559 to Mar. 31, 1928. The total cost of the Nigerian surveys to the same date was £88,700, less than one-fifth of the profit from one single discovery. In the Gold Coast the specially important discoveries made by the Geological Survey are huge deposits of manganese ore (total production to Mar. 31, 1928, valued at £3,350,706); more than 250 million tons of high-grade bauxite, still undeveloped for lack of railway communication; and diamonds, those found since 1921 being valued at £1,758,348. The export duty received last year by Government from diamonds alone was nearly 2¾ times the cost of the Geological Survey for that one year.

The recently established Sierra Leone Geological Survey has already led to the development of large deposits of hæmatite and of alluvial gold and platinum. In Nyasaland, discoveries of deposits of various minerals have been so promising that a prospecting company has been formed with the view to their thorough examination. In Uganda, mining companies and prospectors are advised of areas likely to prove valuable, the normal operations of the Survey being so far mainly geological mapping. Here, moreover, a unique feature is the recent establishment of a seismological station.

Many important discoveries by the above and other geological surveys are also referred to, as well as the invaluable work carried out almost everywhere in connexion with water supplies, constructional materials, and engineering schemes. Sir Albert gives detailed evidence of the great value of geological surveys to young countries, through the application of scientific knowledge and methods, both theoretical and practical, to the discovery of the resources of Nature.

Adaptation.

The general thesis of Prof. D. M. S. Watson's presidential address to Section D (Zoology) is that since adaptation lies at the very foundation of the Darwinian or Lamarckian views of the method of evolution, the assumptions concerning adaptation ought to rest upon the clearest of evidence. A cursory examination shows, however, that this is not the case. Instead, the assumptions that every structure in an animal has a definite use in the animal's daily life or in its life-history, and that an adaptation, that is, a change in structure and by implication also in the habits of an animal, rendering it better fitted to its "organic or inorganic conditions of life", often rest upon no sort of observational basis. Amongst the examples of such fallacious argument cited is that of the enormous development of the depth and complexity of the teeth in the phylogenetic series leading to the modern horse. This alleged adaptation to a change in the food and feeding may be no more than a development associated with the greatly increased bulk of modern horses (fifty times that of their Eocene forerunners), the sustenance of which demanded more food and postulated greater wear in the teeth.

Not all cases of so-called adaptation are so uncertain, but it is vital that investigations should be carried out to decide whether there is any general occurrence of such special relationship between structure and habit, and whether, if it occurs, it is rightly to be regarded as of adaptive origin. In the solution of this pressing problem, physiology, and especially experimental physiology, is likely to play one of its most important rôles in zoological science.

The whole theory of natural selection is based upon the efficacy of specific differences, but the extraordinary lack of evidence to show that the incidence of death under natural conditions is controlled by such small differences, or by physiological differences correlated with such structural features, makes it difficult to appeal to natural selection as the main, or indeed an important, factor in bringing about the evolutionary changes which we know have occurred. At present, its real existence as a phenomenon rests on an extremely slender basis.

The occurrence of a direct environmental effect upon structures, strongly hinted at in some recent experiments, may do away with the need of postulating adaptive changes in, say, the pale coat-colours characteristic of arid regions. Further, the hypothesis that the variable characters separating one geographical race from another are due to a number of genes, all independent and all producing similar effects, may lead to an explanation of the divergence of local races of a species.

[1] The collected presidential addresses delivered at the meeting are published under the title "The Advancement of Science, 1929". The volume is obtainable at 6*s*. of all booksellers or from the British Association, Burlington House, London, W.1.

In short, the present position of zoology is unsatisfactory. We know as surely as we shall ever know that evolution has occurred, but we do not know how this evolution has been brought about. The data so far accumulated are inadequate in character to allow us to determine which, if any, of the proposed explanations is a *vera causa*. It appears, however, that the experimental method rightly used will in the end give us, if not the solution of our problem, at least the power of analysing it and isolating the various factors which enter into it.

Science and Engineering.

The address of Prof. F. C. Lea, president of Section G (Engineering), entitled "Science and Engineering", emphasises the importance of fundamental scientific discoveries and the scientific method in modern engineering developments, and suggests that the only hope of solving many of the problems which face the engineer to-day is by supplementary experience with organised experiments.

Engineering is much older than modern science. In the ancient civilisations great engineering works were carried out, but for two thousand or more years little or no progress in structural engineering took place and there was no development in prime movers. The revival of experimental work in pure science, after the fall of Constantinople, led to discoveries of great fundamental importance, and eventually to the development of the steam engine in the seventeenth and eighteenth centuries and to the discovery by Faraday of the fundamental principles of the modern dynamo and electric motor in the nineteenth century.

During the past century very remarkable developments have taken place in structural engineering, and in this development experiment combined with mathematical analysis has played an important part. Thus the important steps made in engineering in recent times, which distinguish the nineteenth and twentieth centuries from all preceding ones, were commenced and made possible by fundamental discoveries in science, and it can be safely anticipated that no new epoch-making developments in the future will be possible unless preceded by new fundamental scientific discoveries.

Having recognised the debt of engineering to pure science for the discovery of new principles and new facts, only part of the story has been told. In the workshop, in design, in choosing materials, very considerable difficulties had to be overcome by the engineer before success was possible. Inventive ability allied with experiments, research in the development of new materials for tools and machine elements, the perfection of machine shop methods, have all contributed, but wherever success has been sure the methods of science have been followed. To-day there is a serious demand being made upon the engineer to utilise the energy resources of the world more efficiently, but the only hope of real progress is in combined laboratory and workshop research and in the development of new technique. In a matter of such vital concern to industry and the community, much more rapid progress could be made if public organisations and the large power-distributing companies and authorities, as well as private firms, accepted the responsibility of the provision of funds for research. In the universities, fundamental work is being carried out, and much more can be done if funds are available; the National Physical Laboratory is doing work of the greatest value, but it is important, yea imperative, that the same scientific methods that guide fundamental work should be used in industry.

There are many problems of vital interest to modern civilisation in connexion not only with the production of power and the utilisation of sources of energy, but also related to structures and materials, upon which the safety and comfort of thousands of people may depend. These problems can only be solved by supplementing the accumulated experience of engineers by direct experiment and research.

The engineer is faced with many unsolved problems, to many of which he must find immediate, if only approximate and tentative, solutions. If experimental science and mathematics cannot yet give him an exact solution, he must still carry on, and in this way much has been achieved. Not infrequently engineers become impatient of science and lay too great emphasis upon experience; but as an effective guarantee of future progress and in the solution of many problems in design, in processes, in materials, as well as in the discovery of new methods, it is necessary, as Francis Bacon would to-day remind us, to apply "natural philosophy . . . to particular sciences, and particular sciences [must] be carried back to natural philosophy".

Archæology in South Africa.

Mr. Henry Balfour's presidential address to Section H (Anthropology), under the title "South Africa's Contribution to Prehistoric Archæology", reviews the conditions of archæological study in the Union. There are few regions which now remain unsearched for traces of early man. Interest in the problem becomes more intense as it is found that the scattered materials belong to one huge complex. Unfortunately, the opportunities for study offered by recent primitive peoples living in the stone age have been neglected. As in the case of the Tasmanians, so the Bushmen of South Africa are passing away and little light can be thrown by the straggling survivors on the true character of Bushman culture. Even the rock paintings and engravings must be studied archæologically. Yet we can note with satisfaction a steady growth in South Africa of a keen interest in archæological problems. There is abundant stimulus to field workers.

It is manifest that the vast African area south of the Zambezi holds an unparalleled wealth of archæological material due to the arrival of a succession of immigrant peoples from North Africa. South Africa is a *cul de sac*, and the less advanced in culture have been forced down to the *cul de sac*. During long ages this sequence of irruptions has resulted in a congestion of heterogeneous ethnic elements leading to an accumulation of culture relics. The overlapping of cultures led to fusion and confusion, producing complex hybrid industries the elements of which it is the aim of local archæologists to unravel. This is now proceeding apace, thanks to many keen researchers.

The great scientific interest of this material imposes certain responsibilities on the administration. Organisation of research to avoid unprofitable work is desirable, and a carefully selected advisory committee should be appointed. At the present time it is not so much abstract theories as concrete facts that are wanted to establish the relative antiquity, sequence-position, and characteristics of the early industries, their geographical dispersal, routes of migration, and their inter-relationship. One problem requiring careful scrutiny is the evidence of man's antiquity in the Zambezi gravels, where implementiferous gravel drifts lie 400 ft.-600 ft. above the present level of the river in the gorge. One of the most interesting questions for local archæologists is the true culture horizon of the Still Bay industry, of which the finely chipped leaf-blades have by some been taken to be Solutrean, though the technique appears to differ from that of the Solutrean blades of north-west Europe.

Another interesting problem is the 'Kwè, a digging-stick weight of the Bushmen which, on the analogy of other areas, seems out of place in a people whose culture suggests palæolithic affinities. The art of perforating hard stone is in Europe a late development. Did the Bushmen in their southward drift come into contact with some such people as the Gallas, in whose comparatively advanced culture the perforated stone would not be remarkable ?

In South Africa characteristic neolithic types are absent. The transition from stone to iron is abrupt, and there is an absence of linking cultures —a wide unbridged culture hiatus. Although the industries successively introduced offer analogies to the early stone age industries of Europe, and they may be regarded as offshoots from them, it is highly improbable that they synchronise. A migrating culture cannot long continue unchanged. It reacts to new environmental conditions. Certain elements in the complex persist and offer affinities with distant cultures. South African archæology intriguingly suggests culture affinities far ranging in time and space, and also illustrates how they have become attenuated and obscured in the course of long migration.

Problems of Palæobotany.

Prof. A. C. Seward's presidential address to Section K (Botany) is entitled "Botanical Records of the Rocks, with special reference to the Early *Glossopteris* Flora". After dealing very briefly with the earlier chapters of the history of the plant world, with special emphasis on the relatively enormous lapse of time represented by the rocks of the earth's crust older than those which have afforded the records of the oldest known terrestrial plants, a general description is given of the early Carboniferous vegetation and of the richer and more varied vegetation of the latter part of the Carboniferous period. Special attention is directed to the vegetation of the great southern continent of Gondwanaland, which included India, Australia, South Africa, South America, and Antarctica.

The geological age of this southern vegetation—the *Glossopteris* flora—has long been under dispute : it is generally agreed that there was a glacial period of long duration in Gondwanaland when the *Glossopteris* flora was being evolved. Some geologists, notably Prof. Schuchert of Yale University, refer the Palæozoic Ice Age and the early stages of the *Glossopteris* flora to a Permian age ; others believe that glacial conditions prevailed and that the *Glossopteris* flora had already established itself over an enormous area in Gondwanaland before the end of the Carboniferous period.

In other words, the question is : Was there an Ice Age in the region which is now India and in the southern hemisphere at a time when the later Carboniferous vegetation flourished in the northern hemisphere ; or were the Ice Age and the *Glossopteris* flora subsequent to the luxuriant forests of the Coal Age, which covered a considerable part of the world north of the equator ? Evidence recently brought forward by Prof. Schuchert in favour of a Permian Ice Age and *Glossopteris* flora are critically considered. The conclusion reached is that if we could transport ourselves back through the ages into a forest of the northern hemisphere in the latter part of the Upper Carboniferous period, and thence travel by aeroplane to the land that is now South Africa, we should find retreating glaciers and a vegetation in which *Glossopteris* and *Gangamopteris* were prominent plants.

The differences between the Palæozoic and the Early Mesozoic floras is mentioned, and the hope is expressed that a more thorough investigation of South African fossil plants may supply valuable information on the evolution of floras at the critical stage in the history of the plant-world, which occurred at the close of the Palæozoic era. A brief reference is made to the value of fossil plants as tests of climate. The geographical distribution of plants of former ages indicates that climatic conditions in Arctic and Antarctic regions at several geological periods were much more genial than those at the present day. It is pointed out that while there is a tendency to rate too highly the value of extinct plants as guides to climatic conditions, the occurrence of rich Palæozoic, Mesozoic, and Tertiary floras well within the Arctic Circle presents a problem which has not yet been satisfactorily solved. Methods of dealing with this problem are suggested. Finally, reference is made to the importance of studying the geographical distribution of fossil plants with a view to a better understanding of the present distribution of floras over the earth's surface.

Throughout the address allusions are made to lines of inquiry which might profitably be followed in South Africa by students interested in problems connected with the development of the world's vegetation. Prof. Seward pleads for a wider recognition on the part of geologists and botanists, whether professionals or amateurs, of the value of palæobotanical studies in relation to problems of general interest.

Agriculture and the Empire.

Sir Robert Greig, president of Section M (Agriculture), deals in his address with the development of the agricultural resources of the Empire as an obvious means of adding to the wealth of the world. He points out that as trustees for the native populations in the tropical and semi-tropical possessions, development of its natural resources is forced upon the Empire. Administration alone, however good, is not enough; only by increasing the wealth-producing power of these populations can their well-being be secured through better education, sanitation, and freedom from malnutrition and preventable diseases.

The resources of the Empire are mainly agricultural and largely undeveloped. Even in India, the most intensively cultivated part of the Empire, the cultivable waste land is equal to half the present cultivated area, and in Canada, Australia, and South Africa only two or three acres in every hundred are cultivated.

The application of science to the problems of agriculture has already great achievements to its credit. The organisation of research for the development of the Empire offers almost incredible possibilities. But to obtain the best results it is necessary to regard the Empire as a single organism. From this point of view the problems can be outlined, information collected, a campaign planned, and money and men found to undertake research. Conditions are more favourable now for co-operation in research than ever before.

The Committee for Civil Research is in a position to inquire into any non-military problem. The Empire Marketing Board is able to provide funds, and the newly constituted Imperial Bureaux of Agricultural Research can collect and make available the literature on whatever may be the subject of inquiry. These Bureaux, it is hoped, will form a gathering ground for theories and theorists, will act as illuminants and expositors, and eventually as finger-posts to new and profitable roads and by-paths of research.

Thus machinery exists whereby a problem in nutrition, genetics, pathology, economics, or any other science may be attacked simultaneously in different parts of the Empire by many workers acting together. Success has already followed such team work when applied to the investigation of the mineral content of pastures in such widely separated areas as Scotland, Kenya, Australia, and the Falkland Islands.

The problem may arise in several ways: As the idea of some research worker who finds himself unable alone and unaided to deal with it; as the conception of a department of agriculture faced with losses due to animal diseases or crop pests; as the desire of a community to grow and market a new product; or as a clue which emerges from the collection of information by the Imperial Bureaux of Agricultural Research.

The main thing is that the opportunity exists. The Empire presents the largest and finest outdoor laboratory in the world. It provides the greatest extent and variety of facilities for research. The systems of government make it possible, through the Imperial connexion, to co-operate without difficulty or embarrassment. The machinery for co-operation is in being. Funds are available.

By taking thought, and by regarding the agriculture of the Empire as one field for general and comprehensive development, the well-being and prosperity of the nations of the Empire can be increased, and ultimately the wealth of the world as a whole.

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to retain a slight excess of charge of one sign, and in this way is able to arrive at a tolerable compromise.

The search for direct evidence might not seem at first sight very hopeful, but not long ago a sensational suggestion was made by Störmer. His attention was directed by Hals to echoes heard after short-wave (131 metres) wireless signals sent out from Eindhoven in Holland. These echoes have been found by Störmer and Hals at long intervals up to as much as fifteen seconds after the original reception. Now, if we bear in mind that with the velocity of light the longest terrestrial distances only give intervals about $\frac{1}{7}$ sec., it seems inevitable that some extra-terrestrial reflector should be looked for. Störmer finds this in the corpuscular stream as bent round by the earth's magnetic force. Though the boldness of the idea is staggering, it is difficult to suggest any alternative view.

T. L. Eckersley has made an observation on electrical disturbances of natural origin which he interprets as analogous to Störmer's. A click is heard in a telephone attached to a large aerial, which is followed at an interval of about three seconds by a 'whistler' or musical note of short duration. Further whistles follow at intervals of 3·8 sec., each more drawn out than the previous one. The musical notes are regarded as due to the spreading action of a dispersive medium on an electrical impulse. It is only at times of magnetic storm that these phenomena are frequent. Further development of observations of this kind will be awaited with keen interest.

To return to the nebular spectrum: although the main problem has been cleared up in the way described, it would still be an important step to imitate the spectrum in the laboratory, not so much to confirm the origin of the lines as to get direct information about the conditions under which they may be excited. A large volume and high rarefaction (rarity of collisions) is suggested by the nebular conditions, and was plausibly held by Bowen to be an essential. It must be allowed, however, that such experimental evidence as we have at present on passage downwards from metastable states does not definitely point in this direction.

Metastable States.

In discussing the nebular and auroral spectra, we encountered the idea of 'metastable states'. At present this conception is not in a very satisfactory condition. The original idea was of a state which did not allow of direct transition by emission of radiation to the stable ordinary state. Let us compare the levels of the atom to the stories of a building and the optical electron to a man inside the building. The ordinary state of the atom is represented by the man being on the ground floor, and the metastable state by placing him on the first floor. But the internal architecture of our building must be pictured as peculiar. A staircase connects the first floor with the second floor, and another staircase connects the second floor with the ground floor: but there is no connexion between the first floor and the ground floor except by going up higher and coming down again.

Facts which have since come to light require some revision of this. In the nebulæ the electron manages somehow to escape from its prison-house and descend to the level below, not by the legitimate route of going upstairs and down again, but by illicitly breaking through the floor. Abandoning the metaphor, the selection rule which forbids transitions not involving a change in the azimuthal quantum number is violated in all such cases. The inner quantum number rule, which requires that the inner quantum number should not change from 2 to 0 or from 0 to 0 is also violated in one class of cases, and rather meticulously observed in another. This rule permits only the pair of green nebular lines in doubly ionised oxygen which we have discussed; and in deference to it only two are observed, instead of the three which apart from this might have been expected from the triplet ground state. Yet we find the blue singlet line λ4363 of this ion violating the same rule, and the same applies to the analogous case of the aurora line.

In the case of the mercury spectrum, which lends itself well to experimental observation and of which much detail is known, we have laboratory examples of the violation of this rule, as originally shown by experiments of Takamine, Fukuda, and other Japanese physicists. The lines were originally obtained under conditions where a strong electric field was acting, and this was sometimes urged in mitigation for breaking the rule. Again, the lines were of low intensity, and this too was thought to be a partial excuse.

Whatever might have been thought of these apologies originally, their irrelevance was, I think, clearly shown in some experiments of my own, in which one of the 'forbidden' mercury lines was obtained as the second strongest line in the entire mercury emission spectrum, in the vapour passing through a discharge, but altogether away from the region in which the discharge itself was taking place, and consequently in the absence of an extraneous electric field.

In another experiment I was able to obtain the other forbidden line as an absorption line in unexcited mercury vapour, and thus apparently in the absence of any disturbing conditions. In this experiment the quantity of vapour used was very large, about ten million times the amount required to bring out the resonance line of mercury in absorption. The probability of the transition thus indicated is very low, and for the other forbidden line it is apparently still lower. But for all that, as we have seen, this forbidden line can be got in considerable intensity in emission.

The necessary condition in the mercury experiments appears to be a large accumulation of mercury atoms in the relevant metastable state, so that, even with a low probability of transition for the individual excited atom, a considerable number of transitions occur. It has even been proposed to define a metastable state as one with a low probability of transition. This takes us far from the original conception, and makes 'metastability' merely a question of degree. If this conclusion is accepted, a far-reaching revision of our present notions may become necessary. The general softening of outline on our picture of atomic events resulting from the substitution of wave groups for particles seems likely to afford what is required, and allow the occasional transition downwards from a metastable state.

Unknown Elements of High Atomic Weight.

Although we are no longer at liberty to postulate unknown light elements, we are free up to the present to postulate heavier ones than any known terrestrially. Jeans, as is well known, has made use of this hypothesis to explain the origin of stellar energy. In common with other authorities, he provides it by the destruction of matter, with radiation of the equivalent quantity of energy (mc^2) demanded by the theory of relativity. So far there seems to be fairly general agreement. The difficulties arise when we come to the question of stability, and here agreement is not general. Jeans considers that the source must liberate energy at a rate independent of the temperature. I am not qualified, and shall not attempt, to discuss this point. The object of postulating unknown heavy elements is to endow them with the property of going out of existence spontaneously at a rate which is independent of external conditions, except in so far as ionisation, which involves the removal of some of the electrons from the neighbourhood of protons, tends to hinder the process.

In the known radioactive elements we have, of course, instances of unstable forms of matter, and Jeans regards these as transitional; but it must be admitted that substances which undergo spontaneous disintegration do not at first sight form an altogether satisfactory half-way house between those which are quite stable on one side and those which spontaneously go out of existence on the other. Then we have to explain why these heavy atoms are not found on the earth, which, it is generally agreed, originally formed part of the same mass as the sun. Jeans mentions this difficulty, and gives reasons for thinking that the heavy elements would sink to the interior of the mass, so that the earth, formed from the exterior part of it, would not contain them. That a *vera causa* is here appealed to cannot be doubted; but there seem to be some difficulties in assuming that it operates with enough precision to secure the desired result.

The list of known elements ends with uranium, and we must notice that of the occupants of the 92 places in the list up to and including uranium, nearly all answer to their proper numbers when the roll is called. The only exceptions are 85 and 87; and he would be a rash philosopher who attached much importance to these vacant places, which may be filled up any day. Roughly speaking, we may say that the elements up to uranium are all present, and the higher members assumed to exist in the stars are all absent. It is putting a heavy burden on the mechanism of gravitational separation to expect it to achieve this result. The inventors of ore-dressing machinery would, I should imagine, despair of accomplishing anything like it.

Nature works on a vast scale and with plenty of time at her disposal, and it may well be urged that we must be careful of measuring her possible achievements by our own. We may ask, however, whether the more direct indications available suggest that she has in fact made this separation. If there is this cut between the atomic numbers 92 and 93, we should expect most of 92 to have gone into limbo in order to ensure the *whole* of 93 having done so. Yet 92 (uranium) is a relatively abundant element compared with most, being in fact No. 25 on the list of abundance in igneous rocks. Again, we happen to be in a position to say that, on the earth at least, uranium, so far from having sunk to the centre, is concentrated near the surface.

Assuming that uranium exists on the sun as on the earth, then, as first pointed out by Lindemann, there are strong grounds for thinking that it must be in course of formation there, for the life of uranium is too short in comparison with the probable age of the sun to allow us to suppose otherwise. Those who remember the early development of radioactivity will recall that a parallel argument was successfully used by Rutherford to prove that radium must have originated on the earth before the fact was directly proved that it is being generated here. Radium (it was later shown) is generated from a parent body of higher atomic weight, namely, uranium. Jeans would regard the origin of uranium itself as analogous, and if this analogy is accepted it would require the presence of an element of still higher atomic weight, capable of undergoing radioactive disintegration, but, it is to be observed, incapable, *ex hypothesi*, of dissolving entirely into radiation.

No doubt these are very deep waters, and we can scarcely expect at present to fathom them. What would really be most helpful would be a theory of atomic structure in sufficiently definite agreement with experiment as regards known elements to enable us to proceed to investigate the properties of elements of higher number than 92 with confidence.

On the general question of whether the evolution of elements has proceeded from the simple to the complex, or from the complex to the simple, it does not seem to me very much to the purpose to appeal to evolutionary doctrine and the analogy of organic evolution, in favour of the former alternative. Is it not more to the point that radioactive changes are of the latter class? At present this is a question of scientific taste. Perhaps it is not irrelevant to remark that even in organic evolution degeneration of organisms sometimes occurs, and I do not know whether our biological colleagues are in a position to assert that the whole course of organic evolution may not at some future time be reversed by a change of conditions. At all events, it is something to have formulated the more restricted question of whether uranium now comes into being on the sun by a synthetic or an analytic process. It would seem that this is a well-framed question, and that the answer can scarcely be either *both* or *neither*.

Physiology the Basis of Treatment.[1]

By Prof. W. E. Dixon, F.R.S.

The ultimate aim of medicine is the prevention or cure of disease : this practical aspect so far dominates all others that it is often referred to as the healing art ; indeed, it is difficult to think of medicine apart from treatment.

The term ‘ physiology ’ is usually used to designate the science of function, whether it is studied in broad outline and dealing with the mechanism of action or as the physico-chemical mechanisms leading up to this action. Disease means the unusual functioning of tissues which may be the result of accident, hereditary weakness, or parasitic organisms. Generally it is wrong to speak of this as malfunctioning : the unusual functioning is physiological and perhaps the best for the organism under the unusual conditions. The science of medicine, then, is nothing more than trained and organised common sense based on physiology. It is still usual to speak of it as an inexact science ; this is obviously wrong, since medicine uses the same methods as every other science and the results of observation are as definite as those of the chemist or physicist, although it is true that in the complexity of the problem with which the physician may have to deal all the conditions of importance may not be known and the results of an investigation, though correct for the conditions under which it is undertaken, may be misleading.

It is not to medicine as a whole that I wish to direct attention here, but only to that part of physiology which forms the basis of treatment.

When the sciences of physiology and pathology a century ago passed from the realms of natural history to deduction and experiment, they naturally attracted the more original and eager minds in medicine, and the text of the writings of the nineteenth century deals with changes in structure and function. Treatment became neglected, the old shibboleths and rituals of treatment which had held sway for centuries were discarded, and there was nothing with which to replace them. Diagnosis was then and is now far ahead of treatment ; diagnosis is often accurate where there is no satisfactory treatment, and yet diagnosis is only a means to the end.

The science of treatment or pharmacology is therefore relatively new ; it includes knowledge of all kinds dealing with the treatment of disease or alleviation of suffering. It is the climax of physiology and pathology, devised to subserve a practical end, and forms an important part of the great biological topic of the influence of conditions on the living organism. Few drugs now exist the mode of action of which is not understood, and the goal is not so far distant when it will be possible to introduce into the animal economy a factor which will exaggerate or retard the function of any tissue or collection of cells in the body, leaving the others unaffected ; and most of these results have been obtained by the methods used in experimental physiology.

The first object of science is to ascertain facts. Certain facts in physiology are relatively easily ascertained—those, for example, which involve the behaviour of ferments of isolated cells or of tissues, and require well-known chemical or physical methods. Other facts involving the physiology of the whole organism are more difficult to interpret, though they are the basis of the therapeutic side of medicine. More and more is physiology being regarded as the application of physics and chemistry to the phenomena of life. I might go beyond this and say that physiology is getting further and further from practical medicine, and this is the more regrettable as most of the chairs in physiology are connected with the medical schools and because the science of treatment is largely dependent on experimental physiology.

No branch of experimental biology has received less consideration in Great Britain than that of pharmacology : it is also the most neglected branch of medicine, and although the object of medicine is the healing of the sick, it is amazing that medical schools in Britain, often equipped with all other modern laboratories, lack departments of therapeutics. But the advent of institutions for experimental therapeutics is upon us, though Britain has taken little part in the movement. In this connexion we welcome the magnificent buildings of the University of Cape Town, and when the new hospital with its medical school is completed I confidently anticipate that adequate accommodation will be provided for that important branch of applied physiology, pharmacology, and that this will include laboratories of physiology and organic chemistry, which must be in close and direct association with the wards. The enormous importance of one branch of treatment to Africa, chemo-therapy, I will refer to later.

It is not surprising that British pharmacology should be so much behind that of other countries in the production of new curative remedies ; practically all come from abroad ; I may mention ephedrine for spasmodic asthma, liver extract for pernicious anæmia, insulin, the organic arsenicals, the dyes such as 205, the new anæsthetics local and general, hypnotics, and many others.

It has often been stated that the action of remedies may be best determined by experimenting with them on healthy men. This is not true ; quinine is used to treat malaria, yet not one of the subjective symptoms induced in man has the remotest connexion with its curative properties. The same is true of the use of the iodides in syphilis and salicylates in rheumatism. The experiments of Joig and his pupils in 1825 with camphor, digitalis, and other drugs on healthy men added nothing of value to pharmacology. Subjective sensations are, it is true, produced, which are erroneously attributed to the drug which has been taken. Few,

[1] From the presidential address to Section I (Physiology) of the British Association, delivered at Cape Town on July 24.

if any, experiments made on man without the most careful controls are of any real value. Properly controlled experiments have been made, however, with many substances. Precise experiments, for example, have been made both in Germany and America with bromides in epilepsy. In these experiments half the epileptics were given potassium chloride and the other half sodium bromide ; after several weeks' use the bromide had decreased the number of attacks, whilst the chloride had no distinct action.

Chemo-Therapy.

At one time hopes ran high that the chemical structure of the molecule might indicate pharmacological action. During the last fifty years, many laborious researches have been conducted with this object : to modify the molecule that it may conform to some required action. But the mystery remains as mighty as ever. It is most probable that subtle energy factors binding the molecule—factors not displayed in a formula—control the action ; certain it is that drug action is not determined directly by chemical combination with body constituents, but rather by delicate physical processes such as those of adsorption, solution, and surface tension.

Chemists have as yet not even determined the requirements of the molecule for the production of colour sensation. On the other hand, slight alteration of a molecule already complicated and with a known action has led to the production of many useful compounds, and not infrequently we may foresee the type of action which will occur under such special conditions. Considerations of this nature have led to the synthesis of the new local anæsthetics, antiseptics, antipyretics, diuretics, tropeines, and other useful substances.

Parasites causing disease in man may be crudely divided into worms, protozoa, and bacteria. Chemotherapy, that is, specific therapy of infectious disease, has had marked success in curing disease due to parasites in the first and second of these groups ; these diseases are found mainly in the tropics. It has obtained much less success in the third group.

Diseases due to protozoa have an especial significance in Africa, and reference must be made to that area of tropical Africa occupying more than a million square miles in which one form of these, namely, trypanosomes, produce their ravages. Trypanosomiasis is one of the most serious of all tropical diseases and affects both man and beast ; it is a scourge which renders vast tracts of land practically uninhabitable and takes its death-toll often in thousands and occasionally even in hundreds of thousands, and yet it is a disease which I believe should be curable if not preventable. The problem is one of wide interest and importance—scientific, humanitarian, and economic.

The members of two groups of chemical substances excel all others in their curative value in trypanosomiasis and spirochætosis ; these are the organic arsenical compounds and the dyes. The most satisfactory arsenic compound yet discovered for the cure of trypanosomiasis is tryparsamide. It is less toxic than atoxyl and has a slightly higher therapeutic index ; it has a most marked trypanocidal action in animals and has been used with some success in cases of sleeping sickness from *T. Gambiense*. One injection causes the disappearance of the parasite from the blood of man, and if the injections are repeated in courses, the cure may be complete.

Dyes.

Many dye substances have been used in medicine. Trypan red and trypan blue belong to this group. Trypan blue was employed by my colleague, Prof. Nuttall, in piroplasma infections in animals, with results that most South Africans are well acquainted with. Afridol violet, a derivative of diamino diphenyl urea, and some allied dyes have also a powerful action on piroplasma.

How these substances act is not known, for like the organic arsenicals they do not kill the parasite *in vitro*. They have the property, however, of being adsorbed to the blepharoplast of the trypanosome ; this adsorption is associated with diminished virulence of the parasite in infected animals, and after successive inoculations through several animals the organ may disappear. This direct action of a drug on a tissue, causing ultimately the complete disappearance of that tissue, is so remarkable that it is worthy of notice, as it represents the first known action of the kind.

The most valuable member of the afridol violet group so far produced was first made in the Bayer laboratory, but its composition was kept secret. It was, however, afterwards synthesised and its formula published by Fourneau, but only after long trials and infinite patience. The chemo-therapeutic index of this substance has the remarkable figure of 200 to 300 ; and so little as 1/32 mgm. will sometimes cure mice infected with trypanosomes. Fourneau has made many allied substances and derivatives of "205", he has modified the wings of the molecule by the addition of various side-chains, sometimes keeping the wings identical and sometimes changing them by joining two different complexes through the agency of phosgene. The number of such derivatives is obviously legion, and this makes it the more remarkable that he should have succeeded in synthesising "307", which at the present time is superior as a therapeutic agent to all other dyes in trypanosomiasis.

This "307" has a remarkable action on trypanosomes in laboratory animals, being three hundred times more effective than atoxyl. Its discovery has also opened a new era in therapeutics, since it represents the first chemical substance which when administered to man or animals in an infected trypanosome district gives a complete immunity to the disease for several months : it does not necessarily prevent trypanosome infection, but it prevents the effects of the disease. There is much in these experiments that suggests that we are on the fringe of a new pathology, and that our present crude methods of preparing anti-bodies in the future will be replaced by those of the organic and colloid chemist.

Bacterial Infections.

Tuberculosis is another problem of vast importance in South Africa, not only on account of its prevalence amongst susceptible individuals in both the European and native populations, but also because of its association with certain industrial diseases.

Much the most important industrial disease in South Africa is the silicosis produced in the extraction of gold from the conglomerate, both the pebbles and the matrix consisting of quartz. The gravity of pneumoconiosis depends largely on superadded tuberculous infection to which the workers have a predisposition, and in this respect crystalline silica is much more harmful than either amorphous silica or carbon. It may act by direct irritation, by its poisonous properties after solution, by colloidal action, or because it forms locally a nidus suitable for the growth of the tubercle bacillus.

Drugs are employed in tuberculosis either with the object of attacking and preventing the growth of the tubercle bacillus or other organisms with which the disease may be associated, of neutralising poisonous toxins, or of removing or relieving symptoms. It is with the first group that I am now concerned. Two groups of organic compounds are especially remarkable for their chemo-therapeutic action on bacteria. The first group has the quinine complex ; quinine is the methyl-ester of cupreine and it can be reduced by nascent hydrogen to form hydrocupreine. The following table shows the effect of two derivatives of hydrocupreine in arresting the growth of certain micro-organisms :

	Ethyl hydrocupreine (optoquin).	Iso-octyl hydrocupreine (vuzin).
Diphtheria bacillus .	1 in 100,000	1 in 750,000
Pneumococcus . .	1 in 400,000	Negligible
Staphylococcus . .	1 in 500	1 in 16,000
Streptococcus . . .	1 in 1,000	1 in 80,000

The action of optoquin on the pneumococcus and of vuzin on bacillus diphtheriæ is highly specific ; the higher and lower homologues have a greatly diminished effect. Many substances destroy bacteria in the test tube, but these drugs act in the animal body as well as in the test tube, and enough can be given by medicinal doses to animals and men to render the blood of these animals bactericidal.

The second group of drugs which exert a marked action on bacteria are certain derivatives of acridine. Trypaflavin was used during the War for infected wounds : unlike most antiseptics, it acts better in the presence of protein, but is not sufficiently selective or specific on micro-organisms in the presence of body tissues to be of any real value ; it is easily absorbed and readily causes œdema. Rivanol is a more recent derivative of acridine. Morgenroth cured streptococcic infections by injections of rivanol under the skin. The injections to be efficient must be made soon after the infection and in the neighbourhood of the inoculated zone ; rivanol will not cure a blood infection. The destruction of the tubercle bacillus presents two special difficulties : first in the fatty and protective envelope surrounding the bacillus, and second in the small blood supply to the tuberculous lesion.

Hoyle and I have recently investigated two new types of gold compounds in tuberculosis. One of these is a complex aurous salt of ethylenethiocarbamide with the formula $(Au,2etu)H_2O$, where ‘ etu ’ represents ethylenethiocarbamide.

This compound, prepared by G. T. Morgan, is stable, crystalline, and colourless at ordinary temperatures. It is soluble in distilled water, forming a solution neutral to litmus and with a *p*H value of about 6·2. It was tested for therapeutic effects on both human and bovine types of infection. For the former, inoculations were made subcutaneously into guinea-pigs with 1 mgm. doses of a virulent human strain. All the animals, control and experimental groups, died within a few weeks of one another, and all showed characteristic progressive lesions of similar extent.

It was found that treatment with the gold compound in bovine disease in rabbits prolonged life about 50 per cent when compared with controls. We adopted the arbitrary standard that treated animals should survive at least two or three times longer than the average length of life of the controls before clinical trial should be proceeded with. In view of the wide variations in individual susceptibility, and the difficulty that this entails in drawing sound positive conclusions from a small series of animals, it is absolutely necessary to exercise the utmost caution before arousing clinical expectations.

The second compound tested by us was a complex gold derivative of succinimide, prepared by my colleague, Sir William Pope. This compound is non-ionised and the gold is associated in chemical combination in an internal organic ring. It is a white, crystalline, stable compound at ordinary temperatures, readily soluble in water to a neutral solution.

This substance was tested for therapeutic effect in experimental bovine infections in rabbits. In some animals this treatment was supplemented by injections of potassium iodide subcutaneously ; in no case has any therapeutic benefit been observed. There has been no increase in the lengths of life of the treated animals, and the type and extent of disease at post-mortem examination in treated and control animals has in every case up to the present been similar.

These compounds are interesting because one delays death and the other is entirely without action. They may afford a hint as to the lines on which organic chemists should proceed, and perhaps show that gold in the ionic form is desirable.

The Internal Secretions.

In the last twenty years much evidence has accumulated to show that the glands of internal secretion are responsible for the regulation of growth, of metabolism, and often for our appearance if not for our very character. Exaggeration or diminution in the secretion of one or other of the tissues may induce conditions so decided as to be obvious to everybody, though the effects produced by minor alterations in the co-ordination of the several secretions may not be so evident. Giants and dwarfs, unusual pigmentation and anæmia, disproportion in the growth of the skeleton, such as enlarged hands and face, bulging deer-like eyes or oriental eyes and beards in women are noticeable to everyone ; excessive fatness or emaciation, a choleric or bucolic temperament cause no comment, yet may equally arise in the victim from a want of co-ordination in the internal secretion.

The gonads present the clearest evidence of the influence which a tissue may exert on metabolism. I will refer only to the ovary. The ovary differs from other organs of internal secretion in that it functions in a cyclic manner, and it is obvious that extracts made from ovarian tissue may exert a different action according to the period of the cycle when they are made. Numerous extracts have been prepared from the ovary which are reputed to exert one or other type of action. ‘ Oestrin ’ is the name given to one such substance : it can be made from many sources, both animal and vegetable, besides the ovary. Oestrin exerts a very definite action in lower animals, but its use in man is so variable and disappointing as to make it valueless in practical medicine. When it is injected subcutaneously into spayed rats and mice it produces typical oestrus with normal sex instincts, and when injected into immature animals it induces puberty ; regular injections at fixed intervals will keep animals sterile.

Many experimental observations show that the corpus luteum is concerned with the rhythm of the oestrus cycle and with the prevention of ovulation. A persistent corpus luteum, both in the case of animals and women, produces sterility, a condition which is cured by its removal.

A third active substance distinct from oestrin and corpus luteum is elaborated by the ovary and was described by Marshall and myself. This substance is water-soluble and thermo-stable, and can be prepared from the ovary at one stage of its cycle only, by maceration with warm saline followed by boiling and filtering. The injection of this substance into animals causes a secretion of pituitrin, and this in turn renders the uterus supersensitive and highly responsive to other forms of stimulation.

Our experiments showed that at one stage only of the ovarian cycle was this hormone elaborated, namely, at the stage when the corpora lutea are degenerating. So long as the corpora are functioning they control the metabolism of the ovary, but when they degenerate control is lost and the ovary liberates the specific substance which excites the pituitary gland to secrete. This means that extracts of the ovary made between the heat periods or during pregnancy are without effect on the pituitary gland, but extracts made just before the heat period or just before parturition induce secretion of the gland. As the significant action of pituitary extract is to sensitise the uterus it is difficult, if not impossible, to avoid the conclusion that these two phenomena are closely associated.

It is not suggested that the ovario-pituitary endocrine mechanism is the sole factor in producing labour pains. No doubt the fœtus itself acts as a direct stimulus, and without the fœtus the intense muscular contractions would not occur, but it is also clear that the onset of labour cannot easily be accounted for without postulating some further exciting cause apart from the fœtus and the uterus.

In conclusion, no romance can be more remarkable than the fact that doctors, by using pituitary extract to stimulate the uterus in pregnancy, should have adopted the method which Nature herself employs and that physiological function is after all a pharmacological action.

MEDICINE AND PHYSIOLOGY.

Civilisation has been responsible for many new diseases. Our food-stuffs in great cities are often preserved and important constituents of fresh foods may be lacking. The science of dietetics has assumed an enhanced importance lately, which is partly due to the artificial preparation of many of our foods. Many experiments have been made in my laboratory to show that certain foods given in excess to animals fed on a synthetic diet, but containing an ample supply of the recognised vitamins, suffer from poisoning sometimes of the most profound and fatal kind. The same experiments made on animals living on an ordinary diet show that the excess of the ‘ poisonous ’ food is harmless. For example, certain preparations of irradiated ergosterol given to rats which are being fed on a synthetic diet act as a poison, but if the rats are fed on bread and milk the effect of the ergosterol is negligible. In real life we do not live on a completely synthetic diet ; nearly everyone takes some if not an abundance of fresh food, so the practical value of this type of experiment may be over-estimated, though it is of considerable academical interest.

Civilisation has brought bad sanitation in houses, and even our windows may be depriving us of fresh air and filtering out certain rays of light, bringing its attendant tuberculosis—for tuberculosis is a disease of houses. Science is now engaged in endeavouring to remedy the evil effects which it has produced.

I have endeavoured to show that all precise knowledge in therapeutics is based upon controlled experiments on animals or man, and that the elucidation of the action of medicaments by the methods and data of experimental physiology is one of the most important steps taken to place medicine on a scientific basis. How important this is may be gauged from the fact that all fundamental advances in treatment in the last thirty years have originated directly or indirectly from experiments on animals. There can be no doubt that the future of therapeutics, and therefore of medicine as a whole, is intimately connected with physiology.

Britain for fifty years has every reason to be proud of her progress and achievements in physiology ; it is acknowledged that she can show records second to none and that her savants have included some of the world's greatest investigators. It remains for us to hope that in the future she may attain equal success in the associated sciences directly concerned with the relief of suffering and cure of disease.

News and Views.

IN staging joint discussions upon various subjects of general interest, the British Association performs one of the most useful of its public functions. Scientific workers of different schools and training meet, as they seldom do, to focus their peculiar outlooks upon a particular problem; the public benefits by hearing at first hand the latest developments of scientific thought or discovery, and can scarcely but be impressed by divergences of opinion which suggest that science, still in process of development, abhors dogma and finality. The discussion on "The Nature of Life", held at Cape Town on July 25, was more than usually interesting, since it indicated a swing of the pendulum towards the vitalistic view of the nature of life. According to the Cape Town correspondent of the *Times*, General J. C. Smuts, in opening the discussion, developed his theory of 'holism', which he regards as avoiding the difficulties of both the vitalistic and mechanistic theories. Life is neither a substance nor a force; it is a structure, a new emergent structure based on pre-existent physical structures. Evolution from the most primordial forms of matter to the highest forms of mind is a continuous process, and this process is characterised at one end by physical structures with a minimum of functional structure, and at the other end by functional structures with a minimum of physical structure, and in between by a transition area of combined physical and functional structures. The first is called matter, the second mind, and the area of mixed structures, life.

LIFE-STRUCTURES or patterns, according to General Smuts, have the characters of wholes, which are not mechanical aggregates, but in which each part influences and moulds every other part. In a whole, the parts are really members, and the whole itself appears to play a centralising, unifying, and co-ordinating rôle. Dr. J. S. Haldane in general agreed with General Smuts's rejection of orthodox vitalism and mechanism, and accepted the holistic view of life as a unity which maintains and asserts itself in an environment which is part of its whole. Prof. Wildon Carr stood for the vitalistic outlook, and suggested that Smuts's holism is but another name for entelechy, and that the reality of life is activity of an essentially individual and purposive nature distinct from mechanical activity. Prof. L. Hogben said that he is not prepared to believe anything not amenable to experiment; Prof. A. S. Eddington pointed out that the essential requirements of holism are not radically inconsistent with the mechanistic hypothesis; and Prof. G. Barger made striking testimony to the failure of synthetic chemistry to build up a living cell, pointing out at the same time that although the mechanistic view is difficult to accept, resort to other hypotheses seems to be treachery to science.

ON July 23 the Institution of Professional Civil Servants gave evidence before the Treasury Committee, presided over by Sir Harold Carpenter, which is examining the method of recruitment and conditions of service of the civilian scientific and technical officers employed in Government Departments. At the request of the Committee the Institution had previously prepared a preliminary statement of evidence indicative of its general policy in regard to the matters which the Committee is charged to examine. The Institution's witnesses were led by its president, Sir Richard Redmayne, who was supported by Messrs. S. H. Bales, T. Smith, R. A. Watson Watt, and C. L. Leese. As the Institution is representative of all classes of scientific workers employed by the State in the departments under consideration by the Committee and has acted in consultation with the Association of Scientific Workers, its views upon the organisation of the scientific departments and the conditions upon which the staffs should be employed are worthy of full consideration. The Institution submitted proposals for the co-ordination of all branches of scientific research and experiment in a unified State scientific service. Such a service would involve a common system of recruitment, promotion, and conditions of appointment, and uniform scales of salary. The Institution also emphasised the need for appropriate salary scales and status for scientific officers in order to attract suitably qualified candidates. The careers offered to the scientific staffs should be equal to those offered to their professional and administrative colleagues.

THE Institution submitted specific proposals for common grading and salary scales for a scientific service which in its view could be applied to scientific organisations as at present constituted. It considered that the basic grade should normally be recruited from candidates between the ages of 21 and 24 years who possess an honours degree of a British university or its equivalent. Confirmation in the grade should be subject to the issue of a certificate of competence to perform the full duties of the grade, and such certificate should only be issued after a period of two years of strict probation. The Institution has followed the precedent established in the museums, Royal Botanic Gardens, Kew, and the Patent Office, in submitting a long scale for the basic grade in order that men who perform good service but do not possess such exceptional ability as to obtain promotion quickly shall be in a position to educate their children appropriately and to retire on an adequate pension. The Institution considers that provision for special promotion should be made for officers of exceptional ability. The Institution also dealt with the pay at present attaching to the highest posts in the scientific departments, which it considers entirely inappropriate to the status and responsibilities of their occupants.

THE sixty-eighth annual meeting of the Devonshire Association and the summer meeting of the Newcomen Society were held together at Dartmouth on July 23–26. While both societies carried out their own usual programmes of visits, etc., they joined together to commemorate the bicentenary of the death of the great inventor, Thomas Newcomen, who was born at Dartmouth in 1663 and died in London on Aug. 5, 1729. In the absence of the Mayor of Dartmouth through illness, the members of the Societies were officially welcomed by Alderman Pillar on behalf of the Corporation of Dartmouth, after which a eulogy on the work of Newcomen was pronounced in the public gardens at the site of the Newcomen memorial by Mr. L. St. L. Pendred, president of the Newcomen Society. Speaking of Newcomen as a man who had brought fame to his town, his county, and his country, and had given the whole world the art of converting fuel into useful power for the benefit and convenience of humanity, Mr. Pendred referred to the difficulty of visualising the conditions with which Newcomen had to contend. Acquainted with the needs of the mines of Cornwall and Devon, which were being killed by the influx of water with which the antique pumping plant of the day was unable to cope, it was Newcomen's glory that he, and he alone, saw the means of meeting the needs and that he produced a design so perfect in its simplicity that for many a long day no radical improvement in it was effected and no other engine appeared in opposition to it. Knowing little of the man himself, yet we may suspect that he had some of the " Divine insanity of noble minds that never falters or abates, but labours, and endures, and waits, till all that it foresees it finds, or what it cannot find, creates ".

THE last of the joint meetings was held in the Subscription Rooms at Dartmouth on July 25 to hear a lecture on " Thomas Newcomen—Two Hundred Years of Steam Power ", by Eng. Capt. E. C. Smith. Capt. Smith said that though the steam machinery of to-day is the outcome of the work of hundreds of inventors, engineers, and men of science, there are four great landmarks in its history. The first of these is the introduction of the atmospheric steam engine by Newcomen, the second is connected with the epoch-making discoveries and inventions of Watt, the third is the adoption of the compound engine for ships, which we owe to John Elder, and the last is the invention of the steam turbine by Sir Charles Parsons. Historians often fail to realise the importance of the work of Newcomen, who began building engines sixty years before Watt. Watt's great improvements were made between 1765 and 1785, after which came the application of steam to transport on land and sea. Watt had nothing to do with this. The steam engine itself and the locomotive were purely British inventions, but the steamboat was largely due to work in America. By 1840 the total horse-power of the world's steam engines was about 2,000,000 ; by 1880 it was about 28,000,000 ; to-day it runs into hundreds of millions, and there seems no adequate reason to think that the steam engine will lose its place as the most important prime mover. Looking back to the days of its original introduction, one can say that Newcomen stood in relation to Watt very much as Trevithick stood in relation to Stephenson : Watt and Stephenson were the great improvers, Newcomen and Trevithick the original pioneers.

IMMEDIATE success has attended negotiations between the Australian Council for Scientific and Industrial Research and the University of Adelaide for the establishment of a Division of Soils Research for the Commonwealth. The Council recently invited the University to co-operate with it in this project, the broad division of responsibilities being that the latter should provide the required laboratories in the grounds of the Waite Agricultural Research Institute, and the former should provide equipment, staff, and maintenance and generally conduct the work of the Division. Within three weeks the University was able to announce that through the generosity of Mr. Harold Darling, acting on behalf of his family, which has for a long time been intimately associated with South Australian agriculture, the sum of £10,000 had been made available for the erection of the necessary laboratories. It is understood that Prof. J. A. Prescott, while still retaining his chair of agricultural chemistry in the University, will be the chief officer of the new Division. He has for some time been adviser on soils problems to the Council for Scientific and Industrial Research, and under his direction much useful work has been done on the soils of some of the irrigation areas. The new move will make possible a considerable extension of activity which, through the Imperial Bureau of Soil Science at Rothamsted, should ultimately benefit many other parts of the Empire.

IN connexion with Mr. Field's suggestion, referred to in our issue of July 27, p. 156, that some of the early peoples of North Arabia may have moved into the Nile Valley, we may refer to a letter from Mr. Guy Brunton which appeared in the *Times* of July 18, in which he gives extracts from a report presented to the Trustees of the British Museum, describing further excavations in Egypt bearing upon the origin and affinities of the Badarian culture. Some doubt has been expressed as to the early date of this culture, but in the past season a widespread Badarian settlement deposit was found into which were sunk many graves clearly subsequent and typically early pre-dynastic (Amratian). The relation between Badarian and Amratian was clearly indicated by the discovery of intermediate types of pottery. An Amratian flint knife 17 inches long is perhaps the longest known. An important addition to our knowledge of the earliest predynastic civilisation has been made in the confirmation of the early date of the culture to which the name Tasian has been given. This culture differs from the Badarian ; its pottery, while akin to the Badarian, is distinct and thought to be of earlier date. This is now confirmed by the investigations of Dr. Sami Gabra near Deir Tasa, where an undisturbed grave was found to contain a typical pot and two stone celts. This people apparently also used incised beaker-shaped vases of black pottery. Three skulls have been found in good condition. They differ in type from Badarian, being rounder headed, with squarish faces and heavy square jaws.

IN the same issue of the *Times* is a further contribution to Egyptology, which is also of interest to Biblical students. Dr. A. M. Blackman, in a lecture at Oxford, has suggested that the Papyrus Salt may refer to Moses. An incident described in that papyrus states that the punishment inflicted upon a workman for his misdemeanours by a vizir was revoked by 'Mose'. Apparently he was influential enough to secure the deposition of the vizir, though no title is given him and no mention is made of any official position held by him. Dr. Blackman suggests that this casual introduction of his name may point to the fact that he was well known as a redresser of grievances interested in the workman class as we know Moses to have been. If this highly speculative suggestion could be supported, it would be of no little interest. It has, in addition, an important bearing upon another point. If the identification were accepted, it would place Moses' sojourn in Midian as during the last years of Sethos II. At the death of this Pharoah five troubled years followed which would have afforded a favourable opportunity for the Exodus. This would give a date for that event at most fifteen years later than the death of Meneptah, in whose reign it is placed by generally accepted chronology, but whose strong character is scarcely consistent with the course of events of the Biblical narrative.

According to the British Rainfall Organisation, Meteorological Office, Air Ministry, the total rainfall over Great Britain for the six months, January to June 1929, was less than 70 per cent of the average for the same period almost everywhere, the only important exceptions being the counties of Devon, Cornwall, and Pembroke, parts of the south-western isles of Scotland and of an adjoining strip on the mainland, a narrow belt along the east coast of Scotland, an area in north-east Yorkshire, and a part of Sussex and the Isle of Wight. In spite of a June which was generally wet in Scotland, percentage values of less than 50 per cent for the six months were recorded in Ross and Cromarty. Another area of less than 50 per cent included a part of south Yorkshire and the northern portions of Derbyshire and Nottinghamshire. At Camden Square, London, the total fall for the six months was 52 per cent of the average. In Ireland the fall for the six months was generally in excess of 50 per cent. Less than 60 per cent occurred along the north-west coast and around the mouth of the Shannon. More than 80 per cent occurred in places on the east coast, while the highest percentage value for the six months was 116 per cent at Waterford. In most parts of England, Wales, and Ireland, June was a dry or very dry month. Only about 40 per cent of the June average was recorded in the southern Pennine area, in the eastern parts of Lincolnshire and Norfolk, in a large area including much of Cambridge, Bedford, Hertford, and Essex, and round the mouth of the Shannon. More than 180 per cent of the average June fall was measured in the extreme north of Scotland and more than 130 per cent in the extreme north of Ireland. About 150 per cent of the average amount fell in south-west Cornwall. At Camden Square, London, the June fall was 64 per cent of the average.

Several specimens of the Nkosi Island situtunga (*Limnotragus spekei sylvestris*), recently described by Colonel R. Meinertzhagen, have been received in the Department of Zoology of the British Museum (Natural History) from Captain C. R. S. Pitman, Game Warden of Uganda. Nkosi Island, the southernmost of the Sesse Group, in the Victoria Nyanza, is an island covered with dense, dry forest, and the situtungas, which are usually swamp-dwelling antelopes, have assumed more terrestrial habits. Colonel Meinertzhagen estimated that in 1926 there must have been at least two hundred of these animals existing on Nkosi Island. The Department of Entomology of the Museum has received from Mr. F. W. Urich, Port of Spain, Trinidad, six examples of *Pantophthalmus tabaninus* Thunb., a large two-winged fly, specimens of which sometimes measure as much as two inches in length. *Pantophthalmus*, which occurs in the West Indies and other parts of tropical America, is the largest of all Diptera; notwithstanding its formidable appearance, however, it is quite harmless and is incapable of biting. The larvæ have the remarkable habit, unique among Diptera, of boring in the solid wood of living trees, in which they gouge out clean-cut, nearly horizontal tunnels, and feed upon the exuding sap. Mr. Frank H. Taylor has presented a green cicada (*Cystosoma saundersi* Westw.), taken by him at Eungella, Queensland. The song of this insect, which in New South Wales and Queensland occurs locally in vast numbers, is heard in hot and sultry weather before a thunder-storm. It is said to be unlike the shriller and harsher notes uttered by the common cicada, and to resemble the sound of a loud, deep, and guttural 'R', continued incessantly, with vibrations. The Trustees have accepted for the Department of Botany the bequest by the late Mr. Arthur Bennett of his herbarium of British pondweeds. Mr. Bennett made a lifelong study of the genus *Potamogeton*, and the value of his herbarium is much enhanced by the inclusion of numerous notes and correspondence relating to the specimens.

At the eighth annual general meeting of fellows of the National Institute of Agricultural Botany at Cambridge on July 26, the chairman of the Council, Dr. E. S. Beaven, reviewed in turn the principal activities of the Institute in the past year. Two important branches of the work, the Official Seed Testing Station, and the Wart Disease of Potatoes Immunity Trials, are delegated to the Institute by the Ministry of Agriculture, and these functions are supplemented by cognate investigations into germination problems, potato virus diseases, and the yield and maturity of potato varieties. The Potato Synonym Committee, of which Dr. Salaman is the chairman, has reported a substantial improvement in the nomenclature of potatoes; the Council hopes to win the co-operation of seedsmen in extending this work to cereals. Dr. Beaven referred to the encouragement offered in the last century by the Royal Agricultural Society to plant-breeders and, after tracing the relationship between animal and plant breeding and the influence of Mendel's work, pointed out that field trials of the kind undertaken by the Institute would be needed for many years. The difficulty of the task and the value of the results were illustrated by the series of barley trials completed in the past year. Two varieties raised by systematic methods of plant breeding were shown to be generally and significantly more profitable to farmers than any others, and records collected independently by the Official Seed Testing Station and the Essex County Farmers Union not only confirmed this conclusion but also showed that these two varieties are now grown more widely than any others. The study by competent critics of these and the similar results now being obtained at the Institute should win for it the support of agriculturists.

We learn from the *Times* of July 23 that at the suggestion of Dr. R. J. Renison, rector of Christ Church, Vancouver, the Royal Empire Society is having a plaque made in England to be placed in Vancouver Cathedral to commemorate the work of Captain Cook in that part of the world. Records show that it was in 1778 Cook sailed up the west coast of North America. He struck the coast at Lat. 44° 55′ N. on Mar. 7, and he "proceeded to make an almost continuous survey of the coast" up to and beyond Bering Straits as far as Lat. 70° 41′ N., where he was barred by the ice. He named the farthest visible point, Icy Cape; he also discovered and named Nootka Sound, Prince William's Sound, and Cape Prince of Wales; and he penetrated Cook's Inlet. His work is believed to have inspired that of Vancouver in 1792, when the latter circumnavigated the island that now bears his name. The memorial is to be unveiled in September during the visit of Sir John Sandeman Allen, chairman of the Royal Empire Society.

Mr. F. W. Skinner, in *Engineering* for July 19, gives an account of the difficult, but finally successful work, of righting one of the large reinforced concrete caissons which had capsized on July 27, 1927, while being sunk into position for one of the piers of the Poughkeepsie Suspension Bridge, N.Y. The caisson, 136 ft. long, 60 ft. wide, 104 ft. high, when it capsized, had a weight submerged of nearly 13,000 tons, equivalent to about 19,000 tons in air. Owing to the great depth of water, strong tidal currents, formation of ice, and the traffic in the river, the work of righting proved an arduous matter, and it was not until Oct. 8, 1928, that the caisson was finally in position again. The methods employed included the weighting of the higher side of the caisson, lifting the lower side by means of steel pontoons from which the water had been pumped, and pulling by tackles anchored in the river bed. It was estimated that forces approximating to 100,000 ft.-tons were brought to bear on the caisson as against the adverse moment of 40,000 ft.-tons. After righting, the sinking operations were resumed and the pier completed on May 17, 1929.

Watching the modern passenger-carrying aeroplane in the air, it is difficult to realise that a machine built just over twenty years ago is of sufficient interest and importance to justify a place in the Science Museum, Kensington. So fast has been the progress of aeroplane construction, however, that the little monoplane in which M. Louis Blériot crossed the English Channel on July 25, 1909, is now a historic relic. The occasion was commemorated on Saturday last, when M. Blériot crossed the Channel in one of his latest machines, a twin-engine monoplane of about 1000 h.p. The crossing occupied 12 min., as against the 33 min. taken in the flimsy little machine he used twenty years ago. M. Blériot landed at Swingate Aerodrome, Dover, and went by motor-car to North Foreland Meadow, where there is a commemoration stone to mark his landing there in 1909. He was welcomed by the Mayor of Dover and Sir Sefton Brancker, Director of Civil Aviation in Great Britain, and afterwards proceeded by air to London. The same evening, M. and Mme. Blériot were the guests of honour at a dinner, presided over by Lord Thomson, Secretary of State for Air, to celebrate the Seventh International Aero Exhibition being held at Olympia.

A considerable earthquake was recorded at Kew Observatory on July 23. The first impulse reached the Observatory at 8 hr. 47 min. 5 sec. Greenwich Mean Time. The seismograms indicate that the epicentre was close to the north coast of Ireland.

Applications are invited for the following appointments, on or before the dates mentioned:—A lecturer in mechanical engineering at the Swansea Municipal Technical College—The Director of Education, Education Office, Dynevor Place, Swansea (Aug. 10). Inspectors for the purposes of the Diseases of Animals Acts, 1894–1925, under the Ministry of Agriculture and Fisheries—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall-place, S.W.1. (Aug. 12). A technical officer, at the Royal Aircraft Establishment, for writing descriptive matter and instructional handbooks on wireless and electrical apparatus—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (Aug. 13). An assistant in the dairy bacteriology research division of the Ministry of Agriculture for Northern Ireland—The Secretary, Civil Service Commission, 15 Donegall Square West, Belfast (Aug. 14). A taxidermist and an assistant librarian in the Faculty of Science of the Egyptian University, Cairo—The Director of the Egyptian Education Office, 39 Victoria Street, S.W.1 (Aug. 15). A resident lecturer in geography at the Caerleon Training College for Men—C. Dauncey, County Hall, Newport, Mon. (Aug. 21). An assistant lecturer in physics at the Bradford Technical College—The Principal, Technical College, Bradford (Aug. 23). A chemist with experience in research on yeast problems for research work in industrial microbiological chemistry—The Research Manager, Imperial Chemical Industries, Ltd., Technical Department (Nobel Section), Stevenston, Ayrshire. A lecturer in physics at the Memorial University College, St. John's, Newfoundland—S. T. Harrington, Woodfield, Malvern Wells, Worcs. Laboratory assistants at the Royal Arsenal, Woolwich—The War Department Chemist, B.47, Royal Arsenal, Woolwich, S.E.18. A computer under the Government of Tanganyika Territory, for the Survey Department—The Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/1405). A junior assistant in the department of the War Department Chemist—The War Department Chemist, B.47, Royal Arsenal, Woolwich, S.E.18. A lecturer in agricultural chemistry in the University of Reading—The Registrar, The University, Reading.

Research Items.

Salmon Fishery in California.—The development of the use of water-power in Great Britain and its preliminary, the impounding of lakes and damming of rivers, are bound ultimately to have an adverse effect on the salmon productivity of the country, and that probably in spite of the best safeguards which can be agreed upon. The lesson of the Sacramento and San Joaquin Rivers in California, the first rivers there to to be fished for salmon by white men, is a plain one. Since 1874 the fishery has produced 205 millions of pounds of salmon (says *California Fish and Game* for January), and now, in an endeavour to keep up the stock, as many as 100,000,000 young salmon from hatcheries have been planted in a single year. Overfishing is apparently one cause of the decline, but a factor, scarcely less important, is the cutting off of the spawning grounds by dams. An important investigation of the spawning beds has just been completed, and this has necessitated observations of obstructions in the streams and of the workings of fish-ladders and screens. The survey has determined that, as near as can be calculated, there were, in 1928, 510 lineal miles of stream in which salmon might spawn, as compared with the 6000 miles before the dams were constructed. It is estimated that 80 per cent of the spawning grounds in the Sacramento and San Joaquin river systems have been cut off by the obstructions of dams, both power and irrigation. The salmon fishery in California is now at the point when something must be done, and at once, in order that it may be preserved for future generations to enjoy.

An Amphibious Centipede from India.—At the Indian Science Congress, B. Bonnell described the finding of a Geophilid in loose soft mud in the mouth of the Cooum River, Madras. The specimens were obtained in July 1928 when collecting polychæte worms, *Marphysa* and *Lycastis*, in the bed of the river in brackish water. It was found that the centipedes could withstand immersion in water for nearly twenty-four hours. The other amphibious centipedes recorded are *Linotenia maritima* and *Schendyla submarina* on the shores of the Mediterranean and on the Atlantic coast of Europe, and *Pectiniunguis americanus* under seaweed, driftwood, etc., on the shores of the Gulf of Mexico. The author suggests that amphibious centipedes may be more widely distributed than these records indicate.

The Mammals of Ceylon.—Since a provisional list of the mammals of Ceylon was published in 1923, many new forms have been discovered in the island, and new facts have been brought to light regarding distribution. Accordingly W. W. A. Phillips contributes a new check list, in which the names, scientific and native, and the range of each species and subspecies are recorded (*Spolia Zeylanica*, vol. 15, p. 119; 1929). The mammals have increased in number to ninety-eight species and sub-species, and even the bare list brings out some interesting features. Ceylon may be broadly divided into three climatic zones, the low-country dry zone, comprising the northern half of the island and possessing a fauna closely resembling that of the Indian mainland; a low-country wet zone; and a central hill zone. Each zone has a fauna differing in many respects from that of each other zone, and in many cases the forms found in any zone are peculiar to it and are not found in the remainder of the island.

Rhizopoda of the North Sea and Baltic.—Dr. L. Rhumbler (Die Tierwelt der Nord- und Ostsee. Lieferung 13, Teil II. a, "Amœbozoa et Reticulosa)" describes the Amœbozoa and the Foraminifera of these regions. Although marine amœbæ are very common they are still little known. It seems extraordinary that only one species has been described which was actually living in the North Sea, and this one is a parasite in the diatom *Biddulphia sinensis*. Free-living amœbæ have been found by Rhumbler and Gruber in aquaria filled with North Sea water—*Amœba comminuens* and *A. crystallina*—and in aquaria filled with Baltic water from Kiel six species, including *A. crystallina*, have been described. Three of these are well known in fresh water. Many of the small amœba-like organisms found in the sea are most probably phases in the life of certain Foraminifera. In the sub-order Testacea only five species are known in the sea water and these mostly from aquaria. Amongst them is the interesting *Trichosphaerium sieboldii*, which has an alternation of spore formation with a gamete-forming phase. On the other hand, the order Reticulosa is rich in species. The Foraminifera have always been specially studied. They are easily collected and the shells are varied and beautiful. Two species of the sub-order Nuda are included, and a member of the genus *Labyrinthula* not yet identified has been found commonly in the sea-water aquaria of Heligoland. All the rest belong to the true Foraminifera. There are useful keys for the identification of species, of which there are about 200 in the area, chiefly from the North Sea and western Baltic, the eastern part of the Baltic being poor in these little organisms.

Possible Molluscan Hosts for Cercariæ in the Shan States.—The occurrence of schistosomiasis in coolies from Yunnan at a hospital in the Northern Shan States, and the fear of the possibility of the spread of the disease from China into Burma, led to a survey of the molluscs of the Northern Shan States with the view of ascertaining if any known carriers occurred in the region. This survey was conducted in November 1926–January 1927, under the direction of Dr. H. S. Rao, of the Zoological Survey of India, and his report on "The Aquatic and Amphibious Molluscs of the Northern Shan States, Burma," has now been published (*Rec. Indian Mus.*, vol. 30, pt. 4). It is a very careful and thorough systematic account, admirably illustrated, of the 48 species of mollusca (including 29 forms, races, and varieties) met with, of which one genus, *Ekadanta*, and 21 species and forms of gastropods, are described as new. So far as the occurrence of schistosome cercariæ and of the known carrier-snails was concerned, the results of the survey were negative, but the adaptive, if not the specific host of *S. japonicum* occurs in the Shan States, and the constant stream of Chinese coolies which comes in from adjacent infected Chinese provinces is more likely than not to carry with it the insidious parasite. A thorough survey of the frontier districts at all seasons hence seems to be desirable.

Tropisms and Sense Organs of Lepidoptera.—Under the above title, Dr. N. E. McIndoo, of the U.S. Bureau of Entomology, has written an excellent illustrated article which appears as Smithsonian Miscellaneous Collections, vol. 81, No. 10 (1929). It is well known that many phases of insect behaviour are still unexplained and, in turn, behaviour is largely the result of tropic responses. In this paper Dr. McIndoo brings together the available information on the tropisms and sense organs of Lepidoptera, and includes the results of his own special studies on the codling moth. Certain tests carried out with larvæ of this insect indicated that, when in the first instar, their eyes are photopositive and they search freely for food, but they are apparently not aided by their senses until within a few millimetres of the food. Larvæ in the fifth instar sometimes acted indifferently to light, but generally were weakly photonegative. Older larvæ when ready to spin their cocoons are strongly photonegative: they react positively to gravity and to thigmotropic stimuli, whereas the younger larvæ behaved in an opposite manner in relation to these three types of stimuli. Change in tropisms, therefore, brings about great differences of behaviour. The author believes that those sensory structures, termed by him 'olfactory pores', which are widely scattered on the bodies and appendages of both the moths and their larvae, are receptors of smell.

Proteolytic Enzymes in Green Malt.—The attempt to identify the proteolytic enzymes of plants with systems like the tryptic and peptic types of animals has been criticised by C. K. Mill and K. Linderstrøm-Lang (*Compt. Rend. Lab. Carlsberg.*, 17, 1-14; 1929), who prefer to characterise the plant enzymes by the nature of the substances they affect. In green malt, for example, they distinguish only two enzymes of the proteolytic type, a protease (*p*H optimum 4·3) and a peptidase (*p*H optimum 7·6-7·9), the action of which on dipeptides is greatly inhibited by phosphates.

Ocean Surface-Water Temperatures.—Means of accurate and quick recording of surface temperatures of the ocean are described in a paper by Sir Frederic Stupart and Messrs J. Patterson and H. G. Smith in *Bulletin* No. 68 of the National Research Council (Washington, D.C.: National Academy of Sciences). The most effective instrument was found to be a mercury-in-steel thermograph in which the bulb was heavily plated with copper and inserted in the intake of the steamer's condenser. The recording part is of the usual thermograph pattern and is fixed between two ribs of the ship. The trace never showed any signs of vibration. The apparatus was tried on North Pacific and equatorial steamer routes. So far, the most numerous data have been obtained from the North Pacific. A study has been made of departures from normal of North Pacific water temperature, with the view of discovering if any correlation can be found between variations in water temperature and the weather of western Canada. A fairly definite correlation has been established, especially in winter, between the temperature of the water and the intensity of the Aleutian atmospheric low pressure area. When the temperature gradient is large the pressure is low, and this means increased oceanic winds with higher temperatures on the Canadian seaboard. However, when the temperature gradient of the water has its normal maximum in summer, the Aleutian low is not marked, so that other factors must be involved.

Superconductivity of Thorium.—The issue of *Die Naturwissenschaften* for May 24 contains a short note from Prof. W. Meissner, in which he states that he has succeeded in obtaining metallic thorium in the superconducting state. The specimen experimented upon was a single crystal, 12 mm. long and 3 mm. thick. When cooled in liquid helium its electrical resistance was at first a little less than two per cent of its resistance at 0° C. The transition took place at about 1·4° absolute, and at 1·3° absolute the resistance had fallen to less than 10^{-4} of its value at 0° C. Thorium becomes a superconductor at a lower temperature than any other metal which it has yet been found possible to obtain in this peculiar condition, the lowest transition temperature previously recorded being 2·1° absolute for the gold-bismuth eutectic. Prof. Meissner suggests, however, that silicon may become superconducting at some temperature below 1·2° absolute.

The Carbon Molecule.—Dr. R. C. Johnson and Mr. R. K. Asundi have contributed an interesting paper to the July number of the *Proceedings of the Royal Society* on the diatomic carbon molecule which exists in the discharge tube. Two years ago, before the guidance afforded by recent developments of the theory of band spectra had become available, Dr. Johnson had suggested, in connexion with an analysis of the fine structure of the well-known Swan bands, that these arose from a molecule with the same empirical formula as acetylene (C_2H_2). Since then, evidence, which is largely summarised in the present paper, has been accumulating that carbon (C_2) and not 'acetylene' is the true emitter, and this view is now endorsed. In addition, it has been found possible to extend the previously described so-called high-pressure bands of carbon into the ultra-violet and infra-red, and it has now been shown that both these and the Swan bands represent transitions to a common final state. Dr. Johnson also discusses the discharge conditions under which C_2 molecules are likely to be found, and states very clearly and with some extension Mulliken's theory of the structure of this form of carbon.

Aggregation of Small Particles.—A very remarkable instance of the aggregation of small particles has been described by H. S. Patterson, R. Whytlaw-Gray, and W. Cawood in their paper on the structure and electrification of smoke particles which appears in the July issue of the *Proceedings of the Royal Society*. An azo-dye, *m*-xylene-azo-β-naphthol, was volatilised on to a slide. At first a mixture of red supercooled spherical droplets and closely packed crystalline aggregates was formed. Then, on standing, some of the crystalline particles proceeded to develop hair-like tails which were both long and extremely tenuous. As the tail grew, the crystal aggregate diminished in size, and in addition surrounding droplets evaporated, until in the final stages of the rearrangement there were in many cases only the hairs left. The latter were sometimes as long as 0·15 mm., and when a crystalline head still remained, the tail dwindled away from a thickness of the order of 10^{-4} cm. near the head to probably less than 10^{-5} cm. at the other end. No substance other than this particular azo-dye has yet been found to show the effect on any comparable scale. Two good microphotographs of the hairs are reproduced in the paper, and in both the hairs would, in absence of further description, probably be taken to be dirt on the slides.

Dust in New York City Air.—An article by Dr. E. E. Free in the *New York Times* of June 30 describes tests made of the air in New York, in April and May last, to determine the degree of smoke pollution, and the number, size, and character of dust and soot particles in the air at different heights above the street level. The instrument used was the Owens' dust counter. Ultra-violet radiation was examined by a spectroscope. The greatest number of particles counted in any sample was 910,000, the lowest 250,000 per cub. ft. It is stated that rain greatly decreases the dust in the air and that the chief source of dust appears to be domestic fires. The heaviest rain never reduces the dust content of the air to zero, and a heavy downpour was less efficient as a dust remover than a thin, long-continued drizzle. The quantity of dust at any place is governed chiefly by wind direction. An important fact brought out was the decrease of dustiness above street level, so that at about 200 ft. up the dust was reduced by 25-50 per cent. The New York dust was found to consist chiefly of grains of soot, averaging 1/20,000 of an inch diameter. It is assumed that these are removed from the air by settlement after aggregation into larger masses. This is not supported by evidence, and the removal of the particles from the city by the wind does not appear to have been taken fully into account. A discrepancy is indicated between the results of these tests and others made by the Carrier Engineering Corporation. The latter indicated some 2000 tons of solid matter in the air above the city, while the tests described indicated about 4 or 5 tons. It is stated that, from the middle of October to about the middle of April, no measurable trace of ultra-violet radiation reaches even the tops of the buildings in mid-town New York.

A New Valve Effect.—An important new effect in thermionic tubes is described by K. H. Kingdon and E. E. Charlton in the June number of the *Physical Review* (p. 998). It had been found that hot filament tubes containing a trace of cæsium vapour could act as very sensitive detectors of radio signals under certain conditions, and a more detailed investigation showed that this was not being brought about through curvature of the characteristic curves. It was ultimately found that what was apparently occurring was that the cæsium was being ionised at the surface of the filament and then accumulating in the positively charged state near the region of minimum potential which surrounds this electrode, where it modified the space-charges in such a way as to increase the electron current to the grid and anode. The ions have a natural period of vibration about the surface of minimum potential, and when acted upon by an alternating electromotive force of the same frequency, are set into resonant vibration; being then more diffusely spaced, they exert less control on the electron current, which is thus reduced. The calculated and observed periods of the ions are of the same order of magnitude. In a further note by K. H. Kingdon (p. 1075) it is mentioned that a similar effect can be produced by ions generated by electronic impact between the grid and anode, and that their response is sufficiently selective to permit of the resolution of separate rectification peaks for each of the isotopes of neon and argon.

Determination of the Chemical Constituents of Petroleum.—The Bureau of Standards of the U.S.A. is co-operating with the American Petroleum Institute in an investigation for the separation and identification of the constituents of petroleum, and the apparatus and methods in use are described by E. W. Washburn, J. H. Bruun, and M. M. Hicks in the March issue of the Bureau of Standards publication, *Journal of Research.* Details are given of a number of stills of various types, and an interesting part of the paper deals with molecular stills, first used by Brönsted and Hevesy for separating the isotopes of mercury. An apparatus for the combustion analysis of hydrocarbons up to C_{100} is also described, the accuracy of determination of both carbon and hydrogen being about $\pm 0{\cdot}05$ per cent. It has been found possible to carry out the distillation of petroleum at high temperatures without cracking, provided that all air is excluded. A note is included in the paper directing attention to the fact that the danger of poisoning from mercury spilled in laboratories is probably very small owing to the rapid contamination of the mercury surface with oil or grease.

Locomotive Performance.—Mr. E. C. Poultney, in the *Engineer* for July 5 and 12, discusses the comparative efficiencies of two American locomotives—one of the Pacific 4-6-2 type and another of the Atlantic 4-4-2 type—working under varying conditions of speed. In the same journal in 1924 Mr. Poultney dealt with the boiler efficiency and cylinder efficiency of these engines, but in the present articles he treats of the complete locomotive, taking into consideration the combined efficiency of the unit as a whole. He first considers the mechanical efficiency or the power absorbed by the engine in moving its working parts; he shows how fuel consumption is related to power, and gives the fuel and steam rates per dynamometer horse-power and their relation to speed in miles per hour. Other sections of his articles are devoted to superheat and thermal efficiency, boiler efficiency, cylinder efficiency, and, finally, locomotive performance. Each section is illustrated by curves for the two engines, and in a table he gives some interesting figures of the Pacific engine working at varying speeds with a constant cut-off and at constant speed with varying cut-off. In the first instance, the engine was run at speeds rising from 120 r.p.m. to 320 r.p.m., the I.H.P. ranging from 972 to 2290; the efficiency at the same time fluctuating between 5·96 per cent and 7·61 per cent; in the second instance the engine speed was kept at 240 r.p.m., but the cylinder cut-off altered from 20 per cent to 50 per cent. Here the lowest locomotive efficiency was 4·56 per cent and the highest 6 per cent. Comparing the two locomotives when being used under the best conditions for economy in the use of the heat units available in the fuel fired, the Pacific engine showed a decided superiority over the Atlantic engine.

Rating Electric Lamps.—During the last twenty years considerable progress has been made in the standardisation of electric lamps. Formerly it was the custom to buy lamps rated as 8, 16, 32 . . . candle-power. We now buy lamps according to the electric power they require; for example, 10, 20, 30 . . . watt lamps. It may be argued that what a consumer wants to buy is a device to give light and not a device which takes a specified amount of power. This is recognised by the manufacturer. It is much easier to measure electric power than it is to measure candle-power, and the ratio of the two in different types of lamps is known approximately and is often given. It is certainly much easier to rate lamps by the power they take and it can be done more accurately. We think, however, that the approximate candle-power should also be marked on all lamps. Naturally, if the rated watts proceed by decimals, the rated candle-powers do not proceed by decimals, and the differences between them vary according to no simple law. In an official specification published in March last by the U.S. Bureau of Standards, the amounts of the tolerances permitted both from the rated electric power and from the rated light-giving efficiency are given for electric lamps with tungsten filaments. With a 40 watt lamp, for example, the candle-power per watt may vary from 7 per cent below to 7 per cent above the standard efficiency. The corresponding admissible power variation from the standard is 5 per cent. In another official American specification for miniature lamps, issued at the same time by the Bureau of Standards, we find that the average life of miniature tungsten filament lamps for flash-light service varies from 5 to 14 hours, and for automobile service it varies from 100 to 360 hours. The life of a lamp is supposed to be finished when the light it gives has fallen by a definite percentage from its initial value.

Protection from Lightning.

THE desirability of protection from lightning was recognised from the earliest times. The earliest attempts consisted of exorcisms by priests, the wearing of charms, the ringing of church bells, and even the burning of witches. It was not until about 1750, when Franklin proved that a lightning flash was an electrical phenomenon and could be guarded against by suitable conductors, that these superstitions began to die away. Still, it is only of recent years that, mainly owing to the work of Lodge, the true function of these conductors has begun to be understood by physicists. Engineers are now putting into practice what they learn from theory and discover from high voltage experiments. Finality, however, is still far from being attained. We welcome, therefore, the new Code [1] for protection against lightning, which has recently been issued by the U.S. Bureau of Standards and the American Institute of Electrical Engineers.

In this book instructions are first given to guide the conduct of persons during thunderstorms. Then the methods of protecting buildings and miscellaneous property are described, and finally how structures containing inflammable liquids and gases can be safeguarded. In the appendix an account is given of various kinds of 'lightning' discharge and a brief notice of various recent theories.

So far as the rules given for personal conduct during a thunderstorm are concerned, we think they are reasonable. There is no shutting of windows, pulling of blinds, and lighting of candles, customs still adhered to in some places. Neither are nervous people told to go and lie in an empty metal bath, although the advice may be psychologically sound. Lightning fatalities are very rare, and only about ten per cent of them happen to persons who are indoors. All one has to do, therefore, is to stay indoors and keep away from fireplaces, stoves, and other metal objects.

If one is out-of-doors, the following shelters in order of preference are given: (1) Large metal or metal-framed buildings, (2) dwellings having lightning conductors, (3) large buildings or (4) small buildings. If one has to remain out-of-doors, keep away from (1) small sheds and shelters in an exposed position, (2) isolated trees, (3) wire fences, or (4) hilltops and wide open spaces. If one is in the 'wilds', seek shelter in (1) dense woods, (2) a grove of trees, (3) a cave, (4) a depression in the ground, (5) a deep valley or gorge, or (6) the foot of a steep or overhanging cliff. These rules are, of course, not perfect, but their brevity and generality should make them acceptable.

In specifying lightning conductors, we were interested to see that it is apparently immaterial what metal or alloy is used in their construction or what is the shape of their cross section. Instructions are given in the methods used for preventing them from deteriorating. If they are subjected to the direct action of chimney or other corrosive gases, the useful advice is given that they should be protected by a continuous covering of lead not less than one-sixteenth of an inch thick. We are told that the use of glass balls as ornaments on lightning rods is not objectionable. We suppose that this means that the lightning rod is just as efficient when a glass globe is placed on the top of it. We remember being told that during the South African war, British soldiers used to put empty bottles on the top of their tent-poles in the hope that this would prevent their tents being struck by lightning. The methods described of earthing the conductors are quite satisfactory, and no undue stress is laid on the ohmic resistance of the 'earth'.

During the War, several cases occurred of captive balloons and airships being struck by lightning. Fires also were caused by the long sparks which sometimes take place between the airship and the earth at the landing place. These experiences are reflected in the rules. Captive balloons are now earthed through the metal cable and winch by a pipe or tube driven six feet into the ground. Free balloons and airships are provided with an effective earthing wire which is lowered just before landing. It makes contact with a good earth and thus the electrical charges which may have accumulated on them when in the air are conveyed harmlessly to the earth.

In the United States, the protection of valuable or historic trees from lightning by means of conductors is being done on a rapidly increasing scale. In general, a single conductor is run from the highest part of the tree to the earth connexion. If, however, the tree has large branches, conductors are extended to their extremities. Somewhat elaborate arrangements depending on the size of the tree are used for earthing. A shallow network is used to collect the current near the surface of the earth so as to protect the roots of the tree, which experience has shown are as likely to be damaged as the tree itself. It is an excellent plan also to put lightning conductors on trees the neighbourhood of which is frequented by livestock. Full instructions are given for mitigating the dangers arising from wire fencing. Fences are earthed by means of iron posts or, more cheaply, by driving lengths of galvanised iron pipe at least three feet into the ground and attaching it by ties of galvanised wire to the fence. In addition to earthing the fence, its electrical continuity should be broken by breaking the wire at intervals of about a thousand feet and joining up the breaks by insulating material.

Full details are given of excellent methods for protecting structures containing inflammable liquids and gases from lightning. All-steel gas-tight tanks with vents adequately 'flame-proofed' are considered to be completely protected. So also are tanks with floating roofs, which prevent the accumulation of explosive mixtures, provided that there is provision for minimum exposure of the contents.

In an interesting appendix the origin, characteristics, and effects of lightning are described. An ordinary flash of lightning is called streak lightning. In rocket lightning, the growth is so slow that it reminds one of a rocket. In bead lightning we have a string of luminous globes separated by darker intervals. There are other forms such as sheet and globular lightning and St. Elmo's fire.

A brief résumé is given of Simpson's and C. T. R. Wilson's results, and an excellent photograph, taken by a moving camera, is shown, which proves that a flash can be rapidly intermittent. Instructive data taken from U.S. Weather Bureau publications show the frequency of thunderstorms in various places in the United States. A sequel to this code will deal with electrical apparatus and power lines, and it will be of great interest, as there are considerable divergencies in American and Continental practice.

A. R.

[1] Department of Commerce: Bureau of Standards. Miscellaneous Publication, No. 92: Code for Protection against Lightning. Approved April 4, 1929, by the American Standards Association. Pp. xiii+114+2 plates. (Washington, D.C.: Government Printing Office, 1929.) 25 cents.

Studies in Oxidation-Reduction.[1]

THIS bulletin, obtainable for a mere half a dollar, consists of reprints of the masterly series of researches published by W. Mansfield Clark and his associates from 1923 onwards. Twelve pages of supplementary notes have been included. The principal author, well known for his valuable book on "The Determination of Hydrogen Ions", was quick to appreciate that Gillespie's measurements of the electrode potentials induced by bacterial reduction, published in 1920, revealed a method whereby it might be possible to accumulate *quantitative* data concerning oxidation and reduction. The first paper outlines the theoretical aspect of the problem and shows how it is possible to express relative oxidation-reduction intensities in terms of electrode potential. For each system a constant can be found which is a measure of its oxidation-reduction *intensity*, a matter quite apart from the *capacity* of a solution to oxidise or reduce. A series of substances can therefore be arranged, so that when themselves in the half-oxidised or half-reduced state, each one will tend to oxidise one with a more negative constant, and to reduce one with a more positive constant.

The second paper is devoted to a consideration of the theoretical relations between reduction potentials and hydrogen ion concentration. Oxidation or reduction will displace *p*H in one direction or another in accordance with the acidic or basic nature of the group destroyed or created.

The third of the series relates to an experimental study of the electrode potentials of 1-naphthol-2-sulphonic acid indophenol and its reduction product. It includes a valuable description of apparatus and methods.

The fourth deals similarly with the indigo sulphonates, and the fifth with simple indophenols, dibromo substitution products of phenol indophenol and substituted indophenols of the ortho type being studied in the sixth, while the seventh discusses the dichloro substitution products of phenol indophenol.

The eighth is devoted to methylene blue, a substance of great histological and physiological interest, since it is a most useful *intra vitam* stain. The bibliography on methylene blue occupies nineteen pages, with about four hundred and fifty citations, and is probably the most complete in existence.

The ninth is entitled "A Potentiometric and Spectrophotometric Study of Meriquinones of the *p*-Phenylene Diamine and the Benzidine Series". The behaviour of these substances is so complicated, and the tendency to autoxidation is so considerable, that the authors consider it extremely dangerous to draw conclusions from colour reactions with benzidine, *p*-phenylene diamine, and their homologues. In view of the vogue these substances have had as oxidase reagents, the warning should not be forgotten.

The tenth deals with reduction potentials in cell suspensions. Relatively wide spans of potential are covered. Various aspects of the experimental data seem to indicate that cell suspensions are poorly poised with respect to the electromotively active material present at any moment, but that active material is slowly mobilised by cell catalysts from some large reserve. Several of the implications of current theories regarding biological oxidation and reduction are discussed. This discussion and the experimental data lead to the conclusion that the immediate problem is a clearer definition in *experimental* terms of the isolated chemical systems found in the cell.

The supplementary notes supply valuable additions and some trenchant criticism of subsequent work. Attention is directed to the necessity for a clear distinction between "the intensity factor measured in any proper terms but expressed by us in volts, and the capacity factor expressed in chemical equivalents or in faradays". The product is a work term and has nothing whatever to do with kinetics. "Therefore the term reducing *power* (power involves a *time* factor) should never be applied in descriptive text dealing with equilibrium states. The term *reducing ability* is often meant where *reducing power* is used."

The eleventh paper of the series, dealing with toluylene blue, is not included, but some data concerning this compound are included in the supplementary tables.

It cannot be pretended that these papers are anything but difficult reading; the conceptions set forth in them are, however, of fundamental importance; one can search current text-books in vain for any mention of them—though the series started in 1923, and the tenth appeared in 1926. It is to be hoped that all future workers on plant and animal respiration will carry on their researches with a due regard for the theoretical considerations and the exact quantitative data presented by this brilliant American chemist and his collaborators. In its orderly correlation of a large mass of data, in a region which before was in chaos, one is reminded of Loeb's work on "Proteins and the Theory of Colloidal Behaviour".

[1] Treasury Department: United States Public Health Service. Hygienic Laboratory Bulletin No. 151: Studies on Oxidation-Reduction, I-X. By the Staff of the Division of Chemistry. Pp. vi+363. (Washington, D.C.: Government Printing Office, 1928.) 50 cents.

University and Educational Intelligence.

EDINBURGH.—Dr. Thomas W. M. Cameron, of the London School of Hygiene and Tropical Medicine, has been appointed lecturer in helminthology in the Department of Zoology of the University and in the Royal (Dick) Veterinary College. Mr. A. L. Bennett has been appointed lecturer in zoology in the University.

MANCHESTER.—The Council has appointed Mr. N. F. Mott to be lecturer in mathematical physics.

The Grisedale Scholarships for biological research have been increased in value to £200 each, and awards have been made to Dr. Miriam K. Bishop (botany) and to Mr. Ieuan Thomas (zoology).

SIR FRANK HEATH has accepted the invitation of the executive committee to become the secretary of the Universities Bureau of the British Empire. Sir Frank Heath was permanent secretary of the department of Scientific and Industrial Research, and previously principal assistant of the Board of Education for England and Wales in charge of the universities and training colleges branch of the Board.

THE London County Council has awarded Robert Blair fellowships, which carry a grant of £450, to Mr. C. G. Davies, of Gorseinon, Glamorgan, and to Mr. G. L. Riddell, of Muswell Hill, London. Mr. Davies, who is works manager of the Grovesend Steel and Tinplate Company, Gorseinon, will carry out a detailed investigation into modern developments of practice in steel sheet, tinplate, and galvanised sheet manufacture in the United States. Mr. Riddell will study printing and its allied trades in relation to its machinery processes and methods of production in Canada, the United States, and Germany.

FOLLOWING on the representations made in Australia last year on behalf of the Colonial Office by Major R. L. Furse, the Prime Minister has appointed a central committee of advice in connexion with the making of selections from graduates nominated by the various Australian universities for appointment to the Colonial Service. The chairman is General Sir Brudenell White, and the other members are the Hon. F. W. Eggleston, Dr. J. H. L. Cumpston, Dr. A. C. D. Rivett, Major Keith Officer, and Mr. S. S. Addison (secretary). This move will be appreciated in the Commonwealth, though it is improbable that many candidates will be available for some years for scientific posts in the Colonies, particularly in biological divisions of work.

THE following awards for the year 1929–1930 have been made by the Salters' Institute of Industrial Chemistry and approved by the Court of the Salters' Company. Fellowships have been renewed to: Mr. C. G. Akhurst, Imperial College, London (Fellow, 1927–1929), for a further year at the Imperial College of Tropical Agriculture, Trinidad; Mr. H. K. Cameron, University College, London (Fellow, 1928–1929, at the University of Munich), for one year; Mr. H. Diamond, University College, London (Fellow, 1928–1929, at the University of Munich), for one year; Mr. F. L. Gilbert, University College, Nottingham, and Cambridge (Fellow, 1928–1929, at Cambridge), for one year; Mr. C. H. Lea, University of Liverpool (Fellow, 1928–1929, at Cambridge), for a further year at the Low Temperature Station, Cambridge. Fellowships have been awarded to Mr. C. G. Eltenton, Trinity College, Cambridge; Mr. D. L. Hodge, Imperial College, London; Mr. L. C. Bannister, Universities of Liverpool and Cambridge. The Institute has also awarded one hundred grants-in-aid to young men and women employed in chemical works, to facilitate their further studies.

IN several articles in the *Times of India*, under the title "Mathematics and Life", published last year in pamphlet form, Prof. John Maclean, Wilson College, Bombay, advocates a reform in the teaching of mathematics in the first year of university study. Hitherto at Bombay the student who is not a mathematical specialist has looked on mathematics as a fence that he must climb as best he can and then forget about, as a mere obstacle without connexion with his future life. Prof. Maclean's aim is to give the student an equipment of mathematics that will be of direct use to him in after life, whatever walk in life he may have chosen. His course would exclude all portions of mathematics that have no direct application and would give a thorough training in the more useful parts of the subject, using as illustrations problems from various walks in life; it may be problems such as arise in the career the student has chosen, it may be problems with a close resemblance to those of his career and appropriate to be dealt with by the same mathematical tools. Prof. Maclean believes that in this way he will replace the deadening teaching of the past by teaching that will make the mind alert, and the mathematical knowledge available on every occasion—he will substitute an effective education for a nugatory one. Although the universities of Great Britain show no comparable development, our schools have, during the present century, gone through the change advocated, by the scrapping of the branches of mathematics that lead nowhere and by aiming at contact with reality in the retained branches. The effect of this change on the pupils has been remarkable. The old style teaching was understood by about five per cent of the pupils, and the idea prevailed that mathematics was a special gift. On the new lines, every pupil understands and readily applies his knowledge to his own problems. We wish all success to Prof. Maclean, who is a pioneer for the university of the reform that has proved of such value in the school.

Calendar of Patent Records.

August 3, 1822.—Machine saws for felling trees have not found great favour, but many have been invented. An early example was the subject of Mouret's patent granted for five years in France on Aug. 3, 1822. The saw is mounted on rollers and is moved to and fro by manually operated gear, being guided in a frame so as to have a slightly circular motion. The frame itself is also on rollers, and is caused to advance slowly towards the tree with each cut of the saw by means of weights and rope gearing.

August 3, 1832.—A 'bachelor' button which could be attached to the garment without sewing—a type that became very popular during the War—was patented by John Christopher of London on Aug. 3, 1832.

August 4, 1877.—The gas engine was established on a firm basis, and for the first time became a serious competitor of the steam engine as a prime mover, when Nikolaus Otto introduced the four-stroke engine which he patented in Germany on Aug. 4, 1877. Otto had been working at the problem for more than twenty years, and had already in 1867 achieved partial success with the Otto and Langen engine, but the new engine entirely superseded all others and monopolised the world's markets for many years. The improvement was very largely due to the re-introduction of Barnett's proposal to compress the charge of gas and air before ignition (cf. Calendar of Patent Records, April 18).

August 5, 1551.—An early reference to tin-plate manufacture and what appears to be the first instance of a German patent grant is given by Beck in his "Die Geschichte des Eisens", when he records that on Aug. 5, 1551, King Ferdinand granted to Freiherr Hanns von Ungnad of Steiermark the privilege to erect one or more mills for the manufacture and tinning of sheet-iron and to carry on the trade unhindered for a period of twenty years, "in Bedacht der ansehnlichen, nützlichen, beharrlichen, hocherspriesslichen, Dienste, so er sider Eingang unsrer landesfürstlichen und königlichen Regierung mit ungespartem, seinem Leib und Gut willig und unverdrossenlich bewiesen hat".

August 8, 1777.—The first patent for a milk churn was that granted on Aug. 8, 1777, to John Rastrick of Morpeth, the engineer. The churn is in the form of a barrel, with a central shaft having several sets of 'dashers' and rotated by means of an external handle. A ventilator is fixed upon the barrel.

August 9, 1913.—The possibility of the hydrogenation of coal to oils has been recognised for many years, and a great deal of experimental work has been carried out to arrive at a practicable process, but the problem was not solved until Bergius introduced his method of subjecting bituminous coal to the action of hydrogen at pressures of from 200 to 300 atmospheres and at temperatures of from 300° to 500° C., which he patented in Germany on Aug. 9, 1913. Though the technical difficulties, however, have been overcome, the cost of production remains at present too high to admit of the process being commercially successful in competition with mineral oil production.

August 10, 1874.—One of the pioneers of the modern aerial ropeway system of transportation was the German engineer Adolf Bleichert, who was mainly responsible for the development of the two-rope system in which there is a fixed carrying rope and a separate hauling rope, in contrast to that introduced in Great Britain in which a single endless moving rope to which the carriers are fixed is employed. Bleichert's first patent was granted in Saxony on Aug. 10, 1874.

Societies and Academies.

Paris.

Academy of Sciences, June 24.—**Marcel Brillouin**: Movements of the oceans. The Newtonian potential of the ridge in cylindrical co-ordinates.—**B. Cabrera** and **A. Duperier**: The paramagnetic properties of the rare earths. Details of measurements of the variations of the magnetisation coefficients of sulphates and oxides of the rare earths between 20° C. and 400° C. The Curie-Weiss law applies to some of the rare metals, but not to all.—**F. E. Myard**: The correct control of a motor-car.—**Bertrand Gambier**: Geometrical configuration of right lines or circles.—**S. Finikoff**: The periodic series of Laplace containing a W congruence.—**Pasquale Calapso**: Rectilineal congruences on focal surfaces to which correspond lines of curvature.—**Georges de Rham**: Multiple integrals and *Analysis situs*.—**Maurice Gévrey**: Hypotheses concerning the solution of problems at the limits of the elliptic type.—**J. Delsarte**: A fundamental problem of the theory of vortices.—**R. Wavre**: A desideratum formulated by Tisserand and the theory of planetary figues.—**Marcel Chopin**: High temperature determinations of the specific heat of nitrogen and carbon dioxide. The method used aims at the nearly complete elimination of the corrections in a calorimetric measurement of the specific heats of gases at high temperatures. For nitrogen,

$$C_p = 6{\cdot}82 + 0{\cdot}00058t,$$

and for carbon dioxide,

$$C = 8{\cdot}9 + 0{\cdot}61(t/100)^{0{\cdot}673}.$$

These results are compared with earlier data.—**C. Raveau**: There is no second law (of thermodynamics). Outline of a concrete thermodynamics.—**R. Darbord**: Electrostatic calculations concerning the electric discharge between two spheres.—**Fahir Emir**: Superficial layers and superficial solutions of myristic acid. The thickness of the saturated film of myristic acid is 16 A. This is exactly half the distance found by the X-ray method (Becker and Jancke) for the solid acid, and confirms the hypothesis of Marcelin.—**Pierre Chevenard** and **Albert Portevin**: The phenomena during reheating of hypertempered steels.—**A. Sanfourche**: The oxidisability of silicon and the allotropic modification of Moissan and Siemens. Experiments on the effect of the state of division of silicon on its oxidisability and solubility in hydrofluoric acid. **A. Tian**: The solidification of saccharose. Catalysis by water.—**A. Travers** and **Schnoutka**: The hydrated polycalcium aluminates.—**Ligor Bey** and **M. Faillebin**: A reaction of resorcinol and a new coloured indicator. —**E. Bœdtker** and **R. Kerlor**: The synthesis of a dicymyl,

$$p\,.\,p - CH_3\,.\,C_6H_4 - C(CH_3)_2 - C(CH_3)_2 - C_6H_4(CH_3).$$

—**A. Wahl** and **J. Lobeck**: The naphthisoindigotines. —**Paul Fleury** and **Jean Marque**: The reducing power of the polyalcohols towards alkaline solutions of potassium iodomercurate. The amount of reduced mercury can be utilised under certain well-defined conditions for the quantitative determination of mannitol, inositol, dulcitol, and glycol.—**L. Petitjean**: The acceleration of masses of air in atmospheric movements.—**Jean Lugeon**: A method of determining from a great distance the geographical position and velocity of certain discontinuities or meteorological disturbances by means of the atmospherics they emit. —**G. Nicolas** and **Mlle. Aggéry**: *Cerasus Caroliniana*, a new example of andromonœcia. A new type of bacterial disease.—**Mlle. M. L. Verrier**: The structure of the eyes and the physiology of vision in selachians. The eyes of selachians (*Scyllium, Mustelus, Acanthias, Raja*) are inferior to those of the majority of other fishes.—**Gruvel**: The influence of the piercing of the Suez Canal on the marine fauna of the coasts of Syria. A description of about a dozen species of fish which have passed into the Mediterranean from the Indian Ocean and the Red Sea.—**P. Vignon** and **E. Séguy**: The presence of the raised median nervure in the Diptera.—**G. Mouriquand** and **A. Leulier**: The antirachitic action of certain cholesteric lipoids in *Helix Pomatia*.

Geneva.

Society of Physics and Natural History, June 6.—**E. Rogovine**, **L. Wohlers**, and **P. Wenger**: A micro method for the determination of uric acid. The method, described in detail for practical applications, is based on oxidation by excess of potassium ferricyanide followed by a back titration of the excess of ferricyanide.—**Th. Stephani** and **E. Cherbuliez**: Researches on antituberculous chemotherapy (copper and the rare earths). The use of the copper and didymium derivatives of di-iodosalicylic aldehyde and of copper benzoate in solution in oil (they are insoluble in water) has given very encouraging results in the treatment of tuberculosis of the guinea-pig and also in man. These substances are innocuous and their cost is small.—**E. Briner** and **R. Wunenburger**: The ozonation of acetylene. The ozonation of this hydrocarbon with a triple bond has given rise to glyoxal, that is to say, to a substance containing the same number of carbon atoms as the hydrocarbon submitted to ozonation. On account of its great instability, the ozonide of acetylene has not been prepared in the pure state.—**Basile Luyet**: Sensitivity to the ultra-violet in *Mucor* as a function of age. Experiments have been made on *Mucor hiemalis*. By irradiating cultures of ages from 1 to 38 hours, it has been found that up to the age of 22 hours the fatal dose is 10 to 20 sec. and that it changes suddenly to 20 min. when the sporangia have been formed.—**F. Chodat**: The genetics of strawberries. Heterosis. Crossing the Dufour and Moutot varieties has given a very vigorous hybrid. The proportion of large plants was 62 per cent for the hybrid against 4·5 per cent in the Moutot descendants and 15 per cent in the Dufour descendants.

Washington, D.C.

National Academy of Sciences (*Proc.*, Vol. 15, No. 3, Mar. 15).—**Otto Struve**: The longitude of the galactic centre as derived from the intensities of detached calcium lines (see Nature, May 11, p. 737).—**Milton L. Humason**: The large radial velocity of N.G.C. 7619 (see Nature, May 25, p. 811).—**Edwin Hubble**: A relation between distance and radial velocity among extragalactic nebulæ (see Nature, May 25, p. 811).—**Harlow Shapley**: Studies of the galactic centre. (4) On the transparency of the galactic star clouds (see Nature, May 11, p. 737).—**Selig Hecht** and **Ernst Wolf**: The visual acuity of the bee and its relation to illumination. Visual acuity was measured by the determination of the minimum illumination required to produce response to movement of patterns consisting of equal black and white bars. It varies with illumination much as does the human eye, being poor at low illuminations, and increasing with increased illumination, at first rapidly and then slowly, to a maximum. The maximum for both is between 50 and 100 millilamberts, but the human eye can resolve the environment about a hundred times better than the bee's eye. Bees can resolve the environment much more accurately vertically than horizontally. The results are in accord with anatomical findings.—

C. F. Roos: Some problems of business forecasting. Given the necessary supply functions, cost of production functions, etc., available to most business undertakings, it is possible to compute useful figures referring to replacement and enlargement of plant.—Victor K. La Mer and J. W. Temple: The autoxidation of hydroquinone catalysed by manganous salts in acid solutions: a reaction whose velocity is proportional to the driving force.—George B. Kistiakowsky: The temperature coefficients of some photochemical reactions. The rates of reaction of stoichiometric mixtures of hydrogen and oxygen and of carbon monoxide and oxygen have been investigated; the temperature coefficients increase with rising temperature.—M. H. Stone: Linear transformations in Hilbert space. (1) Geometrical aspects. Transformations in complex space which may be applicable to the formulation of the quantum theory.—Neal H. McCoy: On commutation rules in the algebra of quantum mechanics.—H. S. Vandiver: Some theorems concerning properly irregular cyclotomic fields.—Gilbert N. Lewis and Joseph E. Mayer: The thermodynamics of gases which show degeneracy (*Entartung*). A mathematical extension, to all types of molecules, of the work of Bose on photons and of Einstein on monatomic molecules.—Albert W. Hull and Irving Langmuir: Control of an arc discharge by means of a grid (see NATURE, May 18, p. 776).—Joseph Kaplan: The heat of dissociation of nitrogen. The value found from a consideration of the energy of the nitrogen molecule in the D-level is about 9 volts.—Katharine B. Blodgett: Exponential yield of positive ions in argon.—F. Rasetti: On the Raman effect in diatomic gases. Observations on nitrogen, oxygen, and carbon monoxide give results in good agreement with theory.—Carl Barus: Adiabatic expansion in case of vanishing increment (2).—Edwin H. Hall: On electrons that are 'pulled out' from metals. The 'free' and 'associated' electrons of the author's dual theory of metallic conduction are renamed 'thermions' and 'valence electrons'. A discussion of Millikan and Eyring's experimental results on the basis of this theory. The evidence indicates that the thermions are very few compared with the number of atoms (1 to 10^5 or 10^6). Valence electron conduction is effected by intermittent trains of electrons.—Carl E. Howe: A preliminary report on the measurement of the $K\alpha$ line of carbon. Measurements were made by reflection at grazing incidence from a ruled grating in a vacuum spectrograph. The unweighted mean was $44 \cdot 60 \pm 0 \cdot 04$ A.—F. Zwicky: On the imperfections of crystals. The differences between the theoretical and observed breaking strength of crystals has led to a theoretical examination of suggested microscopical cracks in crystals. The phenomenon may be related to cold-hardening and similar effects.—Leonard J. Neuman: The mechanism of spark discharge. In argon at low pressures with nickel grid and sodium-coated electrodes, the liberation of electrons from the cathode by bombardment with swift positive ions is the predominating mechanism; with increasing pressure, generation of electrons in the gas by collisions between swift positive ions and neutral molecules becomes more important.—John W. Gowen: The cell division at which crossing-over takes place. It occurs in *Drosophila* in the chromosomes as they prepare for the first maturation division.—George H. Shull: An unexpected association of factors belonging to three linkage groups in *Œnothera* and its explanation.—George D. Snell: An inherent defect in the theory that growth rate is controlled by an autocatalytic process. The increasing volume of the growing organism invalidates the usual mass action equation applied to growth processes. Appropriate equations are derived.—Robert Emerson: Chlorophyll content and rate of photosynthesis. The chlorophyll content of *Chlorella vulgaris* can be controlled by culture in a medium containing appropriate salts, glucose, and less iron than is normally used. At high light intensities, photosynthesis is a function of chlorophyll content. The curves for rate of photosynthesis as a function of temperature at different chlorophyll contents are similar in form.—Morgan Upton: Functional disturbances of hearing in guinea-pigs after long exposure to an intense tone. There is first an increase of sensitivity to the exposure frequency and then desensitisation to all intensities of it but no general change in the auditory mechanism. This is evidence for a 'resonance' theory of hearing.—Thomas Wayland Vaughan: Studies of orbitoidal Foraminifera: the subgenus *Polylepidina* of *Lepidocyclina* and *Orbitocyclina*, a new genus.

Official Publications Received.

British.

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 67, No. 391, July. Pp. 813-936+xxxiv. (London: E. and F. N. Spon, Ltd.) 10*s*. 6*d*.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1185 (M. 58): The Strength of Tubular Struts. By Prof. Andrew Robertson. (E.F. 199.) Pp. 44. 2*s*. 6*d*. net. No. 1231 (Ae. 382): The Skin Friction on a Circular Cylinder. By A. Fage. (T. 2739.) Pp. 9+3 plates. 9*d*. net. (London: H.M. Stationery Office.)

Annual Report of the Auckland Institute and Museum for 1928–29, adopted at the Annual General Meeting held on 29th May 1929. Pp. 42+2 plates. (Auckland, N.Z.)

Catalogue.

Ancient Geography: a Catalogue of Atlases and Maps of all Parts of the World from XV Century to Present Day. (New Series, No. 3.) Pp. 144+5 plates. (London: Francis Edwards, Ltd.)

Diary of Societies.

SATURDAY, August 10.

Mining Institute of Scotland (at Glasgow).

CONGRESSES.

August 4 to 9.

Geneva Institute of International Relations.

Monday, Aug. 5, at 10 A.M.—K. Zilliacus: The Structure and Working of the League of Nations.
At 8.30.—E. J. Phelan: The Future of the International Labour Organisation.

Tuesday, Aug. 6, at 10 A.M.—Norman Angell: The Economic Causes of War.
At 8.30.—Henri Rolin: The Peaceful Settlement of all Disputes.

Wednesday, Aug. 7, at 10 A.M.—Prof. J. L. Brierly: The Contribution of Law to Peace.
At 5.30.—H. S. Grimshaw: The Problems of Native Labour.
At 8.30.—The Unreadiness of Public Opinion.

Thursday, Aug. 8, at 10 A.M.—Arnold Forster: The Freedom of the Seas and the Outlawry of War.
At 3.—W. T. Layton: Reparations and Debts.
At 5.30.—G. A. Johnston: Industrial Relations.

Friday, Aug. 9, at 10 A.M.—A. E. Zimmern: The Preparation of Public Opinion.
At 3.—Prof. S. de Madariaga: The Monroe Doctrine and the League of Nations.
At 5.30.—Prof. C. K. Webster: The Far East.

August 9 to 12.

Apis Club International Conference (at Berlin).

Friday, Aug. 9, at 9 A.M. (at Institut für Bienenkunde, Berlin-Dahlem).

Saturday, Aug. 10, at 8 A.M.—Excursion by car round Berlin, with inspection of apicultural objects of interest in the museums, and of the air-port.

Sunday, Aug. 11, at 10 A.M.

Monday, Aug. 12, at 9 A.M.—By car to Pichelsdorf; thence by steamer, visiting the bee-farm and mating-station of the Institut.

Papers will be read during the conference on the natural history, physiology, and pathology of *Apis mellifera*, L., the investigation of honey and wax, plant pollination, history of apiculture, etc., as well as with practical beekeeping topics. There will also be communications by Prof. Fiche on recent methods of honey analysis, and by Dr. Krotschy on medical investigations on bee-poison.