NATURE

SATURDAY, JUNE 24, 1922.

CONTENTS.

	PAGE
The Influence of Science	801
Medieval Cartography. By W. H. Barker	803
Pasteur's Scientific Career. By S. P. B.	805
History of Organic Chemistry. By J. B. C.	806
Early British Botanists. By B. D. J.	806
Functions of Industrial Research. By R. S. H.	807
Our Bookshelf	808
Letters to the Editor:—	
On the Continuous Radiation found in some Celestial Spectra beyond the Limit of the Balmer Series of Hydrogen.—W. H. Wright	810
Discoveries in Tropical Medicine.—Sir E. Ray Lankester, K.C.B., F.R.S.	812
The Isotopes of Tin.—Dr. F. W. Aston, F.R.S.	813
The Spiracular Muscles of Hymenoptera Aculeata.—Annie D. Betts	813
Symbiotic Bacteria and Phosphorescence.—F. A. Potts	814
Stone Preservation.—Dr. A. P. Laurie	814
Oscillation Circuits for the Determination of Dielectric Constants at Radio Frequencies. (*With diagram.*)—P. A. Cooper	814
A Century of Astronomy. By Prof. A. S. Eddington, F.R.S.	815
X-Ray Studies on the Crystal Structure of Iron and Steel. (*Illustrated.*) By H. C. H. C.	817
Wireless Telephone Receiving Sets	819
Obituary:—	
Prof. A. Laveran, For. Mem., R.S. By A. B.	819
Dr. J. René Benoît. By J. E. S.	820
John Wanklyn McConnel	821
F. W. Sanderson	822
Current Topics and Events	822
Our Astronomical Column	824
Research Items	825
Carnegie Institution of Washington	826
Melanesian Witchcraft	827
New Buildings of University College, Nottingham	827
Rothamsted Experimental Station	828
University and Educational Intelligence	828
Calendar of Industrial Pioneers	829
Societies and Academies	830
Official Publications Received	832
Diary of Societies	832

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters should be addressed to the Publishers.
Editorial communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

NO. 2747, VOL. 109]

The Influence of Science.

THE great advances of science in recent times, and the countless applications of its discoveries, have led many people to regard it as concerned only with purely materialistic things, and to forget its moral and intellectual influence. In their view science is associated with the transformation of beautiful countrysides into the slums of industrial centres, with high-explosive shells and clouds of poison gas to supersede the slings and arrows of earlier days. Nothing could be further from the truth, however, than to suppose that these debasing aspects of modern civilisation are necessary consequences of scientific progress. They are due to human greed and the same spirit of jealousy as that which led Cain to rise up and slay his brother. They are consequences of the fact that civilised man is little removed from a savage when his primitive instincts are concerned; and if he can acquire the strength of a giant from science he is prepared to use the power for his own purposes.

Science as such has nothing to do with the conquests of nations or peoples, or the upholding of dynasties, or industrial exploration. The end of all scientific investigation is the discovery of truth in the realm of animate and inanimate Nature, including man, his instincts and impulses and his social organisation. As expressed in the motto of the Royal Society, science is not bound by the words of any master, and it therefore holds itself free to examine critically any principle or doctrine in which natural facts or phenomena are involved. It represents knowledge as opposed to ignorance, light as against darkness, the beauty of truth and the truth of beauty. It seeks justification not through faith but by works, and its allegiance is to truth alone so far as human intelligence can comprehend it at any epoch. To this spirit is due not only advances by which forces of Nature are used and controlled for the benefit of man, but also intellectual expansion and the elevation of the moral sense through the understanding of the significance of natural law in determining natural events.

The influence of science upon material progress and human comfort is understood much more commonly than that of its effect upon the human mind. It is difficult for people of these times to realise the liberation of life and intellect brought about by the works of Copernicus, Galileo, Vesalius, and other pioneers of scientific learning. The very foundations of belief were shaken when the earth was removed from the position in which presumptuous man had placed it, and shown to be a minor member of a group of planets revolving round a sun which was itself only one of innumerable similar orbs in stellar space. For

holding this view, and also for describing spots observed by him on the sun, Galileo was denounced to the Holy Office in 1615, and when before the Inquisition in 1633 his condemnation by the Cardinals of the Holy Roman Church contained the words: "The proposition that the sun is the centre of the world and immovable from its place is absurd, philosophically false, and formally heretical, because it is expressly contrary to Holy Scripture. The proposition that the earth is not the centre of the world, nor immovable, but that it moves, and also with a diurnal motion, is also absurd, philosophically false, and theologically considered, at least erroneous in faith." Wherefore Galileo was imprisoned, ordered for three years to recite once a week the seven penitential Psalms, and made to swear, "I abjure, curse, and detest the said errors and heresies, and generally every other error and sect contrary to the Holy Church; and I swear that I will nevermore in future say or assert anything verbally, or in writing, which may give rise to a similar suspicion of me."

As one of his biographers has said, Galileo, like Peter, surrounded by a crowd of enemies, denied his Master; yet for more than fifty years he was the knight-militant of science, a rebel against the dead hand of tradition and authority, whether of priest or philosopher, when it was used to prevent the growth of knowledge through the evidence of the senses. For more than a thousand years the mind of man had been constrained by monkish theology and Aristotelian philosophy, and all attempts at freedom of thought were rigidly suppressed. The Holy Scriptures, together with the works of early Christian fathers and some Greek philosophers, were believed to contain the truth about all things—visible or invisible—and men used them as the final court of appeal as to what was true in Nature. When Galileo discovered the four satellites of Jupiter by means of his small telescope, the philosophers of his time would not look through the instrument to see the objects for themselves, for, as Galileo remarked, "These people believe there is no truth to seek in Nature, but only in the comparison of texts." They held that the moon was perfectly spherical and absolutely smooth, and it was in vain that Galileo appealed to the evidence of observation to the contrary: the sun was supposed to be immaculate, therefore Galileo's observations of spots upon it were illusions: two unequal masses dropped from the leaning tower of Pisa reached the base together, "Yet," he says, "the Aristotelians, who with their own eyes saw the unequal weights strike the ground at the same instant, ascribed the effect to some unknown cause, and preferred the decision of their master to that of Nature herself."

The principles of self-determination and self-government have been responsible since the Armistice for many political changes, but these are as nothing compared with the social effects of the independence of scientific inquiry typified by Galileo's life and work. The right of a man to think for himself was established, and personal observation and experiment took the place of metaphysical and philosophic speculation and dogmatic assertion. The freedom of thought and action now possessed by progressive peoples are direct consequences of the work of Galileo and other scientific pioneers.

Consider the tremendous revolution involved in the substitution of permanent natural law for the conception of a world in which all events were believed to be reflections of the moods of a benign or angry God. The doctrine of daily supernatural intervention meant that men regarded themselves merely as clay in the hands of the potter and did nothing to shape their own natural destiny. They accepted disease as an act of God instead of cleansing their houses, and believed that all the qualities they possessed, as well as the actions they took, were determined by the positions of the planets and other celestial bodies. Every organ of the human body was supposed to have its counterpart in the sky; and when Vesalius by his dissections and Copernicus by his doctrine showed that there was no relationship between the human frame and the order of the universe, the ponderous superstructure of faith and pseudo-philosophy which had been built upon it fell to pieces, and a new mental world had to be reconstructed. Instead of a few thousand stars supposed to exist to influence the earth and affect the purposes of man, we now know there are millions which can never be seen without telescopic aid and millions more that are not visible with any optical means. The universe has been increased ten-thousandfold, and the puerile ideas of three centuries ago have given place to a far nobler conception of the majesty of the universe and the power of the Creator.

The intellectual expansion thus brought about, together with the sense of justice which resulted from the knowledge of the existence and permanence of law in Nature, profoundly influenced human thought and resulted in social changes which had the greatest civilising effects. This end was not attained, however, without sacrifice. The medieval lover of science was obliged to pursue his researches in secret cells and hide his discoveries from all eyes. He was for ever haunted by the maddening vision of the stake. Human nature does not encourage ideas which shatter cherished convictions; and it is usually suspicious of all new knowledge. To probe into truth or try to lift the veil and expose eternal verities was, therefore, regarded as sacrilege by guardians of traditional faith or learning. Our first parents lost Eden because they partook of

the tree of knowledge; and it was by like association with the devil that Faust secured the knowledge of renewed youth.

This view of science is not altogether unknown even in our own times. There are still heresy hunters who, with their own literal interpretation of Biblical writ, seek to extinguish the light of new knowledge. If Darwin and Huxley had lived in the time of Bruno and Galileo they would have suffered like penalties for presenting evidence of man's relationship to other primates. Leaders of the Church now accept the principles of organic evolution, just as there is now an observatory at the Vatican, and active astronomical observers among the brothers and fathers of Catholic priesthood. The truth is great and prevails in the end. Scientific inquiry never ceases and must continually be a disturbing influence. It is applied to all occurrences in which natural facts and phenomena are concerned, and believes nothing without evidence. Science does not set out to establish or depose any particular articles of faith, but to examine critically whatever comes before it in the natural world and to testify faithfully to what is seen. The knowledge thus gained may at times appear to undermine the foundations of faith, but in the course of years there is a readjustment of mental values, in which old errors are lost. From a scientific point of view, a distinction must be made between religion as an essential human instinct and outworn theological creeds or formulæ which assert that belief in unnatural occurrences is necessary for spiritual salvation. It is because of the influence of science that the Dean of St. Paul's can now say publicly, "the materialistic view of the resurrection has never been universally held; it was denied by Origen, the ablest theologian of the third century, and no intelligent man believes it now."

Examination of evidence in the critical spirit of scientific inquiry is responsible for the change of attitude towards scriptural records of natural events and phenomena represented in this remark of Dean Inge's. Only those who remember the contumely to which Huxley and Tyndall were exposed because of their extension of scientific reason to theological fields can appreciate the revolutionary change which has occurred since their day and generation. The great controversy between the evolutionists and the creationists in the second half of the nineteenth century corresponded closely with that between the Copernicans and Ptolemaists three hundred years earlier, and in each case belief had to give place eventually to ascertained knowledge. It is the duty of science to continue to fight ignorance and all that is implied by it, to be intolerant of all that is false, to make honest doubt a virtue, and condemn credulity as an intellectual crime. We may not be more superstitious than our fathers, but the vestiges of primitive man still remain in our natures ready to throw up offshoots under emotional stimulation. Much that passes under the name of spiritualism comes within this category, and when the manifestations enter the domain of matter and energy, the methods by which they must be investigated are those of physical science—critical observation, dispassionate examination of results, and crucial test of conclusions. These are the methods by which science has become synonymous with accurate knowledge, and has led the world into the way of truth. In the present epoch of social and spiritual reconstruction, the active ministry of scientific truth is again needed to help the world to adjust itself to the new conditions which knowledge has created.

Medieval Cartography.

Legendary Islands of the Atlantic: A Study in Medieval Geography. By William H. Babcock. (American Geographical Society, Research Series, No. 8.) Pp. v+196. (New York: American Geographical Society, 1922.) n.p.

THE migration of man across the ocean has differed considerably from his movement overland. On one hand, he has succeeded in taming animals by way of improving on the exertion of his own muscular effort, and in consequence he has perforce followed natural routes determined in part by a minimum of physical obstacles and a maximum or, at any rate, sufficient food supply for his animals, Moreover, through carelessness or accident he has dropped implements or weapons which give clues to the routes he followed and the sites of his settlements. On the other hand, the passage of the sea has called forth a different effort in the art of shipbuilding and seamanship, and the hungry ocean has swallowed up the remains of many a goodly ship which, through storm or adventure, passed over the trackless deep. Moreover, the wanderings of a people leave deeper marks on the historical record than the deeds of the men to whose individual prowess the opening of the sea-ways was largely due.

The author of "Legendary Islands of the Atlantic" attempts to sift legend from fact and vision from observation, in islands depicted on medieval maps of the North Atlantic, and to obtain thereby the links in the story of Atlantic exploration. Yarns of the western sea no doubt became the stock-in-trade of mariners and enabled cartographers to fill with shoals and islands the blank of the Sea of Darkness. Though more recent observations have shown that many of

the islands do not exist as charted, the author establishes his reason for regarding them as indicative of early ocean voyages.

Europe and the North Atlantic are complementary, perhaps even supplementary, in their influence on the migration of peoples westward to populate a New World with the race stocks of the Old. Both the northern and southern seas emphasising the peninsular character of Europe are themselves the nurseries of boatmen, and with their special archipelagoes have invited and facilitated, from before the dim dawn of history, the maritime adventures which in succeeding ages led men to pass beyond the limits of the mainland to the oceanic islands, ever gazing towards the setting sun and wondering on the hidden mystery of the western horizon.

The physical form and phenomena of the ocean have not changed essentially since the dawn of history. Roughly circular in shape, the northern arc from the seas of north-west Europe to the entrance of the St. Lawrence is marked out by the island stations of the Shetlands, Faroes, Iceland, Greenland, Labrador, and Newfoundland. The southern arc swinging between the western coast of Africa with the island groups of Madeira, the Canaries and Cape Verde, and the eastern trend of South America with Trinidad and the Antilles, is emphasised in the intervening regions by prevailing Trades and equatorial currents.

It is therefore not surprising that reasonably accurate knowledge is shown of the various island groups that form the thresholds of the North Atlantic from the Mediterranean and the Northern Seas respectively. But within the central region of southern weed and northern storm and fog, and towards the west, casual, and it may be involuntary, voyages might be made. Here deceptive phenomena, begotten in part by unusual scenes and in part by fear and presentiment, or by stress and hunger, caused mythical and legendary islands to appear, with perhaps Rokel Rock or the Azores as nuclei, and produced enigmas for solution by later cartographical students.

We need not stay with Babcock's treatment of Atlantis. Few will disagree with his finding that every solution of the problem must be conjectural, and many will urge the same conclusions against the other islands upon which the author bases his arguments for the discovery of America in pre-Columbian times. Legendary islands, such as Brazil and Antillia, are not always located in the same regions of the Atlantic, but, like archæological remains, lie scattered over the map. It would have been extremely valuable if the author had plotted as accurately as possible on a modern map the various sites of some of these islands.

On many maps, of which the Catalan map of 1375 is a type, Brazil is shown as an annular island with numerous islets within. This, it is contended, represents the pear-shaped Gulf of St. Lawrence with its containing islands. Reference is made to the Sylvanus map of 1511 in support of this contention.

"Nobody doubts that it [the Sylvanus map] illustrates the St. Lawrence Gulf region, though there has been much speculation as to what unknown explorer has had his discoveries commemorated here, thirteen years before the first voyage of Cartier. Why should not a like episode of discovery and imperfect record have happened at a still earlier date?" (p. 65).

Antillia and its related islands as they appear on the Beccario Map (1435), the Pareto Map (1455), and others, are considered by Babcock to be the islands hitherto regarded as the special discovery of Columbus and his companions.

"There are two names still in common use for American regions which long ante-date Columbus, and most likely commemorate achievements of earlier explorers. They are Brazil and the Antilles. The former is earlier on the maps and records; but the case for Antillia as an American pre-Columbian map item is in some respects less complex and more obvious" (p. 144). "Surely some mariner had visited Cuba and some of its neighbours before 1435";
and again:

"We may be reasonably confident that Antillia of 1435 was really, as now, the Queen of the Antilles."

There is little record but the maps, and it is extremely difficult to determine whether these cartographical approximations are intelligent anticipations or based on experience. The Laurentian portolan (1351) with its broad sweep of Guinea and the distinctly non-Ptolemaic conception of South Africa, Schöner's globe (1515) with its Atlantic-Pacific passage, may with Brazil and Antillia fall into that voluminous class of verbal and cartographical descriptions from Homer until modern times which suggest that all recorded voyages and journeys are the outcome of innumerable "feelers," the experiences of the many upon which the triumphal entry of the discoverer is made.

The contention that these fourteenth- and fifteenth-century maps record adventures and voyages in western waters reopens in a new form the question of the trans-Atlantic voyages of Columbus and of Cabot, and it is to be regretted that Babcock merely mentions in passing the researches of Vignaud, and omits altogether the contention of Biggar for the second Cabot voyage.

The study of Greenland on the maps is somewhat inadequately dealt with, and students of these early maps would have welcomed a chapter on the relations and adjustment of the names of areas carrying such titles as Norbergia, Engronelant, Labrador, Bacallaos, etc., as shown on the Pilestrina map (1503–5) and others of a slightly later date.

The author deals with many other legendary islands, such as St. Brendan, Mayda, and Buss, the last two surviving until the opening of the nineteenth century, while the chapter on Markland reviews briefly the alleged discoveries of the Norse.

The book contains an excellent selection of reproductions and is welcomed as a contribution to the study of early cartographical efforts and their value in unfolding the story of geographical discovery.

W. H. BARKER.

Pasteur's Scientific Career.

Pasteur and his Work. By L. Descour. Translated from the French by A. F. and Dr. B. H. Wedd. Pp. 256. (London: T. Fisher Unwin, Ltd., 1922.) 15*s.* net.

BY the translation of this work Drs. A. F. and B. H. Wedd have made available to the English-speaking public one of the most complete accounts of the scientific career of Pasteur. Even the lay mind will be able to follow step by step and appreciate the series of brilliant researches which gave birth to the science of microbiology, culminating in that triumph of applied science—anti-rabies inoculation. Perhaps the very detail in virtue of which this book will appeal to those actively interested in science, will act as a deterrent to the general reading public. The first two chapters in particular, dealing with Pasteur's work on crystallography, require a degree of concentration likely to scare away all but the more determined. However, in a footnote we are told that these two chapters may be omitted without detracting in any way from the value of what is to follow. This is in fact correct, for these researches, although of great interest and of fundamental importance, serve mainly to show us that Pasteur, despite his unpromising years at school and the lycée, was possessed of a scientific mind which even at this early age bore the stamp of genius. They do not form a consecutive part of the brilliant investigations which follow and they can well be passed over.

The landmarks in the scientific career of this great man are familiar to most, and it would be out of place here to deal with them in any detail. Suffice it to say that in the first ten chapters or so we are given an account of his researches on fermentation, the question of spontaneous generation, putrefaction, aerobiosis and anaerobiosis. Here also an account is given of his study of diseases of wine and beer. Although perhaps less dazzling than his subsequent researches in the realms of animal pathology, this early work of Pasteur is the more interesting in virtue of its fundamental value. These are the foundations on which has been erected the edifice of microbiology. Without the knowledge gained by this work he would not have been able successfully to attack those future problems the solution of which obtained for him undying fame.

The remaining two-thirds of the book are concerned chiefly with his investigation of disease; diseases of silkworms, anthrax, furunculosis and puerperal septicæmia, chicken cholera, swine erysipelas, and finally rabies. Every one of these chapters is enthralling, but perhaps it is the study of chicken cholera which is of the greatest interest. Although his discoveries in this case did not lead to any practical application of great import, it was during these studies that a chance observation paved the way to protective inoculations. He had isolated the causal organism of this disease and shown that it was pathogenic for hens. Returning to his laboratory after vacation and wishing to continue his studies, he inoculated some hens with his cultures. To his surprise the birds remained perfectly well; his cultures had become avirulent. A fresh strain was isolated, and what was still more surprising, the hens which had received the avirulent culture were found now to be resistant to the new strain which control experiments showed to be virulent. Here was the starting-point of his work on virus vaccine and protective inoculation.

It is perhaps unavoidable that in a book of this nature one reads little of the man himself. However, one does catch a glimpse here and there. A man of great single-mindedness and power of concentration, he had a love of honesty which served him well throughout his work. His mind was of the well-ordered, clear, logical type which has characterised French science. These qualities bred in him a positive contempt for anything slipshod or ill-reasoned in experimental work, and when occasion called for criticism of work of this nature, Pasteur did so with a force and vehemence which showed little consideration for personal feelings. It was, however, nothing mean or little in his make-up which led him to do this, but merely anger at what he considered unpardonable blunders. He was not of those who suffer fools gladly. One is given an insight also into Pasteur's attitude to religion. Despite his success in the probing of nature's secrets, he retained unshaken to the end the faith given him by his parents. The following words taken from his speech on the occasion of his reception at the Académie Française reveal this side of Pasteur's character: "The greatness of human action is measured by the motives which inspire them. Happy are those who carry with them a God, an ideal of beauty which they obey: the ideal of art, the ideal of science, the ideal of country, the Gospel idea of virtue. Those are the living sources of

great thoughts and great actions. All are lit by the reflections of the infinite."

The translators are to be congratulated. Their task was by no means easy, but they have accomplished it in an eminently successful manner.

S. P. B.

History of Organic Chemistry.

Geschichte der organischen Chemie. Von Carl Graebe. Erster Band. Pp. x+406. (Berlin: Julius Springer, 1920.) England, 84 m.; Germany, 28 m.

THE history of a science has often been compared to the erection stone by stone of some great edifice; but it appears to the writer that the metaphor is ill chosen inasmuch as the complete building is already planned when the foundation is laid. A closer analogy is that of a jig-saw puzzle in which the separate, irregular bits are slowly fitted into their several places whilst the ultimate result remains hidden until the whole is complete.

This is certainly true of organic chemistry, and although the general plan seems to be taking shape in a marvellous fashion, who would declare the puzzle to be near completion or attempt to forecast its final development? Looking now at the ordered arrangement of its several parts it is difficult for some of us to realise the difficulties of the early investigators, who had to make a selection from an ever-increasing mass of disconnected observations and laboriously to piece them together. It is perhaps one of the remarkable facts in the history of organic chemistry that from the publication in 1832 of the classical research of Liebig and Wöhler on "the radical of benzoic acid," which Berzelius greeted as proclaiming the dawn of a new day, few revolutionary changes in fundamental principles have occurred to retard the steady growth of the science. Even the electrochemical theory, which engaged Berzelius and his opponents of the French and German laboratories in a somewhat embittered controversy, only served to stimulate research and add new facts to the science.

It is interesting to trace the many new theories which owe their inception to the study of organic chemistry. The theory of valency was developed by Frankland in studying the organo-metallic compounds; that of catalysis was formulated by Berzelius in explanation of the ether process. Isomerism was conceived by Faraday in examining the compressed hydrocarbon gases of the Portable Gas Co. The relation of vapour density to molecular weight elucidated by Gerhardt and Cannizzaro, the theory of atomic linking advanced by Kekulé and Couper; of stereoisomerism by Pasteur, van't Hoff and Le Bel, and in recent years of dynamic isomerism, enzyme action, steric hindrance and many other phenomena, which have helped to throw new light on molecular mechanics and structure, all originated with this branch of the science.

In the volume before us, which is printed in clear type, Prof. Graebe describes in considerable detail and in simple and attractive language the history of organic chemistry from 1770 to the 'eighties of last century, and tells us that arrangements have already been completed with Dr. Hoesch to carry the story forward in a second volume. In the arrangement the author has recorded the results not only of experimental and theoretical investigations but has attempted to show by quotations from the original sources the manner in which the new ideas were given to the world, while numerous, brief biographies of chemists are introduced as their names happen to occur.

The volume has evidently been prepared with parental thought and care which the author expresses by the word *Vorliebe*, a feeling which can well be understood in one who, during a long and active career, has himself played no insignificant part in the story he relates. We can cordially recommend the book to all chemists who are interested in the history of their science.

J. B. C.

Early British Botanists.

Early British Botanists and Their Gardens, based on Unpublished Writings of Goodyer, Tradescant, and Others. By R. T. Gunther. Pp. viii+417. (Oxford: Printed by the University Press, 1922.) n.p.

JOHN GOODYER, until recently known only as the contributor of rare plants to Dr. Thomas Johnson, the editor of the second edition of Gerard's "Herball" in 1633, and further commemorated by Robert Brown's orchid genus Goodyera, is the central personality in this absorbing volume.

About twelve years ago Canon Vaughan, rector of Droxford, a Hampshire village famous as the retreat of Izaak Walton when he retired from London, printed an article embodying fresh information, which was followed later by a longer notice by Dr. G. C. Druce in the Report of the Botanical Exchange Club for 1916, pp. 523-550, drawn up from papers in the library of Magdalen College, Oxford. Now, thanks to the assiduity of the author of the volume under notice, he, as librarian, has had the scattered notes arranged and bound, and from them has presented a picture of the man, which is a revelation. He is shown

as an active and accurate botanist, a successful cultivator, and generous in imparting his treasures to his friends. For instance, Willem Boel, the Frieslander, gathered seeds in Andalusia for Goodyer, Coys, and Parkinson, which were distributed to friends; again, from one tuber of the Jerusalem artichoke from Franqueville he raised "a peck of rootes wherewith I stored Hampsheire" in 1617.

Upon the death of Johnson, in 1644, Goodyer was unquestionably the foremost botanist in the kingdom, and his life overlapped the first anonymous essay of John Ray, his Cambridge flora, in 1660; but he was dead six years before Ray's "Catalogus" saw the light in 1670.

In addition to his knowledge of plants Goodyer knew enough Greek to translate the two works of Theophrastus, "De plantis" and "De causis plantarum"; of the former we have now an English version by Sir Arthur Hort in the Loeb Library, but the latter has never been printed in our language. Later, he began copying out the Greek text of the "Materia medica" of Dioscorides and to interline it with an English translation.

Nearly half of Mr. Gunther's volume is devoted to "Notes on contemporary botanists, mostly from Goodyer's Books and Papers." We thus become acquainted with his relations with other botanists, several of whom are unfamiliar, while many more are only slightly known to us, and from these pages we gain much. Among these may be mentioned William Coys of Stubbers in Essex; William How, the author of the first British flora and editor of Lobel's last issued work; John Parkinson, the last of the herbalists; the Rev. Walter Stonehouse, and William Browne of Magdalen, to whom his college probably owed the bequest by Goodyer of his books and papers, the foundation of the volume now under discussion.

The limits of this notice forbid any further dwelling on the contents of a volume of the greatest value and a treasure-house to everybody who is interested in British botany.

One unimportant error may be mentioned as occurring on page 84, namely, that of Mattioli's Commentaries on the "Materia medica" of Dioscorides: seventeen editions were said to be published; the actual number was nearly seventy, for Saccardo speaks of sixty at least, and he was not acquainted with all. But we close the volume with feelings of gratitude to the author; his zeal and devotion have added greatly to our appreciation of the Hampshire and Sussex botanist, whose record does so much to redeem the time when he lived from being considered a barren period for the science of botany.

B. D. J.

Functions of Industrial Research.

Research in Industry: The Basis of Economic Progress. By A. P. M. Fleming and J. G. Pearce. (Pitman's Industrial Administration Series.) Pp. xvi+244. (London: Sir I. Pitman and Sons, Ltd., 1922.) 10*s.* 6*d.* net.

THE case for research and education as the best means of assuring progress in industry is most ably demonstrated by Messrs. Fleming and Pearce, who are well known for their association in directing the Research Department of the Metropolitan-Vickers Electrical Co. Ltd., of Manchester. The book covers a very wide field, and should be read by all who are engaged either in scientific work or in industrial administration. The social aspects of the subject are kept well in view and the great importance which the scientific study of the human factor in industry is destined to take in the resettlement of industry is duly recognised, although the work of the Industrial Fatigue Board receives less attention than it deserves.

The various types of research laboratories and methods of research organisation, including the comparatively new co-operative method illustrated in British Research Associations, are dealt with in detail. Considerable space is devoted to the planning, equipment, and staffing of works research laboratories, and the financial aspect is dealt with more fully than in any previous publication.

An interesting chapter deals with the collection and distribution of information for research and industrial purposes. The problem of making an intelligence department of a works library efficiently productive might with advantage have been elaborated further, in view of the authors' special experience. Although there is need for greater co-ordination among the many agencies for collecting and abstracting scientific information, the necessity for its distribution to and absorption by the industries is infinitely more important. The British scientific worker is, perhaps, less thorough than his fellow-workers abroad in surveying the field of previous work on the problem he is investigating, and, indeed, excessive zeal in this direction may tend to limit originality and initiative. In industry, however, numerous examples of wasted opportunity and moribund conditions could be quoted which are due largely to ignorance of similar industrial practice in other countries. The awakening of inquisitiveness as to foreign methods of manufacture might prove the starting-point for a still greater receptivity among employers, and from this the step to a conviction of the desirability of actual original research is relatively small, as American experience has abundantly shown. Europe, in fact, in competing

for world markets, has more to fear from American receptiveness to new ideas than from any other single factor.

In this country the support of the Department of Scientific and Industrial Research in the foundation of Research Associations is already more than justified by its success in bringing together all types of employer, engaged in particular industries. Contact with outside scientific workers and their more enlightened competitors will inevitably result in a greater appreciation of the advantages of science by the majority of industrial leaders.

Finally, the authors deserve credit for their just appreciation of the special requirements of scientific workers engaged in pioneer research, and particularly of the ways in which such men may be encouraged to prepare for research as a vocation and to follow it without being repressed by works routine. The necessity for supporting pure science work for its paramount object of increasing the sum of human knowledge is strongly emphasised. The book is admirably produced and includes a 16-page bibliography, which should be of service to all interested in the subject.

R. S. H.

Our Bookshelf.

Physico-Chemical Problems relating to the Soil: a General Discussion held by the Faraday Society. (Reprinted from the Transactions of the Faraday Society, Vol. 17, Part 2, February.) Pp. iii+217-368. (London: Faraday Society, 1922.) 10*s.* 6*d.* net.

THE Faraday Society is to be congratulated on the issue of this volume, reprinted from its Transactions; soil investigators in this country now have, in accessible form, a study of one important branch of work from a number of aspects. The volume contains the subject-matter of the general discussion held by the Faraday Society in 1921 on "Physico-Chemical Problems relating to the Soil." There are sixteen papers grouped in the following five sections: (1) Introduction and General Papers, (2) Soil Moisture, (3) Organic Constituents of the Soil, (4) Adsorption Phenomena, and (5) Colloidal Phenomena. The student of soils will find much of interest, not only in the papers themselves but also in the *verbatim* report of the discussion which followed.

Recent work on soils from the standpoint of physical-chemistry has followed two or three main lines, which are discussed in an introductory paper by Sir E. J. Russell. The examination of the soil solution and its relation to soils on one hand and plants on the other, has been much stimulated by the method of the freezing-point depression. American investigators have done much in this direction, and the paper by Prof. Hoagland (California) gives an interesting account of the work to date. Certain assumptions are made in applying this method to the soil solution, and the deductions which follow are discussed by B. A. Keen (Rothamsted) in the course of a paper on soil moisture. Prof. Shull (Kentucky) reviews various theories on the intake of soil solution through the osmotically active membranes of the root hairs.

The part played by colloidal material in soil naturally forms the subject of several papers. N. M. Comber (Leeds) discusses the flocculation of silt and clay on the assumption that the latter is protected by a siliceous emulsoid, and C. G. T. Morison (Oxford) reviews the theories of pan formation. Dr. Mellor (Stoke-on-Trent) deals with the plasticity of clays used in the ceramic industry. The organic matter in soil is of obvious importance in any discussion of colloidal properties. A general review is given by H. J. Page (Rothamsted), and Prof. Odén (Upsala) describes his own important investigations on humus, which have proved the existence of humic acid and shown that the hypothesis of selective adsorption is not a complete explanation of soil acidity. With regard to soil acidity itself there is one review paper by E. M. Crowther (Rothamsted), while Dr. Salisbury (London) discusses the ecological aspects.

Besides acidity, many other phenomena shown by soils have been interpreted on the basis of adsorption. E. A. Fisher (Leeds) presents an able critical review of work on absorptive processes in soils, with especial reference to inorganic substances.

Finally, there are some papers dealing with more purely physical questions. Prof. Odén gives a detailed account of his elegant method of mechanical analysis and a note on the hygroscopicity of clay, Dr. Hackett (Dublin) discusses the rate of ascent of liquids in granular media, while G. W. Robinson (Bangor) specifies certain physical properties of soil in relation to survey work.

B. A. K.

A Text-Book of Aeronautical Engineering: The Problem of Flight. By Prof. H. Chatley. Third edition, revised. Pp. xii+150. (London: C. Griffin and Co., Ltd., 1921.) 15*s.* net.

A SECOND edition of Prof. Chatley's book appeared in 1910, and during the war, when interest in aeronautics attained great heights, this book, like many others on the subject, was bought in large numbers, thus necessitating a third edition. Not very much was known about the subject of aeronautics before the war; systematic treatises had not yet appeared, and Prof. Chatley's book achieved a deserved popularity.

Now that a third edition has been issued, claiming to be "revised," the opportunity should have been taken to make the book a more proportioned, authoritative, and modern exposition. There is scarcely room in a text-book for a detailed account of the ornithopter—not because it is *a priori* clear that one should not continue to make attempts at producing machines based on the flapping-wings principle, but because a text-book should contain what is more or less accepted: it should give a safe (not necessarily orthodox) account of the principles used in practice, with some attempt at justification.

A brief introduction on the problem of flight is followed by a useful statement of essential principles. Then comes a chapter on the propeller, treated by

rather rough-and-ready methods. Much of the chapter on the aeroplane is out of date; it is scarcely correct to say that the air-pressure results for plane surfaces can be corrected so as to apply to curved surfaces by slight charges in the constants, and in any case there are plenty of experimental data for giving a correct account of cambered wings. The chapter on the dynamics of aeroplanes is not very full, while a treatment of the parachute by means of differential equations is inserted for little reason, in a book which is not really a mathematical treatise. In addition nearly three of a total of less than 150 pages are occupied with Glaisher's analysis of the motion of the balloon—with the note that it has little practical value! After the chapter on ornithopters we get a short account of dirigibles and the bodies of aeroplanes, etc. There is also a brief account of stability.

Some of the appendices are useful, although the bibliography is disarranged. Foreign names are misspelt, *e.g.* an umlaut on the "a" in Lilienthal. The author has the ability to produce a real text-book on aeronautics, but the present volume is disappointing.

S. BRODETSKY.

Die Pendulations-Theorie. Von Prof. Dr. H. Simroth. Zweite Auflage. Pp. xvi+598. (Berlin: Konrad Grathlein, 1914.) 13.50 marks.

FIRED by a new view of the shifting of the polar axis of the earth the speculative mind of a distinguished zoologist, Simroth, conceived the idea of a relation between earth oscillation and organic development.

The merit of this oscillation theory of organic distribution was its reduction of the rise and spread of organic forms to a single process in relation to recurring secular change. Simroth assumed that the earth forms an oscillation system of a peculiar kind, such that one maximum line of stress runs north and south through Norway, Germany, the line of elevation of the Alps, and across the western Sahara, while the other companion stress line passes through Bering Strait and the Pacific, west of the American coast. Assuming also permanence of the general configuration of the oceans and continents, Simroth then makes his grand assumption, which is that the evolution of genera has recurred along the European line of maximum oscillation (which is therefore the region of creative evolution) in response to secular changes of environment. From this area of distribution those forms that are primitive migrate eastwards or westwards to areas of less disturbance, whilst the progressive forms adapt themselves to the cold of polar uplift or the warmth of equatorial depression. In this way Simroth accounts for the occurrence of allied forms in widely separated parts of the world. Beings are what they are and where they are, as a "function" of the oscillation system.

The new edition of this work does not remove the difficulties of those who refuse to accept Simroth's hypothesis. The new matter consists merely of 33 pages appended to a reprint of the first edition and contains no references to criticisms such as those of Prof. G. C. Bourne (Proc. Zool. Soc. 1911, pp. 802-805) that refer to a fundamental objection—the secondary nature of marine organisms. If Dr. Simroth has not converted his fellow-zoologists, he is not likely to make converts in other biological fields. Granted that we have no simple alternative to his view, yet the assumptions on which it rests are not in accordance with modern geological opinion; and if that is so, biological speculation on such a weak basis is only misplaced ingenuity. The earth as a system of stresses is likely to prove a much more complex theme than the one Simroth vaguely describes, while the relation between maximum stress and biological progress requires far more critical examination than he gives to it.

F. W. G.

Swiss Travel Almanac. Edited by the Swiss Tourist Information Office. Summer Season, 1922. Pp. 112. (Olten, Switzerland: O. Walter, Ltd.; London: Swiss Federal Railways, Regent Street, 1922).

THIS book is a reminder that Switzerland is ready once more to become "the playground of Europe," and it is especially an appeal to English visitors. The numerous signed essays include one by Mr. A. Latt on "English influences on Swiss intellectual life," recalling many pleasant details of *rapprochement* in the seventeenth and eighteenth centuries. Mr. Schaederlin writes finely of the brave hardihood of alpine trees. Good and readable as the essays are, the great charm of the book lies in its illustrations. The well-known scenes of tourist gatherings are relegated to the advertisement pages at the end, and throughout this modestly styled Almanac we are given an exquisite series of photographs, printed in brown, of "trees and woodlands" in the Alps. Each of these appeals delightfully to the naturalist, who will promptly consult the calendar and the tables of exchange.

G. A. J. C.

Handbook of Commercial Information for India. By C. W. E. Cotton. Pp. viii+383. (Calcutta: Superintendent Government Printing, India, 1919.) 1 rupee: 2*s*.

MR. COTTON'S book is a useful volume which gives in a condensed form, and well arranged for reference, notes on all the principal exports of India, including origin, district of growth, processes of preparation, and conditions of export. It does not profess to be a scientific work or in any sense a rival to larger and more complete gazetteers of Indian products. It has been compiled for traders, and with this end in view notes on ports and commercial organisations are added. Among the State departments connected with trade we find a reference to the geological survey but none to the Survey of India or to the Royal Indian Marine. Does this imply that maps and charts have no bearing on trade? It is to be hoped that the demand for this book will result in the publication of an annual edition.

Das Problem der Genesis des Actiniums. Von M. C. Neuburger. Sonderausgabe aus der *Sammlung chemischer und chemisch-technischer Vorträge.* Herausgegeben von Prof. Dr. W. Hertz. Band XXVI. Pp. iii+64. (Stuttgart: Ferdinand Enke, 1921.) 5 marks.

THE author discusses the experimental work done on the origin and transformations of actinium, and the various hypotheses which have been put forward as to the successive changes in the actinium series. He concludes that at some stages, besides α-and β-particles, particles of mass 3 and charge 2 are emitted. There is a detailed list of references, including some so recent as the year 1921.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Continuous Radiation found in some Celestial Spectra beyond the Limit of the Balmer Series of Hydrogen.

IN the account of his observations of the eclipse of January 22, 1898, published in the Philosophical Transactions, A 197, pages 389 and 399, Mr. Evershed directed attention to a curious continuous spectrum emitted by the solar chromosphere and prominences. This spectrum begins near the limit or head of the Balmer series of hydrogen lines, and extends with gradually decreasing intensity in the direction of shorter wave-lengths. In describing the phenomenon Evershed referred to the early observation by Huggins of an absorption in the corresponding region in the spectra of Vega and other stars having especially strong hydrogen lines (stars of Class A),[1] and advanced the opinion that the spectrum, like the Balmer series which it so curiously supplements, is due to hydrogen. The grounds for this view were afterward strengthened through the discovery by Wood of a continuous spectrum occurring beyond the limit of the sodium series of dark lines, under conditions of laboratory experimentation that favoured the development of the higher members of the sodium series.[2] More recently an emission spectrum, apparently identical in character with the one observed by Evershed in the chromosphere, has been found to be characteristic of the planetary nebulæ.[3] The spectrum seems also to occur in the diffuse nebula N.G.C. 1499,[4] and has been a conspicuous feature in the radiation of the novæ. It may therefore be regarded as rather a commonplace phenomenon pertaining to the spectra of celestial objects which appear to exist under conditions of strong thermal or electrical excitation. For the purposes of this note I shall use the term *outlying spectrum* in referring to it in order to distinguish it from the general continuous spectrum of more uniform distribution which is found even in the gaseous or " bright-line " nebulæ.

The outlying spectrum, as an emission phenomenon, has not, that I am aware, been observed in the laboratory, except possibly by Dufour,[5] who found an ultra-violet continuous spectrum which, however, he associated with the *secondary* spectrum of hydrogen, and not with the Balmer series. In view of its general occurrence in a large group of extremely interesting and important celestial spectra, it would seem desirable that serious effort be directed toward its development in the laboratory, with the view of establishing the circumstances of its origin. As a preliminary step in estimating the conditions likely to prove favourable for its emission it may not be out of place to recall a theoretical explanation that has been advanced to account for it.

In a paper read two years ago before the American Philosophical Society,[6] the present writer suggested that the spectrum might be explained on the basis of the Bohr theory, as resulting from the capture of free electrons by hydrogen nuclei. Although the idea was developed from independent considerations, it cannot be regarded as an original one, since Bohr, in his first paper,[7] had suggested the reverse process to account for the sodium absorption referred to above as having been found by Wood. Inasmuch, however, as he had not applied the consideration to the explanation of an emission spectrum in that region (such as was known to exist in the spectrum of the chromosphere), it seemed appropriate at the time to direct attention to that aspect of the theory, and I venture to revert to it here, both on account of its theoretical interest, and because it may possibly prove suggestive of the conditions under which the spectrum should be sought in the laboratory.

Briefly outlined, the argument is as follows: The mechanism which Bohr sets up for the hydrogen atom is a positive nucleus surrounded by an infinite series of fixed orbits in which it is possible for an electron to revolve. A line of the Balmer series is formed when an electron " jumps " from one of the outer orbits to the second one, and the complete series of lines results from the totality of transfers or jumps from all of the outer orbits. The frequency of vibration is in each case proportional to the energy set free in the transfer from the outer to the second orbit, and the frequency at the head, or limit, therefore corresponds to the energy set free in the fall of an electron from rest at infinity. An electron with an additional velocity of its own will of course give up more energy in its capture than one starting from rest, so it will have to be manifested by a radiation of proportionately greater frequency, that is to say, of less wave-length, than that of the series limit. The exact position of the resulting line will depend upon the amount of the initial kinetic energy, and since this must, in general, vary from one electron to another, the totality of these radiations should make up a continuous spectrum beginning at the Balmer limit and extending into the ultra-violet. It is thus seen that, by this theory, the Balmer series is caused by the falling inwards of electrons forming part of the atomic system, while the outlying spectrum is due to the capture of extraneous electrons. It is scarcely necessary to point out that the reasoning applies with equal force to the Ritz and Lyman series, and to other series of like character.

Preliminary to discussing this explanation it is well to calculate the initial kinetic energy required to produce the observed spectrum. The outlying spectrum can be followed in a number of planetary nebulæ to about 3340Å. This is of course an extremely rough estimate, for the spectrum is faint, and on this side fades gradually to invisibility. The energy required to develop a line here may conveniently be expressed in terms of that needed at the Balmer limit (3646Å) as

$$365/334 \times \nu_1 h = 365/334 \times Nh/4,$$

where ν_1 is the frequency at the Balmer limit, N the series constant, and h is Planck's element of action. Of this energy the amount $Nh/4$ has been developed in capture, leaving the remainder as the original kinetic energy of the electron. Calling this Ek, we have

$$Ek = 31/334 \times Nh/4,$$

substituting the numerical values: $h = 6{\cdot}547 \times 10^{-27}$ and $N = 3{\cdot}290 \times 10^{+15}$,

$$Ek = 5{\cdot}00 \times 10^{-13}. \quad . \quad . \quad . \quad . \quad (1)$$

This is the amount of kinetic energy which must have been possessed by the electron before coming under the action of the capturing nucleus in order that it should be able to develop a line at 3340Å.

[7] *Phil. Mag.*, 26, 17, 1913.

[1] " An Atlas of Representative Stellar Spectra," p. 85. For a more complete investigation of the absorption in the Class A stars, see Hartmann, *Physik. Zeit.*, 18, 429, 1917.
[2] *Astrophys. Jour.*, 29, 100, 1909.
[3] *Lick Obs. Bull.*, 9, 54, 1917; also *Publ. Lick Obs.*, 13, 256, 1918.
[4] Hubble, *Publ. Astron. Soc. Pacific*, 32, 155, 1920.
[5] *Ann. Chim. et Phys.*, (8), 9, 361, 1906.
[6] Proc., 49, 530, 1920.

If we regard the speed of the electron as having been acquired through intermolecular reactions making for the equipartition of energy, the above quantity should be comparable with the energy of molecular agitation. For a temperature of 1000° Abs. the mean kinetic energy of a molecule is

$$E(1000) = 2{\cdot}06 \times 10^{-13}. \quad . \quad . \quad . \quad (2)$$

Comparing (1) and (2) it is apparent that a gas temperature of about 2500° will be required if an electron of average energy is to develop a line at 3340Å. That position, however, marks the extreme end of the spectrum, and radiation in the neighbourhood is therefore to be regarded as due to the capture of electrons of exceptionally high speed. According to Maxwell's law an appreciable proportion of the molecules have three or four times the mean energy, and it is therefore permissible to divide our 2500° by some such figure as that. It accordingly seems reasonable to assume that 1000° Abs. Cent., or even a less temperature, in the presence of the proper degree of ionisation, would suffice to produce the observed spectrum.[1] The temperature of the chromosphere is of course very much higher than that. With respect to the nebulæ, while we have no general knowledge of their thermal states, it will be recalled that Buisson, Fabry, and Bourget have estimated the temperature of the Orion Nebula to be of the order of 15,000° Cent.[2] In the light of such an estimate, the theoretical requirement of 1000° cannot be regarded as extravagant.

The foregoing considerations related to the suggestions that the electron acquires its speed through equipartition of molecular energy, according to the kinetic theory; that is to say, the spectrum has been regarded as a "temperature effect." It is of course quite conceivable that the electronic velocity might be acquired in some other way, for instance, through the action of an electric field, or photoelectrically, as has been suggested to me by Prof. Frederick A. Saunders in a personal letter. The presence in the Class A stars of absorption beyond the Balmer limit may be taken as evidence that photoelectric ionisation is going on in their atmospheres, and as most of the planetary nebulæ have nuclei that are powerful radiators of ultra-violet light, the suggestion is an attractive one. However, unlike the Class A stars, the nuclei show no perceptible falling off in strength near the head of the Balmer series. If absorption through photoelectric action takes place it is probably higher in the spectrum.

The above remarks refer very largely to the upper, or more refrangible limit of the outlying spectrum; of greater importance is the lower limit, since here contact is established with the line series. The spectrum fades gradually to invisibility at the upper extremity; at the lower the termination is, on the other hand, quite abrupt, and should, according to what has been said, lie at the theoretical limit of the Balmer series. As a matter of fact it has been found, I believe in every case, to be perceptibly to the redward of that point. We recall that this outlying continuous spectrum comes down to the junction from the more refrangible part of the spectrum, and the line series reaches up from the other or redward end. The series limit is at 3646Å, while the edge of the outlying spectrum in the chromosphere, according to Evershed, lies at 3668Å; that is to say, the outlying spectrum overlaps the series limit by about 22Å; more than that, it extends 7Å beyond the highest series line observed by Evershed (3661Å). In the radiation of the nebulæ the end of the outlying spectrum is difficult to measure, but it lies quite certainly to the redward of the Balmer limit. In N.G.C. 7009 it has been estimated to be at about 3650Å, in other nebulæ it is at a greater wave-length. More marked is the discrepancy for the absorption spectrum in the Class A stars. Thus in the spectrum of α Cygni the absorption spectrum may be said to begin at 3710±Å, and to reach full strength at 3660±Å,[3] while for Vega[4] the corresponding positions are 3800±Å and 3710±Å. In the latter case we have then the beginning of absorption 150Å to the redward of the series limit, a disparity between theory and observation that might raise a doubt as to whether the absorption bears in reality any relationship to the Balmer series. A consideration of the influence of density will, however, show that an inequality of that order is to be expected.

It is probably significant that in the spectra of α Cygni and of Vega the last of the recorded series lines falls in each case in the neighbourhood of the point where the outlying absorption attains its full value. Thus for Vega the series is lost at 3687Å, and the estimated position of the attainment of full absorption is 3710±Å; for α Cygni the highest line is 3668Å, with full absorption estimated to begin at 3660±Å. The estimates of the position at which full absorption begins are difficult to make, and the positions given are only roughly approximate, but it is quite evident that the series of dark lines which lie to the redward, and the continuous spectrum which extends in the other direction, merge one into the other, and that the second begins at the *actual* and not at the *theoretical* limit of the first.

The inference that the continuous spectrum should begin at the theoretical limit is based on the assumption that the atomic orbits extend to infinity. Bohr has pointed out that the size of the orbit system is necessarily limited by the density of the radiating gas, and has explained the absence of lines of a very high order as a consequence. Applying this consideration to the theory of the outlying spectrum it seems necessary to substitute for the "orbit at infinity" adopted in our former reasoning, the largest orbit in effective operation. Into the atomic system, as circumscribed by this orbit, electrons may be conceived to enter with speeds from zero upward. Now an entering electron of speed zero has less energy than one moving in the outer effective orbit—less by just the kinetic energy of orbital motion. In dropping into the second orbit therefore it sets free a smaller amount of energy, and consequently produces a line of lower frequency (or greater wave-length) than that of the series line which corresponds to the outer effective orbit. But the line formed by this electron must mark the more refrangible edge of the outlying continuous spectrum. We should, therefore, expect the continuous spectrum to begin somewhere on the less refrangible side of the highest visible member of the Balmer series. In other words, there should be an "overlapping" of the bright-line and continuous spectra such as is actually found. The margin of overlap should be proportional to the kinetic energy of the electron in the outer effective orbit, and on this assumption is expressible by the relation:

$$\nu_2 - \nu_3 = \nu_1 - \nu_2,^5 \quad . \quad . \quad . \quad . \quad . \quad (3)$$

[1] A higher estimate of the required temperature was given in the earlier paper. I have not at hand the computations on which it was based, but it seems to have been affected by some numerical error, probably the use of N in place of N/4 for the coefficient of h in the equations preceding (1) of this paper.

[2] *Astrophys. Jour.*, 40, 258, 1914.

[3] *Lick Obs. Bull.*, 10, 103, Fig. 1.

[4] *Publ. Lick Obs.*, 13, 257, Fig. 2. The positions for both Vega and α Cygni are scaled from the intensity curves in the respective references. They are subject to great uncertainty. Compare stellar intensity curves by Hartmann, *Phys. Zeit.*, 18, 431.

[5] The expression follows at once from the frequency-energy relation assumed by Bohr. Let the nth be the largest effective orbit of one of his atomic systems; then for the highest line we have:

$$\nu_2 = N(1/2^2 - 1/n^2).$$

The second term in the parenthesis represents the energy lost during the

where ν_1 is the frequency at the theoretical limit of the Balmer series,

ν_2 is the frequency of the highest line that can be formed,

ν_3 is the frequency at the redward edge of the outlying spectrum.

This expression tells us that, expressed in frequencies (and the relation holds approximately for wave-lengths), the margin of overlap of the continuous and line spectra should be equal to the interval between the highest *observable* line of the Balmer series and the theoretical limit.

There are two factors tending to modify the above conclusion. One is that, by the kinetic theory, comparatively few electrons of approximately zero velocity are to be expected. Since these determine the redward edge of the outlying spectrum, that edge should be faint, and the effective limit might be of slightly less wave-length. The other is the fact that all the atomic systems will not at any one instant be reduced by molecular interference to outer orbits of exactly the same order. In these circumstances we should expect the large systems to determine the highest visible lines, and the small ones to establish the redward edge of the outlying continuous spectrum. The effect here would be to introduce a "blurring" factor, and increase the overlap. While these two factors operate against each other, it seems quite impracticable to attempt an estimate of their net effect.

To check the conclusions, the data on the emission spectrum of the chromosphere and the absorption spectra of α Cygni and Vega are collected in the accompanying table. Unfortunately the emission spectra of the nebulæ have not been measured accurately enough to establish their limits. In our theoretical discussion we have regarded the problem from the point of view of emission, and it is perhaps not entirely justifiable to check the conclusions through recourse to absorption spectra, for absorption and emission cannot, in such a case, be regarded as exactly complementary. It is necessary, however, to use the stellar spectra, since, with that of the chromosphere, they constitute the only radiations that have been sufficiently well observed.

Source.	Highest line of Balmer series. Observed.	Commencement of continuous spectrum. Observed.	Computed.
Chromosphere (em.) .	3657*	3668	3668
α Cygni (abs.) . .	3668	3700 ±	3691
Vega (abs.) . . .	3687	3800 ±	3729

* The most refrangible line observed by Evershed was 3661Å. Mitchell, on the occasion of the 1905 eclipse (*Astrophys. Jour.*, 38, 431, 1913: also Publ. Leander McCormick Obs., 2, 49), photographed six additional lines, the highest being at 3656.8Å, the value adopted here. Evershed's plates were taken with a prism spectrograph and Mitchell's with a grating instrument of considerably greater power. The greater extent of the latter's spectrum is no doubt due to that fact.

The last column contains the positions of the lower edge of the outlying spectrum computed from the frequencies of the highest visible lines, using equation (3). The discrepancy between the observed and derived values for Vega is rather large and undoubtedly exceeds the error of measurement. It should be remembered, however, that in the atmosphere of a star absorption must take place throughout a considerable range of density, corresponding to different levels. The higher lines of the series, on which the computations rest, probably originate in the upper and rarer atmosphere, where the conditions are favourable for their formation, while we should expect the edge of the outlying spectrum to be determined in a region of comparatively high density. This would account for a divergence such as the one shown. Considering the number of extraneous factors that have a bearing on the problem the agreement is probably as good as might be expected. The measurements show the progress of the edge of the outlying spectrum toward the redward as the higher members of the Balmer series fade out, and this is in general accord with the theoretical deductions.

Summary of Conclusions.—The outlying continuous spectrum found in certain celestial spectra beyond the limit of the Balmer hydrogen series is, as was suggested by Evershed, almost certainly due to hydrogen. It should be more completely studied astronomically, and serious effort should be directed toward developing it in the laboratory, on account of its theoretical interest and of its bearing on astronomical problems.

The spectrum is explicable, on the basis of the Bohr theory, as resulting from a change of state, as between a free electron and one in the second orbit. Bohr's original application of the principle to the case of absorption through photoelectric action on hydrogen atoms, is extended to the conception of emission as resulting from the capture of free electrons by hydrogen nuclei.

Theory and observation are in accord in placing the beginning of the outlying spectrum, not at the theoretical limit of the Balmer series, but to the redward of it, the amount of the displacement being greater as the number of observed series lines is less.

It seems possible to account for the spectrum on the basis of either thermal or electrical excitation. Regarded as a heat effect, it indicates for the planetary nebulæ a temperature of the order of 1000° Abs. Cent. or more. (The figure is not, however, offered as an estimate of the temperature of the nebulæ.)

W. H. WRIGHT.

Mount Hamilton, California, April 21, 1922.

transfer from infinity to the nth orbit. This is also equal to the kinetic energy of the electron due to motion in its orbit, so that an electron at rest at the nth orbit will have lost twice that amount. Therefore

$$\nu_3 = N(1/2^2 - 2/n^2).$$

Remembering that $\nu_1 = N/2^2$, the relation (3) follows.

Discoveries in Tropical Medicine.

I HAVE never thrown any doubt upon the influence of the suggestions made by Manson to Ross which led to the close study by Ross of the carriage of the malaria parasite (of both birds and man) by mosquitoes, and the discovery by him that mosquitoes of the kind known as Anopheles and not those of the kind known as Culex are the "intermediate hosts," in which the parasites causing malaria in man undergo necessary and remarkable stages of their development.

I was a member of the Committee of the Royal Society with which Ross was in constant communication during his work in India, and followed that work step by step in the reports sent home by him. My knowledge of the work of Laveran, of Labbé, Danilewski, and of Celli and of Grassi and the Italian school does not support the claims to "discovery" put forward on behalf of Manson by some of his friends. They are exaggerated and inaccurate—though Manson's influence and enthusiasm need no such mistaken advocacy in order to receive recognition.

It is the fact, in spite of assertions to the contrary, that Manson did *not* discover the part played by the mosquito in the transmission of *Filaria sanguinis hominis*. Important details as to the part played by the mosquito—of whatever kind—in that transmission have yet to be ascertained. They are still—at the present moment—a subject of investigation.

The kind of statement put forward in order to do honour to Manson, but really of a misleading nature, is exemplified in the following from Dr. Sambon's letter in NATURE of May 27. He writes: "Sir Ray Lankester ignores Manson's brilliant interpretation of the 'flagellating' malarial parasite, looked upon by the Italians as a form of degeneration; by Manson as the prelude to a further all-important developmental stage outside the body of man." The reader of Dr. Sambon's letter would suppose that Manson had in this matter had "a happy thought" and had put forward a successful speculation. Such is not the case. The nature and significance of the flagelliform bodies developed by the malaria parasite were first discovered by Dr. W. G. MacCallum, of the Johns Hopkins University, Baltimore, and published by him at the meeting of the British Association in Toronto, August 1897, and more fully set forth with admirable illustrations in the *Journal of Experimental Medicine*, vol. iii., 1898. He describes the rapid formation of these bodies in the Halteridium of birds (crows) as others had already done both in that case and in the malarial parasites of man. What is of capital importance in MacCallum's paper is the careful description and drawings of the active—even violent—union of the liberated flagelliform bodies with certain granular spheres or female gametes. A single flagelliform body was thus seen to fuse with one female gamete. MacCallum, having once recognised this sexual process, observed it daily, and then observed the same process in the æstivo-autumnal parasites taken from two cases of malaria in a human subject.

In discussing the significance of his discovery, MacCallum writes that the whole Italian school believed the flagelliform bodies to be due to degenerative changes. "Manson," he writes, "as is well known, has advanced the idea that the flagellate bodies represent the forms in which the parasite exists outside the human body, that the flagella penetrate from the stomach into the body of mosquitoes which have sucked the blood of infected human beings, and that, after a further unknown process of development, they come again (through the water in which the mosquitoes deposit their eggs and die) into the human body." This and other suppositions were entirely set aside by MacCallum's discovery. MacCallum insists that Manson's idea is not based on any observations, but is pure hypothesis! Manson's interpretation of the flagellating malarial parasite was, though erroneous, a legitimate hypothesis, but it certainly was not "brilliant," although we are asked by Dr. Sambon to regard it as being so. E. RAY LANKESTER.

June 5, 1922.

The Isotopes of Tin.

THE insensitivity of the photographic plate in recording positive rays when compared with its sensitivity to light has long been observed, and has been accounted for by the fact that the action of positive rays is purely a surface effect. There has, therefore, always been the hope that considerable improvement could be made in this direction by increasing the concentration of the bromide particles on the surface of the gelatine. This hope has now been realised to some extent by the use of a method which, I understand, has been devised for the production of Schumann plates. It consists essentially in dissolving off more or less of the gelatine by means of acid. I have not yet succeeded in obtaining certain or uniform effects, but in the most favourable cases the sensitivity of the "Half Tone" plates used in the mass-spectrograph has been increased ten to twenty times without seriously altering their other valuable properties.

The immediate result has been the definite proof of the complex nature of the element tin which had been previously suspected (*Phil. Mag.* xlii. p. 141, July 1921). Tin tetramethide was employed, and a group of eight lines corresponding approximately to atomic weights 116 (c), 117 (f), 118 (b), 119 (e), 120 (a), 121 (h), 122 (g), 124 (d) was definitely proved to be due to tin. This conclusion was satisfactorily confirmed by the presence of similar groups corresponding to $Sn(CH_3)$, $Sn(CH_3)_2$ and $Sn(CH_3)_3$. The intensities of the various components indicated by the letters in brackets agree quite well with the accepted chemical atomic weight 118·7, and incidentally preclude the possibility that any of the lines, with the possible exception of the extremely faint one at 121, are due to hydrides.

The spacing of these eight lines, which are only just resolved, show that their differences are integral to the highest accuracy, but the lines themselves compared with known lines on the plate give atomic weights always tending to be 2 or 3 parts in 1000 too light for the above whole numbers. That this remarkable divergence cannot be explained as experimental error is very strongly indicated by the following consideration. The discharge tube had been used previously to investigate some very pure xenon. The line due to Sn^{120} (CH_3) should therefore have appeared exactly halfway between the two strong xenon lines 134, 136. It was actually quite unmistakably nearer the former, so much so that the two were only partially resolved. The same irregular grouping repeated itself in another portion of the field in the following spectrum. It seems, therefore, difficult to resist the conclusion that the isotopes of tin have atomic weights which are less than whole numbers by one-fifth to one-third of a unit of atomic weight, but satisfactory settlement of this important point will probably have to be deferred till a more accurate mass-spectrograph has been made.

Incidentally I may add that the presence of the two faint components of xenon 128 and 130 previously suspected has now been satisfactorily confirmed.

F. W. ASTON.

Cavendish Laboratory, Cambridge, June 7.

The Spiracular Muscles of Hymenoptera Aculeata.

I DESIRE to direct the attention of entomologists to a recently discovered muscle (see *Bee World*, vol. iii. p. 282, April 1922) present in the honey bee (*Apis mellifica*), and probably in many others of the Hymenoptera Aculeata.

The abdominal (respiratory) muscles of *Apis mellifica* were described by Carlet (*Comptes rendus*, Acad. Sci., Paris, 1884, vol. 98, p. 758). His list is incorrect; it misplaces the posterior attachment of the internal oblique muscle and omits the interdorsals and the spiracular muscles. To the latter it is desired to direct attention here. They run from the lateral sternal apophysis to the larger of the two cones of the spiracle on the tergum of the same segment. Thus, when the abdomen is expanded, this muscle is under tension, and will pull open the closing apparatus of the spiracle. During expiration, the abdomen is contracted; the spiracular muscles will therefore be slack during this process, and it appears highly improbable that the spiracles actuated by them can open during expiration. The expired air must therefore pass out of the system mainly through the thoracic spiracles; a fact which renders comprehensible

the immediate ill effects of blocking of the prothoracic spiracles by *Tarsonemus woodi*, the causal parasite of Isle-of-Wight (Acarine) disease.

Spiracular muscles (apparently similar in function to those of *Apis mellifica*) have been found in *Vespa sp.*, *Bombus sp.*, and a wild bee (? *Prosopis*). In a modified form, they are present in *Formica sp.*, being there apparently attached to the anterior edge of the tergum, and not to the sternal apophysis.

To see these, as well as the other abdominal muscles of the bee, I may mention that material preserved in equal parts of methylated spirit and formalin, deeply coloured with light green so as to stain the muscles, is excellent. Dissect in water.

ANNIE D. BETTS.

Hill House, Camberley, Surrey.

Symbiotic Bacteria and Phosphorescence.

IN Prof. Gamble's review of Buchner's "Tier und Pflanze in intrazellularer Symbiose" (NATURE, May 6) reference is made to the work of Pierantoni, according to whom the luminous organs of cephalopods are "essentially cultures of bacteria in media suitable for their nutrition and in situations favourable for obtaining oxygen."

The claims which are made for the existence of similar symbiotes in fire-flies and many other phosphorescent organisms may be extravagant, but Newton Harvey's recent announcement in the Year-book (No. 20 (1921), pp. 196-97) of the Carnegie Institution of Washington is exceedingly important in this connection. Harvey worked on two fishes with very large luminous organs—Photoblepharon and Anomalops—at Banda in the Dutch East Indies. He found bacteria always present in the organs, and emulsions of these organs behaved exactly like emulsions of luminous bacteria. The light continues night and day without ceasing, independently of stimulation. This is characteristic of the light due to luminous bacteria and fungi alone among organisms. Harvey did not succeed in growing the bacteria artificially, however; but considering the conditions under which they apparently live, this would, naturally, be a task of great difficulty. Dahlgren (see the same reference) seems to have confirmed Harvey's discovery in other fishes.

Luciferin and luciferase could not be demonstrated, which is also characteristic of luminous bacteria.

F. A. POTTS.

Trinity Hall, Cambridge.

Stone Preservation.

MAY I throw out a suggestion, which, I believe, is new, as to a method for preserving decaying sandstones from further decay?

Certain compounds of alcohol-radicles with silica, when exposed to moist air, hydrolyse, deposit hydrated silica in a coherent form, and thus act as a cement. The ether can be thinned with alcohol, and is a very stable body so long as it is not exposed to moisture, and if a piece of rotten sandstone is treated with it, in the course of a few days the sandstone hardens up and the resulting cement resists the attacks of acids.

Unfortunately, this process does not solve equally well the important problem of preserving limestones, since, though it binds the particles of limestones together, it does not protect the particles themselves from attack.

A. P. LAURIE.

Heriot-Watt College, Edinburgh, May 31.

Oscillation Circuits for the Determination of Di-electric Constants at Radio Frequencies.

DURING the last year or so a number of investigators have made use of the underlying principles of the heterodyne system of wireless telegraphy in the determination of di-electric constants. The extreme sensitivity of this method, and its freedom from some of the weaknesses which have rendered precise measurements by the older methods difficult of attainment, are rapidly increasing its popularity, and any changes which make for simplicity and for still greater certainty are of interest.

For no apparent reason circuits of the type used only for receiving signals have, so far as the writer is aware, been employed, though greater efficiency is to be expected from the use of a transmitting circuit in conjunction with such a receiving circuit generating local oscillations. In either case it is preferable that the oscillation circuit, of which the condenser containing the material under investigation forms a part, should not rectify, as rectification is necessarily accompanied by distortion of wave form.

Instead of using the two electrically insulated circuits hitherto employed the writer prefers that shown in Fig. 1, in which simple transmitting and receiving circuits are combined in such a way that

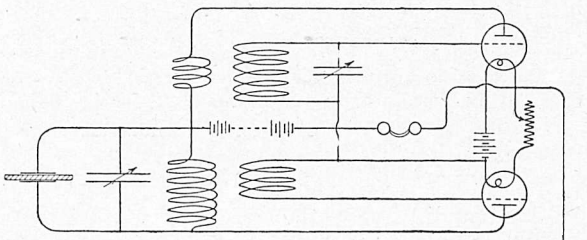

FIG. 1.

oscillations of two different frequencies can be generated although both valves are fed from the same filament-heating and anode batteries. An additional reason why only one valve should be used for rectification with this particular arrangement lies in the fact that, if both valves were rectifying, the unidirectional pulses of current of audible frequency produced in each of the circuits by the rectification of the interfering oscillations would tend to produce a steady current, since they would be quite out of phase with each other.

As is well known to workers who have had experience of apparatus of this kind, changes in the value of the filament-heating current by altering what is virtually the resistance of a valve affect, to a certain extent, the frequency of the oscillations generated. This trouble can be lessened to a very great extent by taking the heating current for both filaments from the same battery of accumulators. The filaments can be connected in parallel, but there is more to be gained by connecting them in series, as will be apparent from the figure. It will be seen that, although the two grids are at the same potential with respect to earth, their potentials with respect to the heated filaments are quite different; in the case of the valve shown in the lower half of the figure the potential difference is such that it can "oscillate" only, while the other valve can both oscillate and rectify.

In conclusion, it should be stated that this letter is written with the kind permission of the Director of Artillery, War Office.

P. A. COOPER.

Explosives Branch, Research Dept.,
Woolwich, April 15, 1922.

A Century of Astronomy.[1]

By Prof. A. S. EDDINGTON, F.R.S.

THE celebration of a centenary is an occasion for retrospect over the past and for hopeful outlook towards the future. We have here representatives of many different sides of astronomy who view it from many different aspects, and I should not be surprised if there are wide differences of opinion as to which are the outstanding landmarks in these hundred years. Like selecting the hundred best books, the selection of, let us say, the six great landmarks of astronomical progress in the century is a pastime which need not be taken too seriously. I shall venture to try my hand at a selection :—

(1) 1839. The first determinations of stellar parallax of 61 Cygni and α Centauri, giving for the first time a definite idea of the scale of the stellar universe.

(2) 1846. The discovery of Neptune. An event perhaps more highly celebrated outside astronomical circles than among professional astronomers, but producing an incalculable moral effect.

(3) 1864–68. The early spectroscopic discoveries of Huggins and Lockyer, and the rise of spectroscopic astronomy.

(4) 1882–87. The beginnings of stellar photography, starting with Gill's photograph of the great comet of 1882 and leading to the inception of the astrographic chart in 1887.

(5) 1904. Kapteyn's discovery of the two star-streams, the beginning of the modern era of investigations of the sidereal system.

Coming to events so near to the present that we cannot yet put much trust in our perspective, I would very tentatively include

(6) 1920. The measurement of the angular diameter of Betelgeuse by Michelson's interferometer method. I would not venture to predict how great or how immediate may be the influence of this last on the progress of astronomy; but it seems to me to be worthy of a place in this select list as a triumph of scientific achievement which is second to none. It is one of those signal instances which convince us that the word "impossible" must be banished from the vocabulary.

This is a record of continuous advance—not in great waves followed by periods of exhaustion. A new impetus has always been found before the last one has begun to fail. Even the allied science of physics has not, I think, had such a continuous record. I am told that there was a period shortly before X-rays and electrons came to the fore, when the physicist had given up anticipating any radical advance; he thought that the big discoveries were already garnered; and the feeling, so present with us to-day, that we are on the verge of something greater than our dreams can shape, had not yet disturbed his placid progress.

The centre of most rapid progress has shifted from time to time, and the various branches of astronomy have had their ups and downs. I suppose that in recent years the department of planetary astronomy has been in the depression of a wave. At least it seems to be so in comparison with the more sensational progress in our knowledge of the sun and stars. Whether we regard the physical observation of the surfaces of the planets or the study of their motions, the openings for advance seem to be few and difficult. But the depression has by no means reached stagnation. We have the remarkable advance in planetary photography, exhibited at several recent meetings of the Society; the discovery of new satellites, including Jupiter's two pairs of twins, and the specially significant phenomenon of the retrograde motion of the outermost satellites of Jupiter and Saturn; the determination of the rotation period of Uranus by Slipher; and the Trojan group of minor planets, the principal merit of which is that they have beneficently prevented the once great science of dynamical astronomy from growing altogether rusty. Renewed interest is added to the exact and regular observation of the positions of planets by Einstein's explanation of the anomalous motion of Mercury; the same observations reveal interesting irregularities in the longitudes of the planets which perhaps reflect inequalities in the rotation of the earth as standard time-keeper. These observations, which else might have seemed to be mere survivals of traditional routine, are seen to be full of importance for the future; and for the same reason we welcome the revival of observations of occultations of stars by planets. On the theoretical side, we have Taylor's important investigation of tidal friction in the Irish Sea, which, true to its name, is responsible for a considerable proportion of the friction and dissipation of energy on this planet; and Jeans's researches have given us new ideas of the origin of the planets which attend the sun, and of the singular (perhaps even unique) character of this system. Many other researches in this field could be mentioned. If the department of planetary astronomy is now the Cinderella of our science, she yet has dreams that her Prince is waiting for her.

It is startling to-day to read a passage from Huxley's "Essays" which runs :—"Until human life is longer and the duties of the present press less heavily, I do not think wise men will occupy themselves with Jovian or Martian natural history." Martian—and I almost fear to mention it—lunar natural history are no doubt thorny subjects, but notwithstanding Huxley's censure, probably the most sceptical among us would admit that the observation of seasonal changes of what is presumably some kind of vegetation on Mars is a recognised astronomical pursuit.

In reviewing the general advance of astronomy during the century, we cannot but be struck by what I may call its *centrifugal* tendency—the tendency to leave the little system ruled by the sun and penetrate deeper and ever deeper into the vast world outside. In the older books, the author leads us deliberately through the planets one by one, and it is with difficulty that the account of the stellar universe can be spun out to any respectable length. Before the first meeting of this Society in 1820 an introductory address was circulated, which contains the paragraph :

Beyond the limits of our own system, all at present

[1] From the presidential address delivered before the Royal Astronomical Society on May 30.

is obscurity. Some vast and general views on the construction of the heavens, and the laws which may regulate the formation and motions of sidereal systems, have, it is true, been struck out; but, like the theories of the earth which have so long occupied the speculations of geologists, they remain to be supported or confuted by the slow accumulation of a mass of facts; and it is here, as in the science just alluded to, that the advantages of associated labour will appear more eminently conspicuous.

While much obscurity still remains, this vast territory has been definitely annexed and occupied. From the planetary system we have passed to the stellar system; and I am not sure if even the study of that great aggregation of stars which we used to think was the whole universe is not becoming a little old-fashioned, and the really up-to-date young astronomer would refuse to bother about anything nearer than a globular cluster. At least it is one of the most startling features of recent research that so much exact knowledge has been obtained of the conditions of stars in globular clusters, not one of which is nearer than 10,000 light-years—knowledge which in many respects far surpasses in precision that which it has been possible to obtain for the much nearer denizens of our own star-cloud.

It may be of interest to examine how this centrifugal tendency is reflected in our Monthly Notices, and I have prepared a table to show how the subject-matter of the papers has changed. The figures claim no great accuracy, because it is often difficult to classify the papers clearly and uniformly; and, of course, the statistics do not distinguish important papers or long-continued observations from trivial notes and controversies. But on the whole the figures seem to be truly representative.

CLASSIFICATION OF PAPERS IN MONTHLY NOTICES, R.A.S.

	1840. (3 years.)	1860.	1880.	1900.	1919.	1920.
Instrumental	6	4	11	3	6	5
Solar System	39	69	73	56	14	21
Stellar universe	18	13	22	21	49	40
Geodesy, navigation, seismology, etc.	14	3	6	..	5	11
Ancient observations	2	1	1	..	1	1
Mathematical (not classed above)	..	..	2	..	1	12
(Ditto, omitting ephemerides, tabular observations, etc., and formal reports of phenomena.)						
Solar system	9	38	34	21	11	17
Stellar universe	7	11	16	12	33	32

It appears that the serious change did not begin until after 1900. Although it shows itself quite suddenly in the statistics, it had been steadily prepared for during a long period. It must be remembered that much of the heaviest work on the stars is by its nature excluded from the Monthly Notices, and appears only in the more voluminous publications of observatories. Solar, lunar, and planetary observations are not usually too bulky to include. Much long-continued preparation for proper motions, spectral classification, radial velocities, stellar magnitudes, etc., began to come to fruition between 1900 and 1910. But I think the great impetus to sidereal astronomy came from Kapteyn's discovery, which I have mentioned among the six landmarks of the century. The two star-streams were the first taste of the many amazing results contained in the statistics collected or being collected. They were the first indication to us of something like organisation among the myriads of stars. Paradoxical as it may seem, the duality of the stellar system was the first clear indication to us of its unity. In the earlier years most of the papers classified in the table as referring to the stellar universe dealt with particular objects—variables, rapid binaries, Novae. It was a period of individualism. But from 1900 onwards the great democracy of the stars was brought into prominence, and a great wave of stellar socialism began. Kapteyn is the typical pioneer of a numerous body of investigators who view the heavens in the spirit of Xavier le Maistre in "Voyages autour de ma Chambre":

> The most brilliant stars have never been those which I contemplate with most pleasure; but the tiniest ones, those which, lost in immeasurable distance, appear only as barely perceptible points, have always been my favourite stars.

Yet perhaps in the very latest years there has been a reaction towards individualism. The statistical mill is no longer working overtime. The queer stars, such as Cepheids, runaway dwarfs, special binaries, are beginning to contribute more largely to the general perfection of the whole scheme. Strange objects which persist in showing a type of spectrum entirely out of keeping with their luminosity, may ultimately teach us more than a host which radiate according to rule.

It is noticeable that in the early years the disproportionate excess of papers on the solar system compared with the outside regions of the universe was not so marked as it afterwards became. This is no accident. The founders of the Royal Astronomical Society, while confessing almost complete ignorance of this domain, were resolved that it should be attacked, and had the conviction that patient research would make the advance possible. Indeed, it was just this which was placed among the most prominent reasons for banding together. With regard to eclipses, planets, and comets, it might be possible to struggle along individually; but the problems involving thousands of stars were too vast for one man or for one generation. They saw that the observations were being piled up, but without uniformity and without system. To quote again from their address:—

> One of the first great steps towards an accurate knowledge of the construction of the heavens is an acquaintance with the individual objects which they present: in other words, the formation of a complete catalogue of stars and of other bodies, upon a scale infinitely more vast than has yet been undertaken, and that shall comprehend the most minute objects visible in good astronomical telescopes. To form such a catalogue, however, is an undertaking of such overwhelming labour as to defy the utmost exertions of individual industry. It is a task which, to be accomplished, *must* be divided among members; but so divided as to preserve a perfect unity of design. . . . The intended foundation of an Observatory at the southern extremity of Africa, under the auspices of the Admiralty, may serve to show the general sense entertained of the importance of this subject, and the necessity of giving every possible perfection to our catalogue of the fixed stars. Deeply impressed also with the importance of this task, and fully aware of its difficulty, the Astronomical Society might call upon the observers of Europe and of the world to lend their aid in its prosecution. Should similar

institutions be formed in other countries, the Astronomical Society (rejecting all views but that of benefiting science) would be ready and desirous to divide at once the labour and the glory of this Herculean attempt, and to act in concert together in such manner as should be judged most conducive to the end in view.

It is largely the Herculean nature of the task before us which has led to astronomy being to-day (whether for good or ill) the most highly organised of the sciences.

The accomplishment of these objects has not been rapid. A passage in the First Annual Report of the Council mentions as one of the greatest desiderata a means of determining the apparent magnitudes of the stars, and ascertaining "a correct scale whereby astronomers may be enabled to express themselves in one common language on this subject." The lapse of a century has not quite sufficed for the completion of this uniform scale; but the main difficulties have been surmounted, and the time is very near now when all astronomers will be able to express themselves in a common language in regard to stellar magnitudes, both visual and photographic.

The foundation of our Society on January 12, 1820, caused a ripple in the aether which has spread out ever since in widening circles. To-day that ripple embraces about 5000 of the fixed stars. The remaining thousand million or so are still outside. Though a good many of the best-known stars must by this time have received the tidings, 90 per cent. of the naked-eye stars are still in ignorance. We should like to think that the stars of the morning sing together with joy on this our Centenary; but the cold truth must be faced that not 1 in 100,000 can yet have heard of our birth. But we shall look out on the heavens again to-night with renewed enthusiasm and joy; and if from the majority of the stars we can expect no more than an unrecognising stare, there are half-a-dozen old favourites which—we may fairly be persuaded—will give us an answering twinkle.

X-Ray Studies on the Crystal Structure of Iron and Steel.

AT the annual meeting of the Iron and Steel Institute last year, Dr. Westgren presented a paper on some X-ray crystallographic investigations on iron and steel. At that time the photograms on which his conclusions regarding the crystal structure of the steel components were based were not very clear, and were not published. Moreover, owing to spontaneous crystal growth at high temperatures, the photogram of gamma iron at 1000° C. did not show any continuous lines, but only a few spots. Since then, Dr. Westgren has continued his investigations and improved the experimental arrangements, and in a paper published with Mr. Phragmen at the corresponding meeting of the Institute on May 5 last, he showed photograms of very great interest and significance.

The X-rays were produced in a tube of the Seigbahn type. Difficulties had previously been experienced in obtaining vacuum-tight bronze tubes which composed the metal body. A more suitable material has been found in Skefko ball-bearing steel, which is remarkably free from slag inclusions and heterogeneities. The anti-cathode was cut off perpendicularly to its axis, and in order to get the characteristic X-rays of iron, which are very convenient for these investigations, an iron plate was soldered on to it. Round the radiating surface five windows were made. The tube therefore gave five beams, and exposures could be made in five cameras simultaneously. The tube was evacuated by the combination of a mercury vapour jet pump and a mercury diffusion pump of the Volmer type. Special arrangements were made for maintaining the vacuum of the desired quality. The tube was usually charged with 45,000-50,000 volts and run with 10-12 milliamperes.

In investigating the crystal structure of pure iron at different temperatures, a wire (0·3 millimetre diameter) of vacuum-melted electrolytic iron containing 99·98 per cent. of the metal was investigated. Arrangements were made for rotating this three or four times per minute during exposures. Photograms were taken at the ordinary temperatures, and at about 800°, 1100° and 1425° C., which gave information of the structures of the iron in the alpha, beta, gamma and delta ranges (Fig. 1). The time of exposure was 2½ hours. The lines in the photograms obtained at the ordinary temperatures are clear and sharp, but in the higher ranges of temperature investigated they appear broad and not very distinct. The author explains this as due to the fact that the iron wire at temperatures of about 1400° C. is extremely pliable. Its position, therefore, changed somewhat during the exposure. Moreover, he found it very difficult to keep the temperature of the wire steady in the delta iron range. If the temperature was maintained at 1450° C., *i.e.* within about 70° of the melting point, the wire became so soft that it could not stand the torsion. The temperature, there-

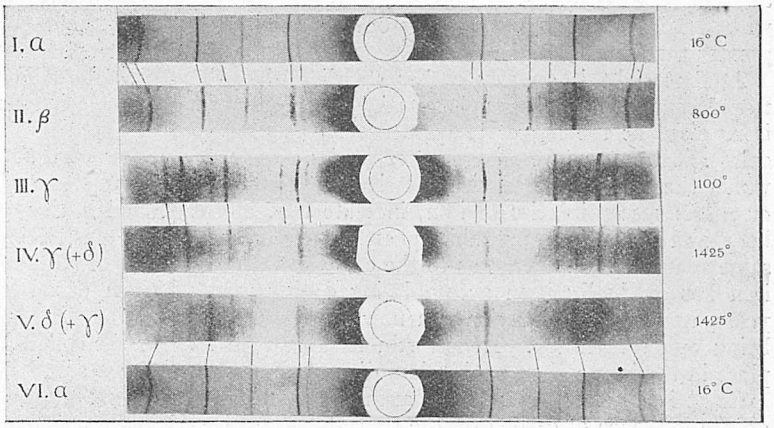

FIG. 1.

fore, had to be kept not above 1425° C., which is near the delta-gamma transformation point. Moreover, it was found necessary to counteract the influence of grain growth at these very high temperatures. For this purpose the temperature was varied every 5 or 10 minutes so as to bring the iron into the range of another modification, *e.g.* in taking the beta iron photogram the temperature was raised from time to time to about 1000° C., and when the gamma and delta irons were investigated the heating current was broken off now and then, so as to let the wire cool down into the alpha range. Photograms of delta iron, which always contained some gamma iron, show, accordingly, lines characteristic both of the delta and gamma varieties.

Experiments carried out on the above lines show that alpha, beta, and delta irons have a body-centred cubic lattice, whereas gamma iron has a face-centred cubic lattice. The former lattice contains an atom at each corner of the cube and one in the centre, the latter has an atom at each corner and also in the centre of each face. It follows, therefore, that although there are generally considered to be four modifications of iron, three of them possess one and the same crystal form. For alpha iron at the ordinary temperature *a* has been found to be 2·87 Å.U.; at 800° C. it has increased to 2·90 Å.U., and at 1425° C. to 2·93 Å.U. This agrees very well with the known dilatation coefficient of alpha iron. The heat expansion of gamma iron also manifests itself in the increase of alpha-gamma from 3·63 Å.U. at 1100° C. to 3·68 Å.U. at 1425° C., which agrees well with the fact that the coefficient of gamma iron is greater than that of alpha iron.

At first sight it appears rather startling that the transformation which takes place at A_3 (beta to gamma) is reversed at the higher temperature A_4 (gamma to delta). However, the diagrams of Weiss and Foëx which the author reproduces, showing the change of magnetic susceptibilities of iron, indicate that alpha, beta and delta iron probably possess one and the same structure. Evidence as to the existence of delta iron has gradually been accumulating during recent years, and this modification can now be regarded as being well established. Henceforth, it must take its place in the iron-carbon equilibrium diagram.

Great interest attaches to the authors' experiments on the influence of carbon on the space-lattice of iron in hardened steels (Fig. 2). These show that the gamma-iron lattice of austenitic steels is enlarged by dissolved carbon. A steel with 1·98 per cent. carbon has been found to have a somewhat larger lattice when quenched from 1100° C. than from 1000° C. The investigations thus show that carbon has a distorting influence on the lattice, and a further interesting point concerning this effect may be noted. The carbon atoms may be situated in the cavities of the iron lattice, but the author concludes that they are distributed quite irregularly in the austenite crystals. If their deforming influence were of a local nature, the interference radiation would be diffuse. The lines of the photograms of the austenite containing high carbon are, however, very distinct and clear, thus proving that the iron lattice is uniformly deformed.

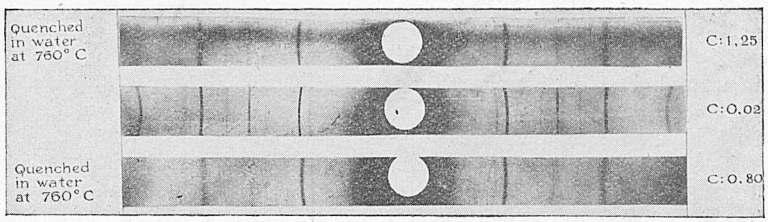

FIG. 2.

Photograms of martensite, the characteristic constituent of hardened steel, show three very faint and diffuse lines, but their cloudiness makes it difficult exactly to determine the position of their intensity maxima. The *a*-values of the alpha iron in martensite are not, therefore, so trustworthy as those of gamma iron in austenite, but the various modifications of iron in all the four photograms published have given the same value, namely, 2·90 Å.U., which indicates that the alpha iron lattice of martensite is likewise enlarged by the carbon atoms present. On the basis of these results, the authors discuss the deeply interesting question, whether martensite is a two-phase system or a homogeneous solid atom disperse solution. If the iron lattice is uniformly deformed, it seems probable that martensite, like austenite, is a true solid solution of carbon of iron. If, however, the photogram of martensite is identical with that of pure alpha iron, it would indicate that the hardened steel contains a mass of alpha iron particles, free from carbon. The photograms thus far obtained point in the direction of the first of these possibilities, and it seems probable that martensite is a real atom disperse solution. The diffuseness of the line in the photograms gives very important information as to the structure of this constituent. As Scherrer shows, the lines of a Debye-Scherrer photogram get broader and more diffuse in proportion as the crystal powder is more finely divided. No quantitative comparisons have yet been made for martensite, but from a qualitative comparison, of a film of steel (0·80 per cent of carbon), with the photogram of an extremely fine-grained gold colloid, the authors conclude that the steel is as highly disperse as the colloid. The lines of the martensite seem to be about as broad as those in the gold photogram. The ranges of homogeneous lattice in the steel have accordingly, on an average, an extension of about 20 Å.U., and each of them contains only a few hundred atoms.

In the concluding section of their paper the authors publish photograms of the iron carbide, cementite, Fe_3C. This they have found to be identical with the well-known crystal plates of speigel iron. By means of a Laue photogram and investigations of an orientated rotating crystal of speigel, it has been possible to deduce the crystal data of cementite. The authors conclude that it belongs to the orthorhombic system. Its ratio of axes is 0·670 : 0·755 : 1. The dimensions of its elementary parallelopiped are 4·53, 5·11, and 6·77 Å.U. The base group consists of four molecules, Fe_3C, which corresponds to a specific weight of 7·62 for cementite.

H. C. H. C.

Wireless Telephone Receiving Sets.

A NUMBER of patterns of complete wireless telephone receiving sets are being introduced to meet the requirements of the popular broadcasting services which will shortly be put in operation. It is regrettable that there has been a tendency, in striving after simplicity and cheapness, to cut the apparatus down to rather fine limits, resulting in the elimination of adjustments and features which are most desirable for really satisfactory working. Indeed many of the sets being advertised are little better than toys. It is true that reception of a sort is quite possible with elementary crystal sets, but the unskilled user will undoubtedly be better served by the slightly more expensive valve apparatus which is now being made in simple and convenient forms.

We have had the opportunity of inspecting an equipment supplied by the firm of Radio Supplies (236 High Holborn, W.C.1) which is typical of a good class of apparatus of this sort. This firm's M type set, which is sufficient for all ordinary reception, is of the two-valve pattern, one valve acting as detector and the other as amplifier, the latter being in the low-frequency circuit, forming what is termed a note-amplifier. The valves with their filament rheostats, switches, terminals, etc., are mounted on a compact case, but the aerial inductance is carried on a separate stand. In this the convenient arrangement is adapted of obtaining a variable coupling by turning a simple milled head, which alters the relative angular position of the coils in question. Alternative coils, which can easily be plugged into place on the swinging arm, are used for different "bands" of wave-lengths. The fine tuning adjustment is obtained by a very compactly arranged variable condenser, and by this means the apparatus can be tuned to any wave-length from 180 to 30,000 metres.

With the pattern of valve employed a six-volt accumulator is generally used for the filament circuits, and it is recommended that this be of the 60 ampere-hour size, if the apparatus is in daily use for long periods, as then it will not have to be charged more than about once a week. It is, of course, possible in places where there are absolutely no facilities for recharging accumulator cells, to use large dry cells for the filaments. The high-voltage or anode circuits of the valves are supplied by compact multicell dry batteries at voltages from 30 to 70 volts according to circumstances. These are made up in blocks about 8 inches long of 30 cells each, and in view of the very small current taken from them, should last nine months without renewal.

A set of this kind, which complete with a small aerial and every accessory would cost from 25*l.* to 30*l.*, will pick up in addition to telephony, spark, tonic train, or continuous wave signals. Even with an indoor "aerial," the concerts from the Hague are audible all over the room, with an ordinary telephone receiver. The firm also supply larger sets with further degrees of amplification, but for all ordinary work two valves are quite sufficient.

Obituary.

PROF. A. LAVERAN, FOR. MEM., R.S.

FRANCE lost one of her great men of science when Charles Louis Alfonse Laveran died on May 18 at the ripe age of seventy-six. His death, following so closely on that of Sir Patrick Manson, may be said to close one chapter in the history of malaria, the important preliminary chapter which paved the way for the brilliant and far-reaching researches of Ross and the Italian observers.

Laveran was born at Paris on June 18, 1845, his father, a military surgeon, being a professor at the school of Val-de-Grâce. The son followed in his father's footsteps, for, after completing his studies in Paris, he decided to become an army doctor, and matriculated as a medical student at Strasbourg. He graduated in 1867, submitting a thesis on the regeneration of nerves. In 1874 he joined the staff of the Val-de-Grâce School of Military Medicine, and in 1878 was sent to Algeria, where he remained till 1883. It was in this country, at Bône and at Constantine, that he turned his attention to malaria, and carried out the memorable work with which his name will for ever be associated.

As a result of his labours Laveran was appointed, in 1884, professor of military hygiene and clinical medicine at Val-de-Grâce, posts which he held for ten years. Thereafter, for a short space, he was concerned with administrative medical and sanitary work at Lille and at Nantes, but his heart was given to scientific pursuits, and, desirous of continuing his researches, more especially in protozoology, he relinquished his appointments in 1897, and retired with the rank of *médecin principal* of the first class.

Laveran then entered the Pasteur Institute where he soon became a professor. There he remained for the rest of his life, always busy, a tireless investigator who never flagged until age and infirmities conquered even his indomitable spirit, and he was no longer able to use his beloved microscope and pursue those studies to which he had devoted his life to such good purpose. As Prof. Brumpt pointed out in his address to the Academy of Medicine, a failure in Laveran's powers was noticeable after the fêtes in connection with the centenary of that Institution in which he took an active part. The effort exhausted him, and he no longer attended the meetings of scientific societies with his wonted regularity, a sure sign in his case of the approaching end.

Laveran's greatest work, and that which entitles him to a place in the medical Valhalla, was his discovery of the parasite of malaria. In Algiers he commenced his studies on the pathology of that disease, and his attention was specially directed to the characteristic pigmentation of the liver and brain in fatal cases. This had already been recognised, but it was

Laveran who demonstrated pigment granules in certain bodies exhibiting amœboid movements in the blood. These bodies were crescentic or spherical in shape, and he looked upon them as of a parasitic nature, though it was not until 1880, when at Constantine, that all doubts were swept from his mind by his discovery of the phenomenon known as "flagellation of the male crescent." So remarkable were the appearances presented that he no longer hesitated to declare his belief.

As is always the way in this conservative world when something new and strange is revealed, there was much scepticism as to the validity of his findings, but Laveran, who possessed most of the qualities of the successful investigator, was not to be daunted. By a series of careful observations, pathological, clinical, geographical, and therapeutic, he routed his opponents and eventually satisfied the scientific world that his conclusions were well founded.

Laveran shared the view which King advanced in 1883 that human malaria was a mosquito-borne disease, but he had no opportunity of testing the theory, which was finally established as a fact by Grassi, Bignami, and Bastianelli in Italy in 1897 after Ross had, in India, completed his epoch-making work on the transmission of bird malaria by culicines, and had seen the early stages of the development of the human malaria parasite in anophelines.

The Academy of Science set its seal on Laveran's discovery in 1889 and elected him a member in 1895. In 1893 he became a member of the Academy of Medicine, and he also joined the Society of Biology. It was not, however, until the true significance of his researches had been rendered apparent by the work which resulted from them that Laveran's claims to be in the first rank of living men of science were fully recognised. Then, indeed, he was paid the honour which was his due, and among many other distinctions was given the Nobel prize for medicine in 1907.

Together with some of his colleagues Laveran founded the Société de Pathologie Exotique, of which he was the first president, and during the dozen years of his chairmanship the society prospered greatly. In the *Bulletin* of the society many of Laveran's papers were published, and he did much to forward the cause of tropical medicine and hygiene throughout the French colonial possessions.

Laveran, like Manson, inspired others with his enthusiasm, and was an acknowledged leader in his own subjects. He wrote much on malaria, and collected his contributions in the well-known "Traitè de Paludisme" in 1898, of which a second edition appeared in 1907.

His work at the Pasteur Institute was most prolific, and much of it was carried out in collaboration with Prof. Mesnil. Together they produced an important work on trypanosomes and trypanosomiasis, which reached a second edition, and was a mine of well-arranged information. Laveran was well qualified to write on the subject from the laboratory standpoint, for he conducted a great deal of experimental work on trypanosome infection, and tested many remedies with the view of finding a cure for sleeping sickness. Turning his attention to leishmaniasis, he published the first treatise on this subject, the study of which led him to investigate many of the flagellate parasites of man and animals. The sporozoa of animals had earlier attracted his attention, and he investigated the properties of sarcocystine, the first toxin extracted from a sporozoon, and the pathogenicity of which was determined by Pfeiffer.

Considerations of space prevent any full account of Laveran's manifold activities. He was never idle, and no sooner was one piece of work completed than he was busy at another. His conclusions have not always been generally accepted, but he had ever the courage of his convictions, and adhered to his well-considered views with that tenacity which was so strong a feature of his character. In reality a kindly man, he was apt to be considered a trifle brusque by those who did not know him, especially if they trespassed overmuch on his working hours, but he was ever ready to aid the genuine inquirer and also to give credit where credit was due. He was precise and accurate in his work, careful in his writings, and possessed in a very high degree the scientific habit of mind, qualities which enabled him to stamp his personality on whatever he undertook, and will entitle him, for all time, to a foremost place in the ranks of those who have advanced the causes of parasitology and medicine in the tropics. A. B.

Dr. J. René Benoît.

The world of science has suffered a severe loss by the death at Dijon, on May 4, of Dr. J. René Benoît, honorary director of the Bureau International des Poids et Mesures, Sèvres. Dr. Benoît, who was born in 1844, commenced his scientific career in the study of medicine, but, having attained his doctorate, transferred his attention to pure physics, working first in Jamin's laboratory, where he prepared a thesis on the electrical conductivity of metals. After some years in industrial life he joined the Bureau International in 1878 as assistant director to Dr. O. J. Broch, whom he succeeded as director in 1889. It was at the Bureau International that his great work was achieved. His first investigations were related to the improvement of thermometric and barometric measurements, and were followed by very careful experiments directed to the measurement of thermal expansions, particularly with the Fizeau apparatus, which he greatly perfected, and which continued to hold his interest to the end of his career. Dr. Benoît took a large personal share in the work of verifying the principal series of prototype metres, and executed a number of very accurate comparisons of the International Metre with other current standards of length, including the British Imperial Yard and the ancient Toise du Pérou and Toise de Bessel, on which the original French metre and the geodesic measurements of central and western Europe had formerly been based.

In 1891 Prof. A. A. Michelson was invited by the Comité International to carry out at the Bureau his contemplated researches into the relation between the metre and the wave-length of light. Dr. Benoît threw himself enthusiastically into this work, and was closely associated with it throughout. Again in

1906, when MM. Fabry and Perot took up the same investigations by the new method of superposed fringes, he gave them the full benefit of his earlier experience and every assistance in his power. The remarkable concordance (the difference was not much in excess of one part in ten million) between the results of the two investigations is sufficient testimony to the accuracy of the earlier work, and although possibly it must be admitted that fortune played its part, and that the absolute accuracy was not quite so high as the agreement between the two results appeared to indicate, an accuracy not inferior to one part in a million may, in any case, safely be considered to have been attained.

Dr. Benoît was associated also with the researches of Dr. Ch. Ed. Guillaume, the present director of the Bureau, into the properties of invar, and was closely concerned with the early standardisation of the 24-metre Jäderin surveying wires, which are now almost universally employed in the measurement of geodesic base-lines. He was further interested, from his earliest days, in questions of electrical standardisation, and spent much time in determining the value of the standard ohm. This work, however, was not part of the regular programme of the Bureau, and the pressure of his other duties prevented him from devoting so much attention to it as he would have liked; but for a period the standard ohm produced by Benoit was the accepted type for precision measurements, and the value he obtained was very close to that accepted at the present time. He was still at work on this subject when failing health and eyesight caused him, in 1914, to tender to the Comité International his resignation of the directorship which he had held with so much distinction.

To appreciate the value of Benoît's work and his unsparing labour and painstaking attention to every detail making for precision of results, it is necessary to read the "Travaux et Mémoires" of the Bureau during the period of his direction. In appreciation of his services the Comité International, on his retirement, appointed him honorary director, and he was present in the autumn of 1921 at the sixth Conférence Générale des Poids et Mesures, showing all his old enthusiasm for the work which had filled his life. He had a most unassuming and charming personality, and those who had the privilege of knowing and collaborating with him will feel a very real and personal loss in his death. He was past president of the Société Française de Physique and correspondant of the Institut de France, of the Bureau de Longitudes, and of the Académie des Sciences, honorary fellow of the Physical Society of London and of the Société Française des Électriciens, and officer of the Legion of Honour.

J. E. S.

John Wanklyn McConnel.

A combination of business ability and legal training with real experience of agriculture as well as of textile engineering, directed by a passion for constructive organisation, brought the late Mr. J. W. McConnel to occupy an exceptional position as an exponent of industry in relation to science, and his death on May 25 at the age of sixty-seven is more than premature. His grandfather founded the firm of McConnel & Co., fine cotton spinners, whose mills are now the second largest in the world, in 1797, and Mr. McConnel was thus one of the aristocrats of the industry. The purchase by McConnels of the English patent rights of the Heilman Comber gave him, as a young man, an exceptional experience with the one new machine which the industry has evolved during the century; this experience influenced his outlook in later years, and seemed to render him much less convinced of finality than most cotton spinners, and hence more eager for the application of scientific methods. Incidentally, it may be mentioned that he was one of the first two students in the then new school of engineering at Cambridge. Thus he was led to advance a scheme for the formation of a special department in Manchester University at the British Association meeting of 1915; but, failing to secure a permanent endowment, he obtained the co-operation of the Fine Cotton Spinners' and Doublers' Association to undertake the proposed scientific work, which has since steadily developed into an experimental department of the combine with workshops and spinning mill as well as laboratories.

The original intention was merely in advance of public opinion, for only two years later Mr. McConnel became chairman of a provisional committee of the Department of Scientific and Industrial Research. He resigned the chairmanship, after two years' work, before the British Cotton Research Association was actually constituted, but not before he had laid the foundations of an immense organisation which embraces the whole industry, and aims at breaking down the watertight compartments into which a highly efficient but conservative industry had segregated itself. It is pleasant to recall the graceful acknowledgment of this "spade work" recently made by Mr. Kenneth Lee at a luncheon when H.R.H. the Duke of York formally opened the Shirley Institute, Mr. McConnel being present as a guest.

The thesis of essential community of interest between grower and spinner had found a strong supporter in Mr. McConnel. Travels to the West Indies, Egypt and the Sudan, supplemented by an active personal supervision of a very large cotton-growing plantation in Mississippi, and of his own estate in Ayrshire, placed him in an exceptional position as an authority on spinning who also knew a great deal at first hand about cotton-growing. Having first applied this experience in laying the broad foundations of the British Cotton Industry Research Association, he developed it further on the committees set up by the Board of Trade, his appendix to the Textile Committee's report leading to the formation of the Empire Cotton Growing Committee, and when the committee was transmuted into the Empire Cotton Growing Corporation under royal charter, Mr. McConnel became chairman of its council.

Mr. McConnel was most remarkable in an ability for learning new methods, subjects, and viewpoints which would have been unusual even in a much younger man. The work he initiated for the cotton industry was neither superficial nor conspicuous, but its effects will endure, and he will be remembered as one of those who thought for to-morrow as well as for to-day.

F. W. Sanderson.

MR. FREDERICK WILLIAM SANDERSON, headmaster of Oundle School, whose tragic death occurred on Thursday, June 15, at the close of an address to the National Union of Scientific Workers on "The Duty and Service of Science in the New Era," made a deep and lasting impression upon scientific education in this country. He had just concluded his address, and Mr. H. G. Wells, who presided, had described him as the greatest headmaster that ever lived, when he slid from the chair in which he was sitting, and a few minutes later died from heart failure. Mr. Sanderson, who was born on May 13, 1857, was 11th wrangler at Cambridge in 1882, and assistant master at Dulwich College from 1885 to 1892, when he was appointed headmaster of Oundle School, Northants, which he transformed from a small and relatively unknown institution to a great and leading educational power. No Public School in the kingdom possesses such laboratories and workshops, and in none is it possible for a boy to be better prepared for worthy citizenship in a modern community. In all subjects Mr. Sanderson introduced methods of instruction which are both effective and stimulating. The practical method of teaching science is combined with lessons on the romance of the subject and points of contact with the action of Nature and the work of man in everyday life: library research is encouraged in connection with history and literature: English by reciting and acting an adapted play of Shakespeare's every term: languages by direct methods, and so on throughout the curriculum. Mr. Sanderson was not only an original thinker but also a tireless experimenter in educational methods, and his breadth of interest was so great that the classical and literary work at Oundle is as distinctive as that in science. The spirit of it all is that of education for service—creativeness rather than personal possession—and Mr. Sanderson's last words were a plea for this uplifting principle in every school. Oundle remains a noble monument to his high ideals and their successful achievement.

WE much regret to see the announcement of the death, on June 18, of Prof. J. C. Kapteyn, foreign member of the Royal Society and professor of astronomy and mechanics in the University of Groningen, Holland.

Current Topics and Events.

DIRE experience, in the form of aerial disasters, is emphasising the fact that the new form of locomotion possesses points of difficulty, and that the complexity of the problems presented is unparalleled in any of the older branches of transport. In delivering the annual lecture in memory of Wilbur Wright before the Royal Astronomical Society on June 15, Mr. Alec Ogilvie dealt with some aspects of the problem, and his address contains the following striking paragraph: "It is not my wish to exaggerate the importance to the world's knowledge of aeronautical research of the Wright brothers, but it is my desire to lay the strongest emphasis on the lesson to be learnt therefrom—namely, that the whole basis of aeronautical progress rests on genuine research in the laboratory, on the development of mathematical lines of attack, and on full scale research work in the field, and cannot possibly rest only or even mainly upon technical development." The lecturer said that the national effort put into aerial research was now far below the pre-war standard, and that the importance of fundamental research is not grasped by those in authority in this country. It may be recalled that the Royal Aeronautical Society, to which Mr. Ogilvie was speaking, has taken an active part in bringing the views of scientific aviation to the notice of the Air Ministry, and is the accepted representative body for that purpose. Moreover, during the later stages of the war, when aviation was taking a leading part in fighting operations, Mr. Ogilvie was responsible to the Air Board for its new designs of aeroplane, and this lends additional interest to his statement that "our rapid technical development during the war period, in which we as a nation overtook both friends and enemies after starting a long way behind, was mainly due to the solid research work which was done in the laboratories of this country between 1909 and 1914. It appears to me, however, that there is some danger that the real lessons of the past have not been understood and taken to heart." Mr. Ogilvie claimed for the Wright brothers a greater measure of praise for their demonstration of the firm structure of knowledge than for their superior skill and technique. The latter has hitherto been appreciated and the former neglected, but indications, still only straws, seem to point to a more even balance between research and technique in the immediate future of aviation.

THE Mount Everest expedition has made another new record in altitude. The *Times* announces that Messrs. Finch and Bruce with one Gurkha camped at 25,000 ft. for two nights and, employing oxygen, finally attained an altitude of 27,200 ft. This is 400 ft. above the record reached by Messrs. Mallory, Somervell, and Norton on May 21, and only 1800 ft. below the summit of Mount Everest. The *Times* also publishes a long despatch from General Bruce, giving details of the organisation of camps and transport on the Rongbuk glacier and Chang La (North Col). The route to the highest camp, at Chang La, was very trying, and unsettled weather added to the difficulties, but each camp was made self-complete with stores and equipment, the Chang La camp having food for ten British and a large number of porters, besides a full Alpine kit and the oxygen apparatus. It has been proved that up to 25,000 ft. a camp can be established without employing oxygen, and this gives considerable hope for the final assault on the summit. In the same despatch Mr. Mallory gives an account of the climb from Chang La camp to 26,000 ft. This altitude was reached without much more physical discomfort than

was experienced some 7000 ft. below, but one of the party, Maj. Morshead, was overcome and had to fall out. In such a case long rest at a lower altitude seems to be essential. The pace was very slow, but a greater height could possibly have been reached if the necessity for returning to the camp had not led Mr. Mallory to believe it wise to turn before the north-east shoulder was reached.

THE long drought of 1921 has been followed by excessive flowering of many kinds of trees and shrubs during the present spring, but in no instance has this been more noticeable than in the hawthorn, for both as a cultivated plant and as a wilding it has rarely been known to flower so freely. Dr. C. J. Bond, of Leicester, directs attention to this subject in a letter just received. In addition to its blossoming more freely than usual, hawthorn has been remarkable from the fact that a considerable number of plants have borne pink or pink-tinged flowers. This has given rise to speculation as to the reason for the sudden appearance of so many pink-flowered plants, and suggestions have been made that it may be due to the abnormal conditions of sunshine and drought obtaining last year and during the present flowering time, or to a process of evolution that is gradually taking place in the species. But pink-flowered hawthorns have not been uncommon in a wild state in the past, and it is doubtful whether the actual percentage of pink-flowered plants is any higher this year than in any previous year, but so many more plants than usual are flowering that they attract more attention. Pink and red flowered hawthorns have been grown in gardens for a very long period, and not infrequently they have been planted in parks, hedgerows, and on the outskirts of woods. Seed collectors in autumn are unlikely to distinguish between these and white-flowered trees, while birds are even less likely to discriminate. From such seeds, plants bearing white, pink, or pink-tinged flowers may be expected. These plants, used for field hedges, may 30 or 40 years later run wild and appear as trees, or seeds carried by birds and dropped in uncultivated ground may produce pink-flowered trees. While interesting, the appearance of pink-flowered hawthorns under wild or semi-wild conditions cannot be regarded as a new phenomenon or of great botanical importance, and it is unlikely that any marked natural change in the colour of the flowers throughout the species is in progress.

AN interesting discovery of a prehistoric village site is reported from Sidmouth. During the last year, workmen who have been employed in laying out the grounds of the residence of Mr. D. Chambers in Sidroad, have brought to light a number of objects, more than three hundred in all, and ranging in date from neolithic times to the eighteenth century. The finds include stone axes, arrow-heads, scrapers, flint knives and cores, a quantity of pottery, objects probably of Saxon and Norman date, and modern glass, of which one fragment is dated 1717. One object of flint, about one inch in diameter, is claimed to be a representation of the human face. Many of these objects were found in the course of removing old earthen banks, some of which may possibly have formed part of the original protective works of the site. The river and an adjacent brook provided an ample water-supply, while the site, which is well above the level of the river meadows, is situated within a quarter of a mile from the old Roman road from Exeter to Lyme Regis. The discovery is of particular interest in view of the evidence it affords of continuous occupation over such a considerable period of time. The objects discovered are now on exhibition in the house of the owners of the site and are available for the inspection of visitors, but ultimately a selection from them will be presented to the town.

THE Albert Medal of the Royal Society of Arts for 1922 has been awarded by the Council, with the approval of the president, H.R.H. The Duke of Connaught and Strathearn, to Sir Dugald Clerk, in recognition of his important contributions, both theoretical and practical, to the development of the internal combustion engine, which in its later forms has rendered aerial navigation possible, and is also so extensively employed in the motor car, in the submarine, and for many other purposes. The Albert medal was founded in 1863 as a memorial of the Prince Consort, who was president of the Society from 1843 to 1861, and is awarded annually "for distinguished merit in promoting Arts, Manufactures, and Commerce."

THE annual conversazione of the Institution of Civil Engineers will be held on Tuesday, June 27, at the Institution, at 8.30 P.M.

THE Jenner Medal of the Royal Society of Medicine has been awarded to Dr. J. C. McVail, and will be presented at the annual dinner of the Society on Thursday, July 6.

MR. J. H. NICHOLSON, assistant lecturer in education in the University of Bristol, has been elected to an Albert Kahn Travelling Fellowship. The value of the fellowship is 1000*l*.

BY invitation of the director of the Royal Horticultural Society's Gardens, Wisley, Ripley, Surrey, the annual field meeting of the Association of Economic Biologists will be held in the Gardens on Friday next, June 30.

THE annual general meeting of the Research Defence Society will be held at the house of the Medical Society of London, 11 Chandos Street, Cavendish Square, W.1, on Tuesday, June 27, at 3.30. The chair will be taken by the Rt. Hon. Viscount Knutsford, and a short address will be given by Sir Walter Fletcher on medical research and national life.

IN connection with the annual general meeting of the Eugenics Education Society a conference on "The Inheritance of Mental Qualities, Good and Bad," will be held at the Royal Society, Burlington House, on Tuesday, July 4, at 5.30. Among the speakers will be Dr. Tredgold, Dr. C. H. Bond, Dr. Bernard Hollander, and Mr. R. A. Fisher.

THE following officers and members of council of the Röntgen Society have been elected for the session 1922–1923: *President*: Sir Humphry Rolleston; *Vice-Presidents*: Sir W. H. Bragg, Sir Ernest Rutherford, and Dr. A. E. Barclay; *Hon. Treasurer*: Mr. G. Pearce; *Hon. Secretaries*: Dr. E. A. Owen and Mr. R. J. Reynolds; *Hon. Editor*: Dr. G. W. C. Kaye; *Council*: Mr. C. Andrews, Dr. G. B. Batten, Mr. A. E. Dean, Mr. K. Edgcumbe, Mr. N. S. Finzi, Dr. F. L. Hopwood, Dr. F. H. Johnson, Mr. C. E. S. Phillips, Prof. A. W. Porter, Prof. A. O. Rankine, Sir Archibald D. Reid, and Dr. R. W. A. Salmond.

REFERRING to a paragraph in NATURE of June 10, p. 755, Dr. Marie C. Stopes writes:—"May I correct the impression your paragraph creates that the Clinic and the *Birth Control News* are activities of the Malthusian League, as this is not the case? The Society for Constructive Birth Control and Racial Progress, with which the clinic and news are associated, is a distinct society with a different basis. The policy of the Clinic and the *Birth Control News* is that of *constructive* and scientific control, as distinct from what is commonly understood as Malthusianism."

WE have received from Messrs. C. F. Elwell, Ltd. (Craven House, Kingsway) a handsomely produced catalogue relating to apparatus for wireless communication. A readable introduction deals with the immensity of the field of wireless telegraphy and the superiority of the continuous wave over the spark system of transmission. The most interesting portion is that dealing with the Elwell arc equipment on the Poulsen system, such as the company has supplied to several well-known long-distance stations, including Horsea, Eiffel Tower, Lyons, Rome, and the initial station of the Imperial Chain at Leafield. This apparatus is listed up to 700 amp. in the arc. Interesting details are also given of steel and wooden lattice aerial towers, ship receiving sets, and various accessories.

Our Astronomical Column.

THE METEORS OF PONS-WINNECKE'S COMET.—Mr. W. F. Denning writes that he regards it as highly probable there may occur a meteoric shower on about June 28. It will be a return of the display which he witnessed on June 28, 1916. If the meteors of this stream are connected with the comet of Pons-Winnecke, they will have a period approximating six years, and as the particles appear to be distributed abundantly along a lengthy section of the orbit, a repetition of the phenomenon of 1916 may be expected. It is true that the cometary meteors were not seen at many stations last year, although the conditions appeared promising, but in Japan a considerable number seem to have been recorded. In any event it is desirable carefully to watch the heavens, at the end of June, for further evidence of this interesting display. There will be no moonlight, and the radiant point in Quadrans or Draco will be favourably placed in the earlier hours of the night.

THE SEARCH FOR NEW STARS.—The period of the year is now approaching when the Milky Way will be very favourably placed for observation in northern latitudes, especially towards the end of June, and in July. The constellations Cygnus, Aquila, Ophiuchus, and Scorpio have been fruitful in Novæ in past years, and they offer the prospect of further discoveries. When the moon is not bright the sky in the regions indicated should be scanned carefully for new objects. The best time to conduct the work will be near midnight, when the summer twilight will not seriously interfere.

An observer who is not familiar with a large number of the naked-eye stars, should compare the heavens with a star atlas, and this method, often repeated, will soon enable him to dispense with the atlas. Certain new stars are very quick in their rise to brilliancy, and a vast difference in their magnitude often occurs in a few hours, so that it is really essential to repeat the search several times in the course of a night. Wherever the galaxy runs the observer's eyes should diligently pursue the quest, and other quarters of the sky should occasionally receive attention.

Though twelve new stars visible to the naked eye burst into view between 1848 and 1921, not one appears to have been recognised during the previous 158 years; but this was probably due, not so much to the dearth of such objects, as to the want of capable observers.

COLOURS OF BINARY STARS.—The giant and dwarf theory of star-development gave a solution to an astronomical enigma of long standing. This was the frequency with which the fainter component of a binary tends to blue, while the brighter component is red or orange. On the old view this implied that the component was of earlier type than the bright star, and hence had developed more slowly. Some suggested, as a way of escape, that the blue of these stars might possibly not correspond with that associated with spectral type A or B. It was, however, found possible to obtain spectrograms of some of these blue components, which did not indicate that they differed from other blue stars. As soon as the giant and dwarf theory was mooted, it became clear that for giant stars the blue stage was in fact later than the red or yellow one.

Mr. Peter Doig examines the question from this point of view in Mon. Not. R.A.S. of April, and finds that it gives much the same line of demarcation between the giant and dwarf binaries as that given by the absolute magnitudes, based on all available parallaxes, including the spectroscopic ones. He gives 33 pairs in which the stars are giants, and 75 in which both are dwarfs. The former list includes Polaris, Regulus, Antares, β Cygni, ξ Bootis, etc.; the latter includes Castor and α Centauri. Mr. Doig notes that in some cases of great difference of mass the companion might have become a dwarf of a redder type than the primary, while the latter was still a giant. He then ventures to extend the principle to give estimated parallaxes for some systems not on the list. For example, α Librae is given as a dwarf, with parallax $0{\cdot}045''$; the parallax of Praesepe is estimated as $0{\cdot}010''$. The paper makes an appeal for the substitution of other terms for "early" and "late" as applied to spectral types, which are misleading in the case of giants. Prof. Turner suggested the terms "hotter" and "cooler" as preferable.

Research Items.

FRAZER MEMORIAL LECTURES.—Some admirers of Sir James Frazer's work in social anthropology have contributed to a fund for the establishment of an annual lecture at Oxford. The first lecture in the course was recently delivered by Dr. E. Sidney Hartland, who naturally selected as his study a subject which he has made his own, "The Evolution of Kinship," based upon the important monograph by Edwin W. Smith and the late Andrew M. Dale on "The Ila-speaking Peoples of Northern Rhodesia." The Ba-ila, or Ila people, inhabit the very centre of the continent, on the banks of the Kafue, a tributary of the Zambesi, being descendants of more than one stream of Bantu immigrants from the north and north-east, coming probably by different routes and at different times. The social organisation of this primitive and hitherto little-known community has been skilfully investigated by Dr. Hartland. Like all Bantu tribes, their civilisation is based on the matrilinear clan, the family being a newcomer into the social field, which is struggling with the clan for influence. Its development into a patrilinear institution is plausibly accounted for by the rule that on marriage a wife goes to her husband's dwelling and makes her home there: he does not come to that of her kindred. Thus the developmental sequence, as among the Australian tribes, is from mother to father right. If succeeding contributors to this foundation maintain the high level of Dr. Hartland's inaugural lecture, the Frazer Memorial Lecture marks an important extension of the study of social anthropology in this country.

AN INSECT DESTRUCTIVE TO FLAX.—In the Scientific Proceedings of the Royal Dublin Society, vol. xvi., April 1922, Mr. J. G. Rhynehart contributes an interesting and well-illustrated paper on the flax flea-beetle (*Longitarsus parvulus* Payk.). This species is a serious enemy of flax and one responsible for considerable loss to growers of the crop in Ireland. It is commonly found throughout Ulster, and of recent years has become a pest in flax-growing districts in Co. Cork. The adult beetle kills many of the seedlings by devouring the cotyledons and growing-point of the flax, but will also eat clovers, grasses, and wild species of flax. The larvæ bore into and feed on the roots of the flax plants, but do not appear to cause any appreciable hindrance to growth. Preventive measures consist of the production of strong, vigorous-growing brairds by the employment of suitable cultivation, seed, and manure; in the destruction or removal of all material likely to afford means of hibernation for the adult beetle; and in the stimulation of attacked seedlings by the application of a light dressing of nitrate of soda. Preliminary experiments indicate the possibility of the use of Bordeaux mixture as a deterrent.

NEW FOSSIL SEA COW FROM FLORIDA.—The hinder part of the right maxillary of a species of Metaxytherium, from the phosphate beds of Mulberry, Florida, is described and figured by Mr. O. P. Hay under the trivial name of *M. floridanum* (Proc. U.S. Nat. Mus., vol. lxi.). Its exact geological horizon is uncertain: it belonged probably to the Upper Miocene or Lower Pliocene, while European species belong to the Miocene or in part to the Oligocene.

PALÆONTOLOGY OF THE BURMA OILFIELDS.—For some years Mr. E. Vredenburg has been accumulating data regarding the marine fauna of Tertiary age in Burma, and the large quantity of material collected by officers of the Geological Survey of India, as well as by the geologists of the principal oil companies, now permits of a marked advance on the results as they were left by Dr. F. Noetling in 1897. A general revision of the Tertiary formations of the Burma oilfields region was published by Mr. Vredenburg last year (Records Geol. Surv. Ind., vol. li., Part 3). This has been followed by a series of papers issued in anticipation of complete monographs on the Tertiary molluscan fauna, which will be considerably delayed for the reproduction of the required illustrations. The papers issued so far cover the four gastropod families of Terebridæ (vol. li., Part 4), Pleurotomidæ, Conidæ, and Cancellariidæ (vol. liii., Part 2). The completion of this work, if not unduly delayed, should be of great value to oil geologists in their attempts in Burma to identify in newly explored areas the known horizons of the established oilfields.

CHANGES OF CLIMATE IN AUSTRALASIA.—Mr. R. Speight, as secretary of the Cainozoic Climate Committee, has drawn up a valuable report for the Australasian Association for the Advancement of Science (A. J. Mullett, Government Printer, Melbourne). Evidence is adduced from the fossil floras from W. Australia to New Zealand to show that a general warm temperature prevailed in mid-Cainozoic times. Extensive estuarine deposits with shells, and the occurrence of Diprotodon, point to a high rainfall in the Upper Pliocene and early Pleistocene epochs, in what are now arid, or almost arid, regions in Australia. Desiccation followed, extending in the south and centre to the present day. Agreement is expressed with Prof. T. G. Taylor's conclusion that "the climatic belts are moving poleward from the equator. The desert region is encroaching on the southern coasts of the Continent. The northern littoral is getting wetter." The laterites of the northern territory and of northern Queensland are referred to greater aridity here in early Pleistocene times. The cooling that gave rise to a glacial stage, at any rate in New Zealand, may have been as much as 5° C. (9° F.) in southern Australia, and occurred before the aridity set in. The question of a general southern glaciation is, however, not touched on in the report.

NEW SENSITISER FOR GREEN LIGHT.—Dr. W. H. Mills and Sir William Pope of Cambridge (Journal of the Chemical Society, May, p. 946) have discovered a new sensitiser for photographic plates, which they state to be the most powerful sensitiser for green light yet known. It is especially noteworthy also because the gap in the bluish green, which appears almost always when using sensitisers for this region of the spectrum, does not occur with it. The substance, 2-*p*-dimethylaminostyrylpyridine methiodide, is produced as bright red prisms when condensation is caused to take place between *p*-dimethylaminobenzaldehyde and 2-methylpyridine methiodide with the aid of piperidine. Gelatino-bromide plates, after bathing in an aqueous solution containing one part of the dyestuff in thirty or forty thousand parts, show almost uniform sensitiveness to light of all wave-lengths from the blue to about λ 5600, at which point the sensitiveness rapidly declines and ends at about λ 6200.

Carnegie Institution of Washington.[1]

THE year 1921 marks the completion of the twentieth year of organised research conducted by the Carnegie Institution. The original aim of the Founder was to give encouragement and support to investigations or to constructive thought in any department of science, literature, or art, and it is gratifying to record the fact that at the end of this second decade, the function of research as an activity indispensable to civilisation and as a necessary prerequisite of progress, seems to have come into fuller recognition than at any previous time in history. Industrial and government agencies, as well as academic interests, have given to fundamental investigation a high place in the list of elements essential for advance. To-day one may say with confidence that no investment of funds or of personal effort can find a work of greater dignity and worth, or one which offers a future giving clearer evidence of abundant and continuing reward, than is open in the field of research.

The work of the Institution touches in one way or another upon nearly all of the principal fields of research, and the investigations have been very fruitful. They have been not merely contributions to knowledge, but they are also the basis for much research of application which goes immediately into human use. It is not necessary in a preliminary statement to do more than direct attention to some of the most significant results which have signalised certain phases of the work of the Institution in the past year.

It is doubtful whether any recent discovery in the physical sciences has attracted wider interest or has contributed more to the ultimate possibilities of astronomical and physical science than the measurement of diameter of a fixed star carried out at Mount Wilson Observatory three days after the annual meeting of the Institution last year. This long-desired result was made possible by many years of development of plant and technique, together with the extraordinary skill of Dr. A. A. Michelson and his associates and the clear vision of Dr. G. E. Hale in bringing together all of the elements required for this particular task. Measurement of the diameter of the star Betelgeuse once accomplished, the dimensions of other stars followed quickly. More recently, by a refinement of the original method, Dr. Michelson has opened the way for corresponding observations on a group of stars which seemed to be entirely out of range in the first use of the interferometer on the 100-inch telescope. The results already achieved give confirmation of much important work done by other astronomers and furnish a new starting-point for a great variety of investigations concerning the nature of the universe. In consideration of the critical problems involved, provision has been made for securing assistance and co-operation of other investigators, and Dr. H. N. Russell, of Princeton University, who has added much to our knowledge of the evolution of the stars, is now associated with Dr. Michelson and others in helping to solve the special problems to which Mount Wilson Observatory has given attention.

A significant event in the operations of the Institution is the completion within this year of a survey of the seas of the world by the non-magnetic ship *Carnegie*. Launched in 1909, this unique vessel has voyaged nearly 300,000 miles, covering the principal areas of the great oceans and securing data on magnetic conditions previously unavailable, which, with those obtained by concurrent studies on land, give a map of magnetic variations not hitherto possible. With the completion of the year's cruise by the *Carnegie*, and the summing up of its results, attention may be directed more particularly to land observations, to critical studies of terrestrial and atmospheric electricity, to experimental studies bearing upon the nature of magnetism, and to the assembly and interpretation of the great mass of data made available from all sources through many years of field work.

Beginning with the year 1921, the Department of Experimental Evolution and the Eugenics Record Office have come to function as an administrative unit known as the Department of Genetics. By this change, the biological studies of inheritance, based upon investigation of many groups of plants and animals, are brought to bear more directly on studies of human genetics conducted through the Eugenics Record Office. Important as knowledge of heredity is in its application to the development of the animals and plants which contribute to our needs, there is no group of questions more significant in the complicated organisation of human society than those concerning the meaning and the possibility of direction or control of inheritance in man. Without full understanding of the biological factors concerned, it might appear that intelligence and social organisation have brought relatively large opportunity for degeneration. On the other hand, adequate understanding of the principles governing the course of descent may give to mankind opportunity for more rapid and more advantageous development than has been known in the past lines of evolution of other organisms.

During the past year a modest chemical laboratory has been erected for the Department of Botanical Research at Carmel, California. This department has carried its work farther into the field of physical and chemical research in the effort to secure more information concerning the basis of plant activities. The new laboratory offers improved opportunity for fundamental work on photo-synthesis or the chemistry of compounds arising under the influence of light, and it is hoped that with present facilities a nearer approach to the solution of this difficult but fundamental problem in the physiology of plants may be obtained.

An important project in the purely humanistic field is that concerning the ancient Maya civilisation of Central America. The expedition of 1921, led into this region by Dr. S. G. Morley, has secured most significant new material by the study of the ancient monuments and the excavation of building sites. The story of this people contributes much that may become critical or determinative in the interpretation of early American history; the great bulk of this record still remains unread. In the past year the Institution has had the benefit of effective co-operation in this work by Mr. William Gates, whose study of both the modern and the ancient Maya language involves lines of investigation which should relate themselves closely to the archæological studies.

The more noteworthy of the allotments made by the Executive Committee during the past year were as follows: 14,000*l.* for the Department of Botanical Research, 25,000*l.* for the Department of Genetics, 28,000*l.* for the Geophysical Laboratory, 42,000*l.* for the Mount Wilson Observatory, and 46,000*l.* for the Department of Terrestrial Magnetism.

In addition, there were minor grants aggregating 30,000*l.*, and 20,000*l.* was allotted for the production of publications. The total allocations amounted to more than 250,000*l.*

[1] Extracts from the Report of the President of the Carnegie Institution of Washington, Year-book No. 20, 1921.

Since the foundation of the Institution in 1902 there has been distributed, chiefly by gifts to libraries and to authors, but to a noteworthy extent also by sales, a total of no less than 226,039 volumes of publications of the Institution. During the past year the publication of 23 volumes has been authorised by the Executive Committee at an aggregate estimated cost of 12,000*l.*, and 18 volumes, with an aggregate of 4068 octavo and 1398 quarto pages have been issued. Twenty additional volumes are now in press.

Melanesian Witchcraft.

AT a meeting of the Royal Anthropological Institute on Tuesday, May 23, Dr. B. Malinowski read a paper on Melanesian witchcraft. The natives of the Coral Archipelagoes surrounding New Guinea, where Dr. Malinowski carried out his researches, have no idea of natural death or disease. If undisturbed by sorcery, a man would, they believe, live in perpetual good health to an old age, in fact there is no reason why he should ever die.

When a sorcerer wishes to destroy a man, either as an act of personal hate or professionally for a payment, he first administers a small dose of black magic and produces a slight disorder. A spell in which the victim's name is mentioned is chanted over his house or garden, or into some leaves which are buried near his doorstep. The man sickens and is made more susceptible to further evil magic, which is now made stronger by the application of a more dangerous spell, and the pernicious substance must be administered by mouth or else burnt in the victim's hut. At this stage the patient takes all sorts of precautions; his house is guarded by relatives, his food is under control and, last though not least, he engages the services of another professional man—a sorcerer is always also a healer—who tries to undo by magical means all the evil done by his colleague. The sorcerer is most dreaded at night when he prowls round the victim's house, surrounded by night birds, his assistants, and tries to enter the hut and to burn the deadly substance.

If he succeeds, the patient may die, provided the good magic has not proved more effective than the evil. If he fails, the sorcerer may have recourse to the final rite of pointing the bone. A regular witch's cauldron is prepared and boiled somewhere in the jungle, and into its seething contents the sorcerer chants a most deadly spell, uttering the victim's name. Then he dips into the mess a pointed bone, a stingaree spine, or a short wooden dagger. Afterwards he steals to the village and tries to get sight of the victim without being seen himself. Pointing the dagger towards the man he jerks and twists it in the air, muttering the final incantation. The man to whom this is done will invariably die, unless a more effective magic has been used for his protection.

The sorcerer firmly believes in the powers of his black art. When he undertakes professionally to conduct a case, whether of killing or curing, he will carry out the various rites scrupulously, often risking his life in the attempt to kill by magic, for, if caught *in flagrante delicto*, he would be mercilessly speared.

It has to be realised that sorcery is almost invariably used to avenge some real injury or to punish some one who has broken the tribal law. The victim feels the weight of public opinion against him and this enhances greatly his natural fear of magic. It is important also to realise that black magic is generally used in carrying out the decrees of tribal law and usage, and that it is mainly at the disposal of the chief, the man of rank, and the man of wealth. It thus supplies savage society with the wholesome, though undoubtedly unpleasant element of fear, without which no social stability or order can exist in a primitive community. It is always a conservative force, which ranges itself on the side of existing order, authority, law, and custom. It is most unfortunate, therefore, that whenever European civilisation comes in contact with savages, the first thing done is to destroy, or at least undermine, the power of the black magician. It is one of the many cases where a mistaken zeal for giving savages that for which they are not yet ripe results in the disruption of their own social order and in paralysing their own powers, without the substitution of any effective means of control.

The late Dr. Rivers, in opening the discussion which followed the reading of the paper, referred to the value of Dr. Malinowski's investigations in indicating in particular the place taken by sorcery in the social complex as a whole. When examined in this relation, the resemblance which the sorcery of the Trobriands offers to the sorcery of other peoples as, for example, in the Western Solomon Islands, is merely superficial. Sir James Frazer pointed out the parallelism in the development of the arts and of witchcraft in the Trobriands, and indicated further that the theory which underlies this system of sorcery is mechanical in that the spirit acts upon, but did not enter into, the body.

New Buildings of University College, Nottingham.

THE foundation stone of the new buildings of University College, Nottingham, was laid on Wednesday, June 14, by Lord Haldane, in the presence of a large company from all parts of the East Midlands. The site is situated at the highest point of the Highfields estate, being about 2½ miles distant from the centre of the city. The present proposals include the central building, which provides accommodation for the faculties of arts and economics and also for the administrative offices. The library adjoins. There is also provided a block for the departments of chemistry and physics with room for extensions. The departments of biology and geology will be temporarily accommodated in the central building. The departments of engineering, mining, technology, and the evening work of the College will continue to be carried on in the present buildings in Shakespeare Street.

The new buildings at Highfields have been designed on the unit system in such a way that future development of the University is rendered possible. Provision is thus made for the ultimate transference of all departments to the new site. The erection of the new buildings has been made possible by the great generosity of Sir Jesse Boot. About two years ago he gave to the College the sum of 50,000*l.*, of which 20,000*l.* was to be devoted to the endowment of the chair of chemistry and 30,000*l.* to the building fund. He has now added a further sum of 120,000*l.* towards the latter purpose. At the ceremony on June 14, Lord Haldane announced that Sir Jesse Boot had sent a further cheque for 10,000*l.*, and that an anonymous donor had forwarded a cheque for 100,000*l.* in aid of the movement. These two cheques were put by Lord Haldane in the hands of the chairman of the University College. With this

quarter of a million it will be possible to provide the buildings necessary to allow of the removal of the purely academic side of the University College from its present site, and also to provide the administrative accommodation which will be necessary for the proposed University if and when its charter is granted. The University College, by the terms of the draft charter to be presented to the Privy Council, will form the nucleus of the new institution, to be reinforced from time to time by the association of other colleges in the province as they are approved by the Board of Education. Hence it was appropriate for the architect of the new buildings, Mr. Morley Horder, to describe his drawings in the Royal Academy of this year as of the East Midland University.

The buildings will be of sober classical style in the English tradition of Wren. They will be grouped in a range of quadrangles rising from a lake, some twelve acres in extent, with a terraced garden in front. As the railway passenger approaches by the Midland line from Trent, the white Portland elevations of the various buildings will be seen on high ground to the left. Owing to the conformation of the site a view is obtained from the front of the University over the valley of the Trent.

The Highfields Park which surrounds the University buildings affords opportunities for such extensions as the future may demand. Beyond the ample provision thus made, extending to many acres, the large park, by the noble generosity of Sir Jesse Boot, is dedicated to the use of his fellow-citizens. On the southern side of the lake a wide boulevard, containing alternate roads and avenues of trees, affords an approach to the city from the west, and incidentally a means of access to the University buildings. From this boulevard there will open playing-fields, some of which will be allotted to the University. The amenities, therefore, of the city and the University will be combined in a manner which is advantageous to both. The laying out of the boulevard, the lake, and the park will involve a cost of some 200,000*l*., which again is a gift from Sir Jesse Boot.

The imaginative construction of the whole imposing scheme is peculiarly that of the donor, and his especially is the credit in this respect. There are not many persons who have entered completely into his idea, and it is characteristic of his point of view that he insists that the first part of the buildings to be erected must include the fine terraced garden which shall unite the University buildings with the lake. This garden involves the fine stone retaining walls which are necessary upon the sloping ground. Lord Haldane spoke effectively of the ideal of a civic university, and it thus appears that it will be materialised through a conception which involves, not only the relation of the university to the city, but of the city to the university. Such a conception has formed itself for the first time in the mind of a citizen.

Rothamsted Experimental Station.

THE Society for Extending the Rothamsted Experiments on Agricultural Science held its annual meeting at the Rothamsted Experimental Station, Harpenden, on Wednesday, June 14, when some 80 members of the Society and guests were present.

The morning was occupied in the inspection of some of the experimental fields, which were demonstrated by members of the staff. After luncheon the meeting was addressed by Lord Bledisloe, who presided in the absence of the Duke of Devonshire. Lord Bledisloe described the important function fulfilled by the Society for Extending the Rothamsted Experiments in assisting the station to pursue its investigations in agricultural science. He mentioned that it was hoped with the aid of Government grants to begin the construction of new laboratories at Rothamsted for the study of diseases and pests of agricultural crops, and to make other much-needed additions to the station. As the Government grant is conditional upon the station itself raising a certain sum by private donations, the Society hopes to collect 5376*l*. during the current year for this purpose. Lord Bledisloe concluded by voicing the congratulations of the meeting to the director, Sir John Russell, on the honour of knighthood recently conferred upon him in recognition of his work in agricultural science.

Sir John Russell then gave a brief account of the problems under investigation in the laboratories, after which the Minister of Agriculture, Sir A. Griffith-Boscawen, in a short speech, said that the policy of the Government was to make provision for, and to encourage, agricultural education and research as the safest and best means of helping British agriculture. He added that in this policy he had the support of all shades of agricultural opinion, and referred to the general approval of the recent grant of 1,000,000*l*. for education and research which was made when the Corn Production Act was repealed. Sir Daniel Hall, the Chief Scientific Adviser to the Ministry of Agriculture and a former director of Rothamsted, also spoke, and pointed out the great value of the experimental fields to Rothamsted, in that they focussed attention upon problems which had both scientific and practical interest.

Mr. Shepperson of the National Farmers' Union, and Mr. George Dallas of the Workers' Union, also expressed on behalf of their respective organisations their support of the policy outlined by the Minister of Agriculture.

In the afternoon the visitors inspected the laboratories and discussed with the staff some of the investigations in progress. Special attention was given to the work of the entomological and mycological laboratories, which at present is being conducted in unsuitable and overcrowded quarters. It is hoped that the effort of the Society for Extending the Rothamsted Experiments will enable adequate accommodation to be provided for this work in the near future.

University and Educational Intelligence.

CAMBRIDGE. — Mr. F. C. Bartlett, St. John's College, has been appointed reader in experimental psychology and director of the Psychological Laboratory. Mr. H. A. Cox has been appointed Gurney University lecturer in forestry. Mr. G. S. Carter, Gonville and Caius College, has been elected to a research studentship at Naples and nominated to use the University table there. Honorary degrees are to be conferred on ex-President Taft, Chief-Justice of the Supreme Court of the United States of America, and upon Mr. H. Stone, University lecturer in forestry.

The following elections and awards are announced: to a Harkness scholarship in geology, H. Hemmings, St. John's College; to Frank Smart prizes in botany and zoology, J. Barker, Trinity College, and C. F. A. Pantin, Christ's College, respectively; to the Wiltshire prize in geology, W. D. West, St. John's College.

ST. ANDREWS.—At a meeting of the University on June 9, a letter was read from Prof. A. S. Butler resigning the chair of natural philosophy as at the end of September. It was agreed to announce the

vacancy of the chair and invite applications. The appointment of a professor of education to the chair vacant owing to the death of Prof. John Edgar has been deferred, and applications are invited for a lectureship in education with a salary of 500*l*. a year. The following appointments have been made: Mr. F. Whyte, to be lecturer in engineering in University College, Dundee; Mr. M. McGibbon, to be demonstrator in botany, and Miss J. M. Reid to be demonstrator in zoology at St. Andrews.

THE United States Bureau of Education has issued as Bulletin No. 30, 1920, a supplement for 1918 and 1919 to the Digest of State laws relating to public education which it published in 1915. It shows considerable activity on the part of the State Legislatures, the output of the two years being about 3000 enactments without counting those of local application or ordinary appropriations. Among those of special interest are the provisions for establishing continuation schools. Seventeen States passed laws making attendance compulsory, in most cases until the age of 18, and for not less than 8 hours a week. Numerous laws were passed to promote "Americanization" through adult education in the English language, civics, etc. Connecticut, for instance, established a State Department of Americanization under a Director; New York required the State University to prepare courses of instruction in patriotism and citizenship and provided for enforcing the attendance of children over 8 years of age; Texas provided for at least ten minutes instruction each day in intelligent patriotism, and required school boards to provide a flag for each school building; S. Dakota required instruction in patriotism in all educational institutions, both public and private. Five States passed acts providing for military training in schools, one (New York) requiring such training not exceeding three hours a week for boys between 16 and 19. Illinois passed a law prohibiting fraternities, sororities, and secret societies in schools.

IN Bulletin No. 8, 1921, of the United States Bureau of Education, Mr. W. J. Osburn of the Department of Education of the State of Wisconsin has brought together a large number of extracts from reports made in the course of the past seventy years by English, French, and German observers. His comments are characterised by the United States Commissioner of Education as fair and helpful interpretation. While the object of the treatise is to extract from the work of the critics its maximum value for Americans, it is of great interest to educationists generally and provides most useful safeguards for those who in other lands are endeavouring to obtain inspiration and guidance from recent developments and experiences in American institutions. Most conspicuous among the criticisms dealt with are, naturally, those contained in the report of the Mosely Education Commission which was sent from England with instructions to find out to what extent American commercial prosperity has been due to their educational system. Many of the criticisms are by French university exchange professors; German critics have, in general, it appears, shown a bias in favour of autocratic methods and a consequent lack of understanding and sympathy. While satisfied that American achievements and tendencies compare, on the whole, favourably with those of other countries, Mr. Osburn directs attention to several serious shortcomings. He says, for instance, that conditions in the teaching profession leave much to be desired as regards salaries, security of tenure, and pensions, although the social standing of the teacher is good, while the annual output of teacher training institutions is less than one-fourth of what it should be.

Calendar of Industrial Pioneers.

June 25, 1879. Sir William Fothergill Cooke died.—While a student of anatomy and physiology at Heidelberg, Cooke in 1836 had his attention directed to the electric telegraph, and in 1837, on his return to England, he became a partner with Wheatstone. Joint patents were taken out in 1837 and 1838 for instruments with five and two needles, and in 1845 the single needle instrument was produced. After that the telegraph was speedily adopted on all the railway lines of the country. The first commercial telegraph of Cooke and Wheatstone was erected in 1837 on the London and North Western Railway between Euston and Chalk Farm.

June 26, 1827. Samuel Crompton died.—Employed in a cotton mill in Bolton, where he was born in 1753, Crompton devoted himself to the improvement of cotton machines. After five years' work, by combining the principle of Arkwright's rollers and Hargreaves' spinning jenny, he was able to produce, by means of his "mule," a yarn of hitherto unexampled fineness. Too poor to obtain a patent he remained comparatively poor, but in 1812 the merits of his invention were recognised by Parliament granting him a sum of 5000*l*.

June 26, 1810. Joseph Michel Montgolfier died.—The elder of the brothers, to whom is due the invention of the hot-air balloon, Montgolfier was born at Annonay in 1740, and became, like his father, a paper manufacturer. His first experiments with balloons were made at Avignon in 1782, and on June 5, 1783, Michel Montgolfier and his brother, Étienne, made the first public experiment in Annonay, where a century later a monument was erected to them. The use of hydrogen in balloons was due to the physicist, Charles.

June 28, 1817. George John Singer died.—The inventor of the gold-leaf electrometer, Singer in early life was a maker of artificial flowers. Given to private study he wrote on electricity and electrochemistry, made improvements in electrical apparatus, and at his premises in Princes Street, Cavendish Square, gave lectures which were attended by Faraday and Francis Ronalds. He died of consumption at the age of 31.

June 28, 1915. Charles Ernest Paolo Della Diana Spagnoletti died.—For thirty-seven years—from 1855 to 1892—Spagnoletti was chief electrician and telegraph engineer to the Great Western Railway, and in 1885 served as President of the Society of Telegraph Engineers, now the Institution of Electrical Engineers. He brought out numerous electrical appliances for signalling, recording, and controlling, and was the inventor of a dynamo.

June 29, 1890. Alexander Parkes died.—Apprenticed to a Birmingham brassfounder, Parkes afterwards worked for Elkington and, during a period of forty-six years, took out some sixty patents relating to electroplating and other processes. He discovered the method of using zinc for the desilverisation of lead, and about 1855 invented the material now known as celluloid.

June 30, 1893. Jean Daniel Colladon died.—Of Huguenot descent, Colladon was born in Geneva on December 15, 1802. With the mathematician, Sturm—with whom he made experiments on the velocity of sound in the waters of Lake Geneva—he went to Paris and studied under Ampère and Fourier. Returning to his native city, he became a professor in the Geneva Academy and engineer to the Geneva Gas Co. He lectured on the steam engine, brought out a dynamometer, experimented on hydraulics, and was a pioneer in the use of compressed air for the transmission of power. E. C. S.

Societies and Academies.

LONDON.

Royal Society, June 1.—Sir Charles Sherrington, president, in the chair.—T. H. **Morgan**: The mechanism of heredity (Croonian lecture). The changes taking place when the germ-cells ripen are such that, granting the hereditary elements are carried by the chromosomes, the changes can serve as a mechanism, furnishing an explanation of the principles of heredity discovered by Mendel. In the course of the ripening of the germ-cells, irregularities occur at times in the distribution of the chromosomes, which can be followed in successive generations. The departures from the ordinary course of inheritance that are there shown, are found to be *exactly* related to the new distributions of the chromosomes. The facts furnish convincing testimony that the Mendelian characters are carried by the chromosomes. By the aid of the phenomenon known as "crossing-over" it is possible to determine that the hereditary elements lie in a single line in each chromosome. It is even possible to form a rough estimate of the upper limits of size of these elements, although at present such estimates are necessarily very crude, and are interesting only as the first attempt to determine the size of the "gene."

Geological Society, May 24.—Prof. A. C. Seward, president, in the chair.—A. C. **Seward**: Geological notes on western Greenland. Many localities were visited on the northern and north-eastern coasts of Disco Island, on the coast of Nugsuak Peninsula, also Hare Island, Upernivik Island, Ritenbenk, Sarkak, and Jakobshavn. Greenland is nearly 1700 miles long, with an average breadth of about 600 miles; approximately a hundred glaciers from the inland ice reach the sea, the largest of which, Humboldt Glacier, ends in a cliff 60 miles broad. Various forms of icebergs were seen. An account of the characteristic types of vegetation and the physical and geological features of Greenland was followed by a more detailed description of the Cretaceous and Tertiary sedimentary series of Disco Island and the Nugsuak Peninsula, and of the overlying and protecting basalts which in some places rest directly upon the old Archæan land-surface, to the exclusion of the sedimentary series. Most of the sedimentary rocks are freshwater in origin and there is evidence of recent sinking of parts of the western coast.

Linnean Society, June 1.—Dr. A. Smith Woodward, president, in the chair.—A. C. **Seward**: A study in contrasts: The past and present distribution of certain ferns (Hooker lecture). Ferns spread by vegetative means, and the lightness and resistant nature of their spores make them very successful as colonisers and emigrants. When Treub visited Krakatau three years after its violent volcanic eruption, he found eleven species of ferns as pioneers of the new flora. As a class, ferns are cosmopolitan, though certain of them are strictly limited in their range and highly sensitive to the influence of physical or climatic conditions, *e.g.* the Bracken, *Cystopteris fragilis*, and *Polystichum Lonchitis*. The apparent identity of living with dead plants gives reality to Hooker's idea expressed in one of his letters: "Geology gives no evidence of a progression in plants. I do not say that this is a proof of there *never* having been a progression—that is quite a different matter—but the fact that there is less structural difference between the recognisable representatives of Conifers, Cycadeæ, Lycopodiaceæ, etc., and Dicotyledons of the chalk and those of the present day, than between the animals of those periods and their living representatives, appears to me a very remarkable fact." The unfolding of plant-life through successive stages of earth-history shows a series of outbursts of energy; the records of one period tell us nothing, while those of the next reveal a fresh type of vegetation or, it may be, a single genus in possession of widely scattered regions of the world. The beginnings are always hidden from us. Between the Mesozoic and the Palæozoic records there appears to be a wide gulf. The difficulty of making direct contact between the age of pteridosperms and the succeeding age of ferns may be due to the difficulty of determining whether a Palæozoic fern-like frond should be classed as a pteridosperm or a true fern. In the latter part of the Triassic period we seem to pass suddenly to a new phase of plant evolution which may be intimately associated with some far-reaching event in the physical history of the earth's crust. Possibly crustal foldings in the latter part of the Palæozoic era, and the prevalence of desert or semi-arid conditions over wide regions during a part of the Triassic period, were vital factors influencing the progress of plant development. The rocks accessible cannot give all the clues sought; parts of old continents remain but others are beyond our reach.

The Optical Society, June 8.—Sir Frank Dyson, president, in the chair.—J. **Guild**: Angle comparators of high precision for the goniometry of prisms. The method of substitution is utilised. Measurements accurate to 1″-2″ can readily be made, and with a more elaborate arrangement an accuracy of about 0·1″ is possible. For the latter, minute variations in the direction of a beam of light emerging from a collimator, caused by placing near the focal plane of the latter a "variable prism" of simple design, are measured.—T. **Smith**: The changes in aberrations when the object and stop are moved. If the aberrations of any centred optical system are known, both for an object which intersects all rays transmitted by the system and for the centre of the effective stop, the position in the image space of the emergent portion of a given incident ray is known, and the aberrations in the image of any other object for any stop position can be expressed in terms of those for the first object. The relations in the second case are expressed in terms of the first when the objects are planes normal to the axis of symmetry.—T. **Smith**: The classification of optical instruments. Five classes are proposed, based upon the separation of the four Gaussian constants into two groups according to their signs. This classification cannot be modified by the addition to the system of inverting prisms and the like, and the properties usually associated with the sign of the lens depend upon its class according to the new system. Each class may have systems of positive or of negative power.—T. **Smith** and L. M. **Gillman**: Note on achromatism with one glass. Systems composed of thin lenses of the same kind of glass, and achromatised by selecting suitable positions for the components, are members of the class (AD) (BC), so that if the object is real the image is virtual. Apochromatic systems constructed from normal achromatic lenses belong to the same class. The aberrations for systems constructed of a single glass, but belonging to other classes, are of considerable magnitude.—H. S. **Ryland**: An improved subjective test for astigmatism. The test apparatus consists of an opaque disc perforated along two diameters at right angles with a series of square apertures. These apertures and the distances between them subtend angles of 1′ at the usual testing distance. The plate is illuminated by diffused light from the rear.

DUBLIN.

Royal Dublin Society, May 23.—Dr. F. E. Hackett in the chair.—H. A. **Lafferty**, and G. H. **Pethybridge**: On a Phytophthora parasitic on apples which has both amphigynous and paragynous antheridia; and on allied species which show the same phenomenon. The Phytophthora in question is *P. Syringæ* (Klebahn) and not *P. Cactorum* (Schroet), which has several times been found causing decay of apples both in Europe and America. In addition to these two species *P. Fagi* also produces two kinds of antheridia. The grouping of the twenty-two species of Phytophthora is discussed and the elimination of the recently erected genus Nozemia proposed. The economic significance of this form of apple rot is small.—A. G. G. **Leonard** and Miss A. M. **Richardson**: The occurrence of helium and argon in the boiling well at St. Edmundsbury, Lucan, Co. Dublin. The gas from the well consists almost completely of "nitrogen" with small quantities of carbon dioxide. The removal of nitrogen and carbon dioxide leaves a small amount of residual gas consisting of argon and helium. The percentages of argon and helium are 0·95 and 0·074 respectively.—H. H. **Poole**: Some further notes on the distribution of activity in radium therapy. Tables are given showing the approximate distribution of activity for different arrangements of emanation needles, and the skin activities with tubular applicators of various diameters and thicknesses.

PARIS.

Academy of Sciences, May 29.—M. Albin Haller in the chair.—The president announced the death of M. Ernest Solvay, at the age of 84 years.—L. **Maquenne** and E. **Demoussy**: Plant growth in media poor in oxygen. Seeds of radish, pea, wheat, and rape germinated in sterile sand and wholly submerged in running water gave seedlings possessing an assimilation capacity comparable with a normal plant. If a small proportion of carbon dioxide is added, the weight of the dry-plant material is higher than, or at least equal to, the weight of the original seed. The leaves of certain species of plants (sorrel, Aucuba) can retain their vitality in the absence of air for a long period.—M. **Riquier**: The singular integral figures of partial systems of the first order to which the method of integration of Jacobi applies.—E. **Mathias**, C. A. **Crommelin**, and H. Kamerlingh **Onnes**: The heat of vaporisation and the difference $m'-m$ of the specific heats in the saturated state for argon, oxygen, nitrogen, and hydrogen.—M. Henri Lebesgue was elected a member of the Section of Geometry in the place of the late C. Jordan.—F. H. **Murray**: Drawing arcs of circles of large radius.—J. W. **Lindeberg**: The law of Gauss.—P. J. **Myrberg**: Automorph functions of several independent variables.—M. **Ferrier**: The deviations of light rays passing in the neighbourhood of a star. A theoretical study of the deviations caused by the atmosphere of a star. This is superposed on the Einstein effect, and in certain cases might mask the latter. The cases of the Earth and Moon are worked out in detail.—J. **Guillaume**: Observations of the Skjellerup comet, made with the *coudé* equatorial of the Observatory of Lyons. Positions are given for six consecutive days, May 19-24, together with the positions of the comparison stars. The comet is vaguely circular, of about 0·5′ diameter and without marked condensation.—Mlle. O. **Jasse**: Observations of the comet 1922b (Skjellerup), made at the Observatory of Marseilles (Eichens equatorial, 26 cm. aperture). One position is given, for May 24.—A. **Danjon**: A new interference method for measuring the apparent diameter of stars. The Jamin system of thick plates is utilised. If the star has no appreciable apparent diameter it disappears completely when passing over the centre of a dark band, but if there is an appreciable disc the extinction will be incomplete. A formula is given for the maximum and minimum brightness, and the determination of the diameter is reduced to the photometric measurement of the maximum and minimum brightness when the star is observed through the interferometer. Experiments have been carried out on an artificial star, but the successful application of the method will depend on the influence of the movements of the atmosphere.—Gustave **Guillaumin**: The plane lines of slipping of pulverent, coherent, or plastic bodies.—Jean **Lecarme**: Experiments relating to the course of a pendulum and a chronometer, carried out at Chamonix and at the Mont Blanc Observatory, between August 1 and September 10, 1921. The chronometers were checked by the wireless signals from the Eiffel Tower and showed an unexplained loss of 30 seconds per day. The values of g at Paris, Chamonix, and the summit of Mont Blanc were determined by the pendulum and compared with the calculated figures.—S. **Zaremba**: The relativist conception of space.—Louis G. **Stokvis**: The circular diagrams of unbalanced triphase systems and the definition of their degree of lack of balance.—H. **Weiss** and P. **Henry**: The influence of the time factor on the interpenetration of solids by chemical reaction. Experiments were made on two pairs of metals—silver-antimony and copper-antimony. The depth of interpenetration was determined for varying times and temperatures, and the results given graphically.—Joseph **Blondeau**: Study of some dialkyl benzyl cyanides and the corresponding alcohols, amides, amines, and acids.—R. **Locquin** and Sung **Wouseng**: The action of acetylene on the sodium derivatives of ketones and the preparation of the dialkylethinylcarbinols. The sodium derivative of the ketone was prepared by the action of sodium amide on the ketone in ether or benzene. This is then allowed to react with purified acetylene with continual agitation and the product decomposed with ice-water. Starting with the ketone R.CO.R′ the alcohol R.R′.C(OH).C≡CH is obtained. The generality of the method is shown by its application to four ketones.—L. **Blaringhem**: Sex heredity in *Lychnis vespertina*.—A. **Lécaillon**: The fecundity of hybrids obtained by crossing the male *Dafila acuta* with the female *Anas boschas*. These hybrids form an exception to the general rule and are fertile.—W. R. **Thompson**: Mathematical study of the action of insect-destroying parasites. Duration of the parasitic cycle and the increase of the proportion of parasite hosts.—Emile F. **Terroine** and René **Wurmser**: The energy yield in the growth of *Aspergillus Niger*. This mould growing in a glucose medium, after certain corrections are made, accounts for 66-70 per cent. of the energy of the glucose. It is pointed out that Fingerling, Köhler, and Reinhardt have obtained values of the same order in the case of the growth of the pig.—MM. Georges **Bourguignon** and **Conduché**: Experiments on the introduction of the iodine ion by electrolysis in man, and its elimination by the urine.

SYDNEY.

Linnean Society of New South Wales, March 29.—Mr. G. A. Waterhouse, president, in the chair.—G. A. **Waterhouse** (Annual Address): (I.) The need for a zoological survey of Australia. The fauna of Australia is a national asset, although probably the finest collections of the Australian fauna will be found in museums outside Australia. Systematic zoological survey has not been attempted. Im-

mediate steps might be taken by the Commonwealth Government to institute a Federal Museum, in which could be gathered together specimens of Australian animals and accurate information concerning their distribution. Doubtless many private individuals would donate part of their collections to form the nucleus of such a display of the Australian fauna. (II.) Breeding experiments with the Satyrine genus Tisiphone. The genus Tisiphone is confined to the coast and Main Dividing Range of eastern and south-eastern Australia, and the *T. abeona* extends, with six sub-species, from southern Queensland into Victoria, but specimens from a small area round Port Macquarie appeared to be natural hybrids. In October 1920, pupæ and larvæ of *T. morrisi* were obtained from Urunga, at the mouth of the Bellingen River, and reared. Similarly, larvæ of *T. abeona* from near Sydney were reared. Crosses were obtained and the work carried to the third generation. The results afford some proof that *T. joanna* is a natural hybrid. The distribution of Tisiphone may help in elucidating the physiography of eastern Australia in Tertiary time. Possibly before the uplifting movement at the end of the Pliocene the ancestor of Tisi[illegible] in eastern Australia, and became restricted [illegible] ere moisture was more ab[illegible] as responsible for discontinuous [illegible] opment took place independen[illegible] f this Gap. Later the northern and southern forms were able to reach the coast, and where they met the very complex race *T. joanna* was developed.—W. F. **Blakely**: The Loranthaceæ of Australia. Pt. I. The range and origin of the family were given and the seeds and germination, parasitism, union with the host, adventitious roots, mimicry, dispersal and agents of distribution described.—Vera **Irwin-Smith**: Notes on nematodes of the genus Physaloptera, with special reference to those parasitic in reptiles. Pt. II. A review of the Physaloptera of lizards. The characters useful in the determination of the various species received particular attention.—Marguerite **Henry**: A monograph of the freshwater Entomostraca of New South Wales. Pt. I. Cladocera. Descriptions of fifty species, belonging to seventeen genera, were given; five of the species are new and the presence of others in Australia is recorded for the first time.

April 26.—Mr. G. A. Waterhouse, president, in the chair.—H. J. **Carter**: Australian Coleoptera: Notes and new species. No. ii. A series of Chalcotænia, together with a table of the Australian species, and some Australian species of Stigmodera are described. Eight species of Buprestidæ, eleven species of Tenebrionidæ, and one genus and five species of Cistelidæ are new.—F. **Muir**: A new genus of Australian Cixiidæ (Homoptera). The new genus is allied to Leptoclamys Kirk. Specimens were collected near Sydney. The abnormal development of the front legs indicates that the nymph is probably subterraneous in its habits.—T. Harvey **Johnston** and O. W. **Tiegs**: New gyrodactyloid trematodes from Australian fishes, together with a reclassification of the super-family Gyrodactyloidea. The first species of monogenetic Trematoda belonging to the Gyrodactylidæ from Australasia are described. The hosts comprise seven species of freshwater fish and five species of marine fish. A new super-family and five new sub-families are proposed. In addition to the new Australian genera five others are proposed, mainly for North American species. All the known freshwater species show affinities with Australian marine species, thus emphasising the marine origin of the Australian freshwater fish fauna.

Official Publications Received.

Fifty-third Annual Report of the Trustees of the American Museum of Natural History, for the Year 1921. Pp. 259. (New York.)

Koninklijk Nederlandsch Meteorologisch Instituut. No. 106. Ergebnisse aerologischer Beobachtungen. 9. 1920. Pp. x+176. (Utrecht: Kemink en Zoon.) 3.00 F.

Sitzungsberichte der physikalisch-medizinischen Sozietät in Erlangen. 52 und 53 Band, 1920–1921. Pp. xix+221. (Erlangen: M. Mencke.)

Diary of Societies.

FRIDAY, JUNE 23.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—F. W. Woods: Irrigation Enterprise in India.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—J. W. Fisher: An Experiment on Molecular Gyrostatic Action.—Prof. A. O. Rankine and C. J. Smith: The Viscous Properties and Molecular Dimensions of Silicane.—W. N. Bond: The Pressure-Gradient in Liquids flowing through Cones.—Dr. E. E. Fournier d'Albe: Demonstration of a Mercury-drop Method of producing Visual Effects by Means of Sound.

MONDAY, JUNE 26.

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (at Medical Society of London), at 5.—Prof. F. S. Langmead, Dr. W. P. S. Branson, and Dr. James: Discussion on Cardiac Children as a Public Health Problem.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—F. Coleman: Types of Difficult Extraction and their Treatment.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presentation of the Royal Gold Medal.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—R. A. Frazer: The Oxford Expedition to Spitsbergen, 1921.

TUESDAY, JUNE 27.

RESEARCH DEFENCE SOCIETY (Annual General Meeting) (at Medical Society of London), at 3.30.—Sir Walter Fletcher: Medical Research and National Life.

MINERALOGICAL SOCIETY (at Geological Society of London), at 5.30.—Dr. W. F. P. McLintock and S. R. Ennos: The Structure and Composition of the Strathmore Meteorite.—A. Brammall and H. F. Harwood: The Dartmoor Granite (part), its Petrology and Accessory Minerals.—H. F. Collins: Some Crystallised Sulphates from the Province of Huelva, Spain.—Prof. H. Hilton: The Graphical Determination of the Constants of a Shear.—Prof. H. Hilton: A Note on Crystallographic Notation.—A. F. Hallimond: Glauconite from Lewes.—Dr. L. J. Spencer: Ninth List of New Mineral Names.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Prof. A. Mawer: The Study of English Place-names.

INSTITUTION OF CIVIL ENGINEERS, at 8.30.—Annual C onversazione.

WEDNESDAY, JUNE 28.

ROYAL SOCIETY OF ARTS (Annual General Meeting), at 4.

ROYAL SOCIETY OF MEDICINE, at 5.—Lt.-Col. H. Watkins-Pitchford: Thanatophidia, or Poisonous Snakes of Africa.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—C. E. Tilley: The Petrology of the Metamorphosed Rocks of Start District (South Devon).—Dr. A. R. Dwerryhouse: The Glaciations of the Counties of Antrim, Down, and Parts of Armagh, Londonderry, Tyrone, Monaghan, and Louth in Ireland.

THURSDAY, JUNE 29.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Sir J. J. Thomson: The Analysis by Positive Rays of the Heavier Constituents of the Atmosphere; of the Gases in a Vessel, in which Radium Chloride had been stored for 14 Years, and of the Gases given off by Deflagrated Metals.—Sir Robert Hadfield, Bart.: The Corrosion of Iron and Steel.—Dr. W. B. Dawson: Harmonic Tidal Constants for Standard Ports of Reference in Canada.—Prof. J. C. McLennan and M. L. Clark: The Excitation of Characteristic X-rays from Light Elements.—J. C. Bramwell: An Abnormal Relationship of the Electrical to the Mechanical Response in the Ventricles.—T. S. P. Strangeways: Observations on the Changes seen in Living Cells during Growth and Division.

FELLOWSHIP OF MEDICINE (at Royal Society of Medicine), at 5.—H. J. Paterson: The Diagnosis of Gastric Disease.

INSTITUTION OF ELECTRICAL ENGINEERS (at the Natural History Museum), at 8.30.—Annual Conversazione.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Sir Thomas Horder: Report on Renal Function Tests.—K. Walker: The Accessory Sexual Glands of the Rhinoceros, the Flying Wombat, the Ornithorhynchus, the Zebra, and the Tapir.

FRIDAY, JUNE 30.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at the Royal Horticultural Society's Gardens, Wisley), leaving London 11.15–11.30 A.M.—Annual Field Meeting.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.45.

PUBLIC LECTURE.

(*The number in brackets indicates the number of the lecture in the series.*)

TUESDAY, JUNE 27.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: The Idea of Time in the History of Philosophy (2).