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A "Tour de Force."

THERE are three fundamental subjects in education—the history of our race, the world around us, and the conditions of health, happiness, and effective work. They correspond to Le Play's "famille, lieu, travail"; to the biologist's "Organism, Environment, Function." Fundamental they certainly are, but it is generally admitted that most men know little about any of them and understand less. We are perhaps deplorably slow to learn, but we are also very badly taught. Especially in regard to the history of mankind it is difficult to forgive our teachers, for we spent so long over it (the other fundamentals were for the "modern" side) and we know that we were not unappetised. Yet for bread we got stones. We find the same disappointment among most of our fellows, the disappointment of half-educated men who know their deficiencies. There are well-known ways of making the study of history grip—the use of graphs and charts, the biographical approach, with its calendar of great men, the emotional and dramatic methods so vividly illustrated by Dr. Hayward, and so on; but they seem rarely to be tested in schools or colleges, and widespread ignorance of a supreme subject prevails. We except, of course, those who are by birth historically minded, who learn in spite of bad methods or the absence of any; though even those who know many historical facts seem often like students who are familiar with fossils, but unaware of the æonic pulse and progress of life.

These bitter reflections are prompted, of course, by Mr. Wells's "Outline of History,"[1] which convinces us of sin. For here we find what, in spite of its imperfections, is of the nature of a revelation—a sketch of the continuous movement from the nebula that became the earth to the League of Nations, a suggestion of the sweep and surge of civilisation, not in one corner, but all the world over, an attempt to focus attention on the things that have counted in the past and are living on, around us and in us, to-day. We use such words as "sketch," "suggestion," and "attempt," not in any disparaging way, but because no single man could offer anything else. The book is called "The Outline." There are probably big omissions, unconscious misinterpretations, mistaken accentuations, and so forth, but the point is that Mr. Wells has shown his day and generation the sort of history of the world that every educated man should have as a possession in his mind. It is a fine thing to have achieved what has hitherto been called impossible. We recall two books of many years ago—Haeckel's "Natural History of Creation" and Krause's "Werden und Vergehen"—which traced the cosmic genesis from nebula to consolidated earth, and the organic evolution from Protists to Man, and did this in a vividly picturesque way. They may not have been quite so fine as we thought they were, but, errors and omissions excepted, they were fine books.

Mr. Wells's "Outline" is another such big gift to education. Perhaps it will be a still bigger gift when someone writes another like it from a different point of view. For out of the mouth of two or more witnesses there is some chance of the truth being stated. But, as the author says, the book is an "experimental contribution to a great and urgently necessary educational reformation, which must ultimately restore universal history, revised, corrected, and brought up to date, to its proper place and use as the backbone of a general education. We say 'restore,' because all the great cultures of the world hitherto, Judaism and Christianity in the Bible, Islam in the Koran, have used some sort of cosmogony and world-history as a basis. It may indeed be argued that without such a basis any really binding culture of men is inconceivable. Without it we are a chaos." We would also quote the striking sentence which expresses Mr. Wells's appreciation of what a

1 "The Outline of History: Being a Plain History of Life and Mankind." By H. G. Wells. Revised and corrected edition. Pp. xx+652. (London: Cassell and Co., Ltd., 1920.) Price 21*s*. net.

living conception of world-history may mean: "A sense of history as the common adventure of all mankind is as necessary for peace within as it is for peace between the nations." Yet we go on fumbling with educational methods, if such they may be called, which we know do not grip.

As is noted in the Introduction, it is usual to say that the time-table of instruction is full up, and that the idea of learning world-history is preposterous.

"If an Englishman, for example, has found the history of England quite enough for his powers of assimilation, then it seems hopeless to expect his sons and daughters to master universal history, if that is to consist of the history of England, *plus* the history of France, *plus* the history of Russia, and so on. To which the only possible answer is that universal history is at once something more and something less than the aggregate of the national histories to which we are accustomed, that it must be approached in a different spirit and dealt with in a different manner. This book seeks to justify that answer. It has been written primarily to show that *history as one whole* is amenable to a more broad and comprehensive handling than is the history of special nations and periods, a broader handling that will bring it within the normal limitations of time and energy set to the reading and education of an ordinary citizen. . . . History is no exception amongst the sciences; as the gaps fill in, the outline simplifies; as the outlook broadens, the clustering multitude of details dissolves into general laws."

We are forced to add that there would be no difficulty about the time for instruction if the methods employed were psychologically sound, if the suggestions of "historical associations" and clear-headed enthusiasts were put into practice. It is certain, for instance, that the purely intellectual presentation usually slips off the child's mind like water off a duck's back, and that it ought to. Moreover, in higher classes what is wanted is not history *plus* history, but a discipline in the way of reading history of such a kind that it will be natural to continue learning. What we so often do not get are centres of crystallisation—a less static metaphor than it used to seem.

There are nine books in "The Outline of History"—The Making of our World; The Making of Man; The Dawn of History; Judea, Greece, and India; The Rise and Collapse of the Roman Empire; Christianity and Islam; The Great Mongol Empires of the Land Ways and the New Empires of the Sea Ways; The Age of the Great Powers; and then a prospect—The Next Stage in History. It was said of Buffon that he took all Nature for his province and was not embarrassed; but Mr. Wells has an even wider reach. It seems almost superhuman—to be so well done; but the author tells us frankly: "There is not a chapter that has not been examined by some more competent person than himself and very carefully revised. He has particularly to thank his friends Sir E. Ray Lankester, Sir H. H. Johnston, Prof. Gilbert Murray, and Mr. Ernest Barker for much counsel." There is a long list of authorities who have helped in various ways to keep the book true to the facts (their footnotes are illuminating); and he has been fortunate in securing in Mr. J. F. Horrabin a skilful illustrator who has put brains into his drawings.

It need scarcely be said that "The Outline" is a *personal* document—materials had to be selected, much had to be left out; prominence is given to some figures, others are in the background; the relative significance of various movements had to be judged, and all this has been obviously influenced by the author's philosophy. The difference here between Mr. Wells and other historians is that he is so clearly aware of the relativity of his work. There is another way, of course, in which the book is personal: it is written in good style—clear, picturesque, and incisive—and it expresses throughout the serious purpose of improving things by understanding them. Another personal characteristic, familiar to readers of Mr. Wells's books, is the courage of his convictions.

The First Book gives in very brief compass an account of the genesis of the earth and the evolution of organisms. There are a few points that puzzle us, such as an indication that the breastbone of Pterodactyls had no keel, but the sketch is masterly. The Second Book deals with the ascent of man, his Primate ancestry, the extinct Neanderthal offshoot, the first true men and their thoughts, the differentiation into races, with their various languages. The Third Book pictures the dawn of history, the primitive Aryan life, the first civilisations, the early traders and travellers, the beginning of writing, the emergence of priests, and the establishment of classes and castes. The treatment is a fine illustration of the art of leaving out what obscures the main issues and of the reward that comes to a man of science who has insisted on seeing things clearly. It is of great educational value to have this vivid and accurate picture of the rock whence we were hewn and the pit whence we were digged.

What dominates the Fourth Book is the idea that by the beginning of the third century B.C. there had already arisen in the Western civilisation of the Old World the great structural ideas (1) of communicable and verifiable knowledge, as contrasted with priest-guarded mysteries; (2) of one universal God of Righteousness, whose temple is the whole world; and (3) of a world polity of which Alexander the Great became the symbol. "The rest of the history of mankind is very largely the history of these three ideas of science, of a universal righteousness, and of a human commonweal." The Fifth Book gives an account of the rise and collapse of the Roman Empire—an account which seems to us to betray bias. It was a very unsound political system. "The clue to all its failure lies in the absence of any free mental activity and any organisation for the increase, development, and application of knowledge." It was "a colossally ignorant and unimaginative Empire." When the smash came "there was one thing that did not perish, but grew, and that was the tradition of the world-empire of Rome and of the supremacy of the Cæsars." The Great War "mowed down no fewer than four Cæsars" who insisted on keeping up the evil tradition. We do not hear much of Roman Law from Mr. Wells, but he frankly confesses that he "contemplates the law and lawyers of to-day with a temperamental lack of appreciation."

The Sixth Book is chiefly concerned with Christianity and its idea of the Kingdom of God, and with Islam with its broad idea of human brotherhood under God. It is admitted that the founder of Islam "had to tack on to his assertion of the supremacy of God an assertion that Muhammad was in especial his prophet, a queer little lapse into proprietorship, a touchingly baseless claim for the copyright of an idea which, as a matter of fact, he had picked up from the Jews and Christians about him." Regarding Christianity, the author quotes with approval a sentence from Dean Inge's "Outspoken Essays": "St. Paul understood what most Christians never realise, namely, that the Gospel of Christ is not *a* religion, but religion itself in its most universal and deepest significance." Thereafter follows a passage which will interest many, in which Mr. Wells declares that there is no antagonism between science and religion. What he says seems to us to suggest rather that there is no antagonism between science and *morals*. "The psychologist can now stand beside the preacher and assure us that there is no reasoned peace of heart, no balance and no safety in the soul, until a man in losing his life has found it, and has schooled and disciplined his interests and will beyond greeds, rivalries, fears, instincts, and narrow affections." And then he goes on to say, all too elliptically: "The history of our race and personal religious experience run so closely parallel as to seem to a modern observer almost the same thing; both tell of a being at first scattered and blind and utterly confused, feeling its way slowly to the serenity and salvation of an ordered and coherent purpose. That in the simplest is the outline of history; whether one have a religious purpose or disavow a religious purpose altogether, the lines of the outline remain the same."

In the Seventh Book the Age of the Land Ways is illustrated by the great empire of Jengis Khan and his successors, very sympathetically sketched ("the blood in our veins was brewed on the steppes as well as on the ploughlands"). Land ways give place to sea ways and Western civilisation has its renascence ("Europe begins to Think for Itself," "Paper Liberated the Human Mind," "the expansion of human horizons," "intimations of a new and profounder social justice"). The Eighth Book is devoted to the Age of the Great Powers.

"Tremendously as these phantoms, the Powers, rule our minds and lives to-day, they are, as this history shows clearly, things only of the last few centuries, a mere hour, an incidental phase, in the vast, deliberate history of our kind. They mark a phase of relapse, a backwater, as the rise of Machiavellian monarchy marks a backwater; they are part of the same eddy of faltering faith, in a process altogether greater and altogether different in general character, the process of the moral and intellectual reunion of mankind. For a time men have relapsed upon these national or imperial gods of theirs; it is but for a time. The idea of the world state, the universal kingdom of righteousness, of which every living soul shall be a citizen, was already in the world two thousand years ago, never more to leave it. Men know that it is present, even when they refuse to recognise it."

Glimpses of this same vision we find throughout the book; it is so dominant in Mr. Wells's mind that he has seen all history in the light of it. Whether it makes for good history we do not know; it has made for a fascinating book which it does one good to read. Its influence will be far-reaching.

To what prospect does his study of universal history lead Mr. Wells? The trend of human evolution points in the direction of internationalism —but beyond. "Our true nationality is mankind." Religion and education, closely interwoven influences, have been the chief synthetic forces throughout the great story of enlarging human co-operations: of the former we may look for a revival, of the latter a re-adjustment informed with science. As a necessary basis for world co-operation, as a preparation for a world league of men, there must be "*a new telling and interpretation, a common interpretation, of history.*" And that this book will further. "There can be little question that the attainment of a federation of all humanity, together with a sufficient measure of social justice, to ensure health, education, and a rough equality of opportunity to most of the children born into the world, would mean such a release and increase of human energy as to open a new phase in human history." Mr. Wells looks forward to "the final achievement of world-wide political and social unity," which will be reached by and based on righteousness as well as science, "perhaps with long interludes of setback and disaster," but "it will mean no resting stage, nor even a breathing stage, before the development of a new struggle and of new and vaster efforts. Men will unify only to intensify the search for knowledge and power and live as ever for new occasions." Almost the ending of what we cannot but regard as a great book is a key sentence: "Life begins perpetually."

The Dioptrics of Huygens.

Œuvres Complètes de Christiaan Huygens. Tome Treizième. Dioptrique 1653; 1666; 1685–1692. Fascicule i., 1653; 1666. Pp. clxvii + 432. Fascicule ii., 1685–1692. Pp. 434–905. (La Haye: Martinus Nijhoff, 1916.)

NEARLY ten years have elapsed since we reviewed the twelfth volume of this great work (NATURE, vol. lxxxiv., p. 491), of which vol. xiii., consisting of two parts of altogether nearly 1100 pages, only lately reached us, though dated 1916. It contains everything written by Huygens on geometrical optics, both what was incorporated in the "Dioptrica" published in his "Opuscula Posthuma" in 1703 and 1728, and various extracts from his manuscripts now printed for the first time.

Already in 1652 and 1653 Huygens had written a treatise on refraction and telescopes, divided into three books, and by the present editors called part i. In the next twelve years he occupied himself with the subject from time to time, as appears from his correspondence. In 1665 he resumed more systematically his researches on spherical aberration, and found results which seemed to him so important that he wrote an essay (part ii.) on them. This was soon interrupted by his settling at Paris as a member of the Academy and a pensioner of Louis XIV., but within a year he had a copy made of all he had yet written on the subject, and this is still in existence. In 1668 Huygens tried to verify by experiments his theory of spherical aberration, by which he thought he would be able to compensate the aberration of the object glass by that of the eyepiece; but this led only to disappointment, and he perceived that it was colour-effects which prevented the realisation of his ideas. He next got the idea of forming the object-glass of two lenses, situated close to each other, an idea which was never incorporated in his MS.; and it was probably the uncertainty he felt about the value of his latest results which still made him put off the publication of his work. In 1672 he heard of Newton's discovery of the composition of white light, and after some hesitation he realised its fundamental importance for the problems of dioptrics, so that the results he had himself found had not the value he had supposed them to have, and they were therefore removed from his MS.

In the meantime the undulatory theory of light had arisen in the mind of Huygens, and he proposed to write a larger work dealing with the new theory and its applications, in which his MS. on dioptrics might find a place. But in 1677 he discovered the explanation of double refraction in Iceland spar, which he considered the finest confirmation of his new theory, and beside which all his earlier work on dioptrics appeared to be of secondary importance. He therefore decided to let this work be preceded by a treatise on the undulatory theory of light and its principal applications, without dealing with the theory of lenses and telescopes. This was the origin of the celebrated little book, "Traité de la lumière," which, though not published till 1690, had been practically completed in 1678. Finally, in 1684, Huygens resumed his researches on the magnifying power of telescopes and questions related thereto, and it was probably in the following year that he wrote nearly all that which in the present edition has been put together in part iii., on telescopes. In 1692 he wrote to Leibniz that he seemed to have finished with the subject, though everything was not yet written down. He then numbered the pages of his MS. in the order which he proposed to follow in the final redaction. This pagination was generally followed in the posthumous edition of 1703, but in this way parts written at very different epochs are mixed up together. The present editors therefore preferred to follow the chronological order, so that the gradual development of Huygens's ideas could be clearly seen. A synoptic table at the end of the introduction shows where each section of the two old editions is to be found in the new one, and also what is now printed for the first time.

As already mentioned, the first part is the treatise of 1653 on refraction and telescopes. Of this, Book I. deals with refraction due to plane and spherical surfaces and lenses. Huygens describes various methods of determining the refractive index of liquids or glass, but thinks it unnecessary to attain great accuracy in this, as the value of the index varies slightly for different liquids and different sorts of glass. He then investigates the two principal problems of this book: the determination of the foci of lenses, and of the places where the images of objects in known positions are formed. If this book had been published in 1653, Huygens would have had undoubted priority for most of his results, though he had (without knowing it) been anticipated by Cavalieri as regards foci. But the important propositions on the places of images were quite new. In September, 1669, when Huygens sent to the Royal Society a series of anagrams to secure priority, Barrow's "Lectiones Opticæ" were in the press. In this work there is a determination of the foci of a spherical lens, and of the position of the image of a luminous point situated on the axis of the lens. And when the "Dioptrica" of Huygens was at last published, in 1703, the "Dioptrica Nova" of Molyneux (1692) and a paper by Halley in the Phil. Trans., 1693, had also much diminished the importance of Huygens's discoveries.

Book II. is "On the Apparent Size of Objects seen by Refraction." Among the contents is an elegant theorem of far-reaching applicability. When an object is seen through a number of lenses, and the positions of the eye and the object are interchanged, while the lenses are undisturbed, the apparent size of the object will be unaltered, and the image will have the same position, upright or inverted. A striking application of this was made by Huygens in Book III., where he shows that the magnifying power of a telescope is the ratio of the diameter of the object-glass to the diameter of the pencil of parallel rays emerging from the eye-lens.

Book III. deals with telescopes and contains, among other things, a description of the Huygenian eye-piece.

As described above, part ii. of Huygens's works treats of spherical aberration, and part iii. of telescopes and microscopes, representing the outcome of his lifelong studies and experiments, made in order to improve the theory and construction of refracting telescopes.

These two beautiful volumes reflect as much credit as did the previous ones on both the editors and the printers. The lengthy introduction and the footnotes are most valuable contributions to the history of optics. The numerous figures in the text are facsimile reproductions of Huygens's own rough diagrams.

J. L. E. D.

Analysis of Foods.

Food Inspection and Analysis: For the Use of Public Analysts, Health Officers, Sanitary Chemists, and Food Economists. By Albert E. Leach. Revised and enlarged by Dr. Andrew L. Winton. Fourth edition. Pp. xix+1090+xli plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) Price 45*s*. net.

IT is now some sixteen years since this work was first issued, and in the interval it has become favourably known in this country to analysts and others concerned with securing the purity of foodstuffs. In its general plan the book remains much as it was when the first edition was reviewed in these columns (NATURE, vol. lxxi., p. 50, November 17, 1904), though naturally there have been many additions and amendments. The author and reviser have brought between two covers some essential information upon almost every subject with which, in the exercise of his profession, the food analyst is likely to be concerned—from the "cutting up" of beef and mutton to the equipment of a laboratory, and from the taking of a photomicrograph to the use of a hydrogen electrode. The more he employs the book, the more the reader will be confirmed in the impression that the literature of the subject has been well searched and judiciously abstracted for him.

No doubt this quality of comprehensiveness largely accounts for the success which the work has achieved. Still, the quality has its inherent defect. So many things are dealt with that, even in this bulky volume of more than a thousand pages, little space is left for discussion of the difficulties which arise either in making the various analyses or in correctly interpreting the results. It is here that the personal judgment and experience of the individual analyst must come in. The book gives him valuable help, but of a generalised kind. It puts up analytical signposts to indicate the high roads for him, but when off the beaten track he must find his own by-ways.

In preparing the present edition Dr. Winton has had expert assistance for the revision of various sections—as, for example, those on dairy products, meat, cereals, spices, oils, sugars, colouring matters, and flavouring extracts. A special chapter upon the determination of acidity (hydrogen-ion concentration) by the electrical method is contributed by Dr. G. L. Wendt; this contains a lucid explanation of the theory and practice of the process, with details of the apparatus employed. Very few errors have been noticed, but in the section on alcoholic beverages there are some slight inaccuracies respecting English proof spirit. This contains 49·28 per cent. of alcohol by weight, and 57·10 by volume, instead of the values given in the text (49·24 and 57·06); whilst the correct factor for calculating proof spirit from volume percentage is 1·7535, not 1·7525 as stated. Analysts in this country should be on their guard against using the table on p. 754 for determining the original specific gravity of beer. This table was superseded several years ago, so far as statutory purposes are concerned, and it is now mainly of historic interest. The last remark applies also in some degree to the methods described for detecting and estimating methyl alcohol.

As a whole, however, the new edition well maintains the reputation of the work. It contains so much trustworthy information that chemists concerned with foodstuffs will find it invaluable.

C. S.

Adventitious Plants of Tweedside.

The Adventive Flora of Tweedside. By Ida M. Hayward and Dr. George Claridge Druce. Pp. xxxii+296. (Arbroath: T. Buncle and Co., 1919.)

THIS is an interesting book. The usual lists and records of alien plants are not particularly inviting to the botanist generally, and there is no doubt a tendency to look with a tolerant eye upon the labour which is devoted by many workers to the botanical treasures of waste grounds and rubbish heaps. But the present book, like its prototype in Southern France, treats the whole subject on a high plane, and brings out many important general conclusions. The record is founded mainly on the careful fieldwork of Miss Ida Hayward continued for several years. The main share of the identification and classification of the plants has fallen to Dr. G. Claridge Druce. Dr. Druce is so well known for his intensive studies on the flora of Great Britain that one need only say that this part of the work is in keeping with his high reputation. Not the least interesting section of the book is the introductory part, where a summary of the origin of this adventive flora is given along with a short history of the development of the town of Galashiels and its woollen industry. There follows a review of the sources from which Galashiels derives the wool it manufactures into tweeds. Some little space is given to the remarkable survival of the seeds after the very drastic treatment they are subjected to when the wool is passed through some of the preliminary processes. The results obtained of the temperature-resisting power of certain seeds are certainly very remarkable.

In these days of printing difficulties one must refer specially to the excellent way in which the book has been printed. The general list has not been spoiled by paring down the text from pressure of space. Quite ample summaries of the orders and of the genera concerned are included in the text. With the limitations now imposed on the publications of scientific matter by the greatly enhanced cost of printing, one looks with a certain amount of envy on the appearance presented by the book under review, which is quite up to prewar standard. The correctness of the records and the proof-reading leave little scope for criticism. On p. 235, Fig. 71 is subscribed "Polygonum" instead of "Polypogon." On p. 122 *Cotula coronopifolia* is mentioned as recorded for the first time in Scotland by Miss Hayward for August, 1908. It was previously recorded in the Trans. Bot. Soc. Edin., vol. xi., 1873, p. 256, by Mr. William Evans, near Aberdour, Fife. But these are minor points.

The authors need have no care for what Dr. Druce terms the "scoffs of some suburban botanists at the inexhaustible rubbish heaps of Tweedside." The book is worthy of its place beside "La Flore Adventice de Montpellier." Those interested in the flora of Great Britain, especially from the point of view of the influence of cultivation and industry upon the native flora, would do well to have this book upon their shelf. It raises much wider issues than the mere record of accidental aliens.

Meteorological Constants.

Smithsonian Meteorological Tables. Fourth, revised, edition. (Smithsonian Miscellaneous Collections, vol. lix., No. 1.) Pp. lxxii+261. (Washington: Smithsonian Institution, 1918.)

THE first edition of the "Smithsonian Meteorological Tables" was issued in 1893. It is now fourteen years since the last edition came out, and the opportunity has been taken in the present edition to make a number of changes, some of which call for brief comment.

The tables dealing with the relative accelerations due to gravity at different latitudes have been recomputed on the basis of the recent work of the U.S. Coast and Geodetic Survey. New water-vapour pressure tables have been recalculated from the latest Reichsanstalt investigations, a modification of Van der Waal's formula being employed for the purpose of interpolation.

These alterations have involved extensive revision of a number of associated barometric tables, together with those dealing with the ventilated hygrometer, the treatment of which is very satisfactory. The most important advance in the matter of the wet- and dry-bulb hygrometer was the discovery (known to Belli so far back as 1830) that it may be made a trustworthy instrument if the wet bulb is exposed to moving instead of to still air. Even then different instruments were found to give different readings to an extent depending on the shape and dimensions of the thermometer bulb and stem.

But all such idiosyncrasies were swept away by the later discovery that if an air-velocity of not less than 3 metres per second is employed, agreement results in the readings afforded by various instruments. In practice the velocity of the air need not be known so long as it is above that which gives sensibly the greatest depression of the wet-bulb thermometer.

Among other new tables are those for converting barometric inches or millimetres of mercury into the millibars which now receive international acceptance.

The various logarithmic and simpler trigonometrical tables which appeared in former editions have now been omitted—a retrograde step, we think, from the point of view of the convenience of the reader.

It may not be known to all readers of NATURE that the Smithsonian tables are not obtainable in the ordinary way by purchase through a bookseller.

Our Bookshelf.

Elements of Radiotelegraphy. By Lieut. Ellery W. Stone, U.S.N.R.F. Pp. vii + 267 + xxxiii plates. (London: Crosby Lockwood and Son, 1920.) Price 16*s.* 6*d.* net.

THIS is a work written with the primary object of forming a manual of instruction for those in the wireless branch of the U.S. Navy, but on account of the clear sketch of the subject it gives, it will probably appeal to a wider circle. The way in which the elementary principles are set forth should be appreciated on both sides of the Atlantic. Details are given of several systems better known in America than here, but French and German methods, as well as some originating from this country, are also dealt with. The book has a breadth of outlook which is refreshing after some works which tend towards making one think that all wireless progress is due to one group of investigators. The author does not favour any one system unduly, although naturally he has to base a certain proportion of his remarks upon the various systems employed in the American Fleet. This includes a good deal of interest regarding the recent developments of the Poulsen arc system, and apparatus up to 1000 kw. is illustrated. We only regret that considerations of space have rather curtailed the treatment of the thermo-ionic valve, or "electron tube," and that wireless telephony, as distinct from telegraphy, receives only a passing reference, for it is well known that the American Navy made early advances in this direction. The treatment throughout is non-mathematical; the range covered embraces elementary principles as well as up-to-date methods, and the illustrations are excellent.

Exercises from Elementary Algebra. By C. Godfrey and A. W. Siddons. Vols. i. and ii., complete. (With Answers). Pp. x + 395 + c. (Cambridge: At the University Press, 1920.) Price 7*s.* 6*d.* net.

THE exercises in this book are identical with those in the first edition of "Elementary Algebra" by the same authors, with the exception that some new revision papers have been inserted. The first fourteen chapters deal with elementary algebra up to quadratic equations, graphs, and the graphical solution of equations of degree higher than the second. Then follow thirteen chapters which take in logarithms, surds, progressions, rate of change and simple differentiation and integration. An appendix of eight chapters on various forms of linear and quadratic equations, on factors, etc., has been added.

Catalysis and its Industrial Applications. By E. Jobling. Second edition. (Text-books of Chemical Research and Engineering.) Pp. viii + 144. (London: J. and A. Churchill, 1920.) Price 7*s.* 6*d.* net.

THE first edition of this useful little book was reviewed in NATURE for February 17, 1916. Since that time, the subject of catalysis has undergone extensive developments, and the present edition aims at bringing the book up to date. Besides necessary alterations, two chapters have been added, one on the synthesis of acetic acid, alcohol, and allied compounds, and the other on enzymes, electro-chemistry, and vulcanisation accelerators. A number of references, both to text-books and to patents, are given at the end of each chapter for the assistance of readers desirous of obtaining fuller details of the processes discussed.

William Smith: His Maps and Memoirs. By T. Sheppard. Pp. iii+75–253+plates. (Hull: A. Brown and Sons, Ltd., 1920.) Price 7*s.* 6*d.*

MR. SHEPPARD has spared no pains in making bibliography attractive. He has reproduced by photography original title-pages and maps; he has added portraits, and views of William Smith's homes at Midford and at Harkness—the latter from a good oil-painting. By quoting characteristic passages, including "The Geology of England: Mr. Wm. Smith's Claims," published in 1817, he has given a very interesting and effective picture of the man. The rarity of Smith's original works—only 250 copies seem to have been printed of the four parts of "Strata identified by Organized Fossils"—has rendered Mr. Sheppard's collation of various copies a labour of time as well as of pious erudition. The result is a book that will be welcomed in every scientific library. Smith's sections across various English districts are here given in a reduced form, and we are grateful to the Yorkshire Geological Society for undertaking this liberality of illustration when Mr. Sheppard's memoir first appeared in its Proceedings. As the author points out, Messrs. Cruchley of London, in quite recent years, sold road-maps of English counties reproduced from John Cary's plates (though of course with the addition of railways), and on some at least of these William Smith's geological data still appeared. If the original plates exist, it might be possible to reconstruct for libraries Smith's "Geological Atlas," much as it was issued between 1819 and 1824.

G. A. J. C.

Practical Histology. By Prof. J. N. Langley. Third edition. Pp. viii+320. (Cambridge: W. Heffer and Sons, Ltd., 1920.) Price 10*s.* 6*d.* net.

PROF. J. N. LANGLEY'S work is a laboratory manual containing full directions for students undergoing a course of practical histology. Though primarily a book of histological methods, a description is given of the appearances which should be found after the instructions regarding each preparation have been carried out, but the volume does not aim at being a descriptive histology, and contains no illustrations beyond those of apparatus. Provision is made for the instruction of both junior and senior students, the large type in general representing the course of practical histology for elementary students in Cambridge. Histological methods vary somewhat in different schools, but whatever the general procedure may be, this volume is full of useful information, and may be turned to in confidence for assistance in the preparation of any histological specimen.

Prof. Langley, in his preface, comments on the desirability of histology being taught by the physiologist, seeing that minute structure and function are so bound together. The plea is a good one, but the point of view of the pathologist must not be neglected, for the medical student rarely arrives at a full appreciation of the value of histology until he has studied the pathological alterations which occur in the normal tissues.

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.]*

The Separation of the Isotopes of Mercury.

WE have been successful in achieving a partial separation of the isotopes of mercury by evaporating mercury at low pressure and condensing the evaporated atoms on a cooled surface. The rate of evaporation of the isotopes being inversely proportional to the square root of their atomic weight, and practically every atom leaving the liquid being condensed on the highly cooled surface, a partial separation of the isotopes of mercury was to be expected.

By using the pyknometer method the following numbers have been obtained in one set of experiments for the density of the condensed, and in another set for that of the residual, mercury, when taking the density of ordinary mercury as unity:

Condensed mercury ... 0·999980
Residual mercury ... 1·000031

The apparatus contained 40 c.c. of mercury. In the first set of experiments about one-seventh of the mercury was evaporated and the density of the condensed part determined; in the second set about three-fourths of the mercury was evaporated and the residual portion examined. After the separation every portion was distilled again several times in the ordinary way and the density measured after each distillation. No difference was found between these measurements, the error of measurement of density being less than one in a million.

J. N. BRÖNSTED.
G. HEVESY.

Physico-Chemical Laboratory of the Polytechnic High School, Copenhagen, September 23.

The British Association.

THE leading article in NATURE of September 16 directs attention to a matter which must have exercised the thought of most men of science. There is certainly a widespread feeling that the British Association might be better occupied than in listening to papers on special subjects, often given before very small groups of people. Speaking of my own section, that of Physiology, it has become more and more difficult to get promises of communications of this kind, and discussions on questions of interest at the time have been arranged. I am inclined to think, however, that the addresses of presidents of sections are useful when they present general aspects of the science which would be inappropriate in papers published in the proceedings of learned societies or in journals and describing original discoveries. The discussions would undoubtedly be of more value if the practice of joint meetings of several sections were more extensively made use of than is the case at present, since it is becoming less and less possible for a worker in any one branch of science to acquaint himself with advances in other branches, although these may have a very material bearing on his own work. There can be no doubt that the more he knows of other sciences the better equipped is the worker in any particular branch. If the Association were able to remove some of the dangers of the excessive specialisation into which modern science seems to be drifting, it would be a function useful to men of science themselves. I am inclined to think that the reading of original papers, and probably also discussions on subjects of interest, to one section only might well be given up.

But, however this may be, I thoroughly agree that the chief function of the British Association is to arouse interest in science amongst the general public. How this is to be done is not an easy problem. One thing that might certainly be done is to adopt the suggestion of the *Electrician*, and arrange that the latest discoveries in science should be described in simple language. It seems to me that this should be done by several individual workers rather than by one lecturer alone, even in the case of a subject of comparatively narrow field. It is not always possible to know where a hearer may find difficulty of apprehension, and different ways of putting things aid in clearness of grasp. In fact, something more in the nature of a public discussion might be more stimulating and instructive. I am somewhat ignorant as to how far the popular lectures as at present given can be considered to be successful. Personally, I find a set lecture of a length approaching an hour somewhat tiresome; but opinions differ as to this. The presentation of a new discovery by more than one person might tend to overcome the difficulty referred to in the article in NATURE, namely, the fact that genius for discovery is not always associated with facility of popular exposition or with an attractive manner of bringing out its importance. At the same time it should not be forgotten that there is a natural interest in hearing an account of a new discovery from the lips of the man who made it, even though he may not be able to make it as clear as may another speaker whose gifts are of a different kind. Men of science themselves are not devoid of this interest or curiosity. If the practice of formal lectures is followed, I feel sure, from remarks that I have heard, that the method adopted at the Royal Institution is the best—I mean the absence of any introduction or votes of thanks. At the end of an hour's lecture the audience is more or less fatigued and apt to be impatient of the kind of remarks usually made.

If the Association were known to be made up of members from all kinds of callings and positions in life, its pronouncements on such national problems as the teaching of science in schools, the relation of science to the public services, and so on, would have a greater influence. It has already done good work in this way, and could do more.

There is another way in which I venture to think the Association might be useful. Sensational, exaggerated, and inaccurate statements with regard to supposed new discoveries appear from time to time in the daily Press. Those unfamiliar with the facts find it difficult or impossible to learn the truth about them, and when the statements are found at a later date to have no basis scientific credit is likely to suffer. Such assertions as the overthrow of Newton, and even of the foundations of science, by Einstein's work, and the wild statements about the transplantation of glands of internal secretion and about Besredka's work on immunity, require authoritative correction. Possibly committees of a more or less permanent character might meet throughout the year, but it is not easy to see how it could best be done.

The mention of committees suggests an appreciative reference to the Special Reports issued from time to time by the Association. These are frequently of great value as showing the wide bearing of facts in one branch of science upon other branches. The reports on "Colloid Chemistry" may illustrate my meaning. These various reports are by no means so widely known as they should be, and this part of the activity of the Association might well be continued.

I feel some doubt as to whether the research committees repay their cost, and whether their work would not be better transferred to the Department of Scientific and Industrial Research or to the Medical Research Council, as the case may be.

This letter contains little, it is to be feared, in the way of suggestion for constructive advance, but I should like to add my testimony in support of the position taken up in the article in NATURE.

W. M. BAYLISS.

University College, London, September 21.

THE leading article in NATURE of September 16 brings out very clearly what many of us feel to be an increasing difficulty at the meetings, not only of the British Association, but also of most other scientific societies. In fact, it is scarcely an exaggeration to say that members sit through the bulk of meetings and listen to the majority of papers out of mere courtesy. Only in rare instances, when the paper read happens to touch the listener's special line of work, can one take an intelligent interest in the proceedings. Even then it is wise to wait until a paper is in print before forming an opinion. Some good-natured person, however, often sacrifices himself and offers a few trite, and usually irrelevant, remarks which pass muster for a discussion. Under these conditions one is tempted to ask oneself what real good is achieved by such meetings and in what way they can help the progress of research. I admit this state of things is far worse in some subjects than in others; in mathematics it exists in an aggravated form. On the other hand, I have rarely attended a meeting of the Royal Astronomical Society without being stimulated and interested. But this defect is found, in varying degrees, at every scientific meeting, and it grows steadily worse as years go by.

Much of the trouble seems to be due to the increasing subdivision of the departments of science and the tendency of each subdivision to create a nomenclature of its own, so that science is being rapidly threatened with the curse which fell upon the builders of the Tower of Babel. Often a mere name, which if explained in terms known to all scientific workers would be at once mastered, proves a decisive stumbling-block. Thus it is not infrequent to hear the engineer complain of the general unintelligibility of the ordinary mathematician or physicist, but he seems entirely unaware that he himself uses what seems to the others an equally unintelligible jargon.

Another contributory cause, to which your leading article alludes, is that the rapid growth of many border-line sciences is now overshadowing the old recognised domains. In much of the new physical chemistry, for instance, both the physicist and the chemist brought up on classical lines feel themselves equally at sea. The thing has grown up unnoticed, as it were; they have had a glimpse here and a glimpse there, but they have no clear understanding of the new foundations or of how their own work is affected by the new developments. Many would like to obtain this understanding, but find that in order to do so they must first read up hundreds of scattered original papers containing 90 per cent. of matter of no interest to them, and they may have neither the time nor the inclination for the task. The fact is that research in such border-line sciences has outstripped the text-book writer; and although text-books are often bad, they nevertheless have a useful, even an essential, function to fulfil.

If such are the difficulties confronting the trained scientific worker, what are we to say of the intelligent amateur in a provincial town, such as the British Association regularly visits? To him, indeed, much must be Greek, even of the presidential addresses; and the papers, many of quite special and trivial interest, which make up the bulk of the business of the sections, can make no appeal whatever. Indeed, the only surprising thing to me is that any such persons attend the meetings at all; it speaks volumes for their keenness and devotion that some do.

But if the British Association is really to take for one of its tasks the bringing of science home, so to speak, to the British public, if it is to give its energies to what the French call "vulgarisation," and if in addition it is to promote co-operation and understanding between workers in different branches, then it must modify not only the procedure at its meetings, but also the character of its printed reports. These are often scrappy and confusing in the extreme. More attention ought to be paid to systematic expositions of recent scientific developments set forth in such a manner that they can be read and understood by everyone with a fair all-round scientific education, and supplemented by exhaustive references for those who wish to go into the subject. Such "Reports on the State of Science" will not be a new departure in the history of the Association. A good recent example of a difficult mathematical subject so treated is to be found in H. Bateman's report "On the History and Present State of the Theory of Integral Equations," printed in the 1910 Report. On the other hand, much of the material now published under the heading "Reports on the State of Science" seems to me far too special, and could with advantage be published elsewhere.

As to the meetings, I agree entirely with the view expressed in the leading article that the function of a section "should not be technical discussion by specialists for specialists, but the enlightenment of an extensive group of workers as to main lines of advances in fields not specifically their own." To obtain this result what is needed is not a succession of papers by individual specialists, but rather one or two stimulating addresses by a carefully selected lecturer who can be trusted to avoid the faults referred to in your article.

At the same time I suggest there should also be social and entirely informal meetings for semi-private discussion. These should be for real, effective comparing of notes by workers on the same lines, each set chatting round its own table; a member, during the course of one meeting, might talk and listen at several tables in succession.

About organisation, the arbitrary division of science into watertight sections is inevitably bound to lead to trouble as subjects grow. (Incidentally, there is much to be said against the present classification.) The main trouble, however, is that with the sections as at present it is nobody's business to arrange joint meetings to deal with border-line subjects. A possible solution would be to have standing joint committees of groups of sections, the sole duty of which should be that of co-ordination. If need be, the same section could appear in more than one group; thus chemistry might take its place both in a physical and in a physiological group.

L. N. G. Filon.

University of London, University College,
September 21.

The problem of the best use that we can make of the annual meetings of the British Association is one that presents many difficulties. There is so much to be accomplished and so little time available—less than ever since 1914, though in this respect I understand the former conditions are to be restored next year.

At present the most important functions of the Association are to stimulate and maintain the interest and activities of local workers, and to enable men of science who are engaged on problems which require the co-operation of a number of observers scattered about the country to obtain new recruits. At the same time the meetings give them the opportunity of addressing a wider audience than that afforded by the scientific societies—an audience which includes a large number of university workers who are resident in the provinces during the university terms and a certain proportion of the men and women, all too few in number, who take an intelligent interest in science, though they have not adopted it as a career.

But, as you have indicated, the Association has almost wholly failed to appeal to the man of at least ordinary intelligence and education who has never seriously considered the purpose and achievements of science. This is, I believe, largely the fault of the methods of our schools. If science has been taught at all, the aim has been to drill the pupil in the use of correct technical language and in the exact mathematical expression of natural laws, instead of to implant a living interest in the subject—a far more important matter in the early stages of mental development.

However that may be, the task with which we are now faced is to attract to the meetings those who are at present quite apathetic about all that concerns the progress of science. We already have a few popular lectures on Royal Institution lines, and no doubt it would be desirable to increase their number; but they should be comparatively brief—forty minutes at most—and arrangements should always be made for the discussion of debatable points by competent speakers. Nothing is so calculated to increase the interest and facilitate the understanding of a subject as its presentation from different aspects. Perhaps the greatest successes of recent meetings have been the inter-sectional discussions, which have on one hand aroused popular interest, and on the other done much to develop co-operation between different branches of science.

I am not in agreement with the idea that a meeting of the British Association should not be made an occasion for the announcement of new discoveries or for the description of new developments in research. Provided they are not of too abstruse a character, they are of great value in increasing the prestige of the Association among its members.

If, however, we wish to attract larger audiences of the general public and secure a wider membership, we must do more to advertise the meetings. Something in the nature of a *catalogue raisonné* of the more interesting features should be circulated some weeks beforehand, especially in the neighbourhood to be visited. Short illustrated articles should be contributed to the local papers indicating the topics that are to be considered and the problems that present themselves for solution—sufficient to whet, but not to satiate, the curiosity of the man in the street, so that he may understand that he will not be compelled to listen to dissertations on abstract subjects in unintelligible phraseology, but will have the opportunity of hearing important and interesting questions discussed in a simple, straightforward fashion that any intelligent man will be able to follow.

John W. Evans.

Imperial College, September 22.

I have been greatly interested in the leading article in Nature of September 16 on the position of the British Association. Anyone is interested in an expression of his own views in better language than he can himself command.

While it is the function of the several scientific societies to do their utmost for the advancement of science, each within its own narrow limits, the Royal Society affording common ground for discussion for the *élite* only, the British Association has primarily a double duty to the nation and to the world. On one hand, it should encourage the "cross-fertilisation of the sciences," as no other body can, by bringing together the members of its various Sections so that each may help the others. This co-operation is valuable, not simply on the border-land where the sciences appear to come in contact, but also because it may penetrate the whole area of a science. Perhaps the time is not far distant when we shall cease to speak of "a science," and the unity of *science*, already begun to be recognised in the elementary schools, will be universally acknowledged. It has been stated that when two Sections meet in common the attendance is greater than the sum of the attendances at the separate meetings of the same Sections. This indicates the need, and the direction in which to look for improvement. On the other hand, the Association is mainly responsible for making known to the public the recent advances in science and their bearing on social life—in other words, their possible practical applications. To this end representatives of each Section should be annually appointed for the task of reporting to the next meeting, in terms which will appeal to the man in the street, the progress which has been made in the advancement of science and its applications. It has even been suggested that two sets of reports should be prepared in this way, one as described and the other for experts, and that these reports should form the chief material for the meeting, not much encouragement being offered to original papers suitable for their respective societies. In the preparation of these reports there should be much intercourse between the representatives of the several Sections, and many of them should be the result of joint work. In some cases distinguished investigators should be invited to describe their results in popular language, irrespective of previous publication in the transactions of learned societies. The advancement of science depends not only on the skill and genius of the expert, but also on the appreciation of the people.

September 24. WM. GARNETT.

As one who regularly attends the meetings of the British Association, and in particular those of Section A, may I be allowed to state that I cannot recall in the last twenty years any meeting of the Association when the attendances at Section A were more numerous than at Cardiff. On several occasions it was almost impossible to obtain a seat in the large lecture hall assigned for our meetings unless one came in good time. This was particularly the case when the discussion took place on the constitution of the atom, so admirably exposed by Dr. Aston and by Sir E. Rutherford. A very large audience also assembled to hear Sir Oliver Lodge's controversial note on popular relativity, and the room was full for the discussion on the origin of spectra. And, too, the majority of those who attended, or at least a very large proportion, were not professional physicists, but members of the Association who take an interest in science in general, and who came to hear about the latest advances in physical science. It is for these members that the Association caters, and it would seem that, so far as Section A is concerned, it is fulfilling its functions quite admirably.

This testimony as to the efficiency of the Association may serve as an antidote to some of the jeremiads as to the decadence of the Association which have appeared in the columns of NATURE. The only drawback to the complete success of Section A was that some of the speakers did not seem to realise the very indifferent acoustical properties of the hall in which our meetings were held.

The relatively meagre attendance at the two evening discourses was accounted for by the local strike of tramwaymen. This made it difficult to get to distant parts of the city when the discourses were finished. A. L. CORTIE.

Stonyhurst College Observatory, September 25.

IN your leading article in NATURE of September 16 you have expressed what many of us have long felt: that the British Association is losing its interest for the people of the locality in which it meets. This is mainly on account of the highly technical character of most of the papers, which are suitable only for meetings of the special societies. The Association should not be regarded as a means of publishing new observations unless these are of fundamental importance. Its object is rather to give an opportunity for the local worker to exchange ideas with those who are more favourably placed. Again, the laboratory worker may come in contact with the practical man in many subjects to the benefit of both. Another useful function it may perform is in the discussion of border-land subjects in which more than one Section may be interested, and which do not lie definitely within the limits of any one of the special societies. In these functions, the extension of scientific interest to wider classes of the community and the removal of the barriers between different sets of scientific observers, the Association may meet a crying need of the time. ARTHUR R. CUSHNY.

University of Edinburgh, September 27.

Uses for Aircraft.

WHEN in the year 1912 I gave the first of the James Forrest lectures on aerial flight, I said that the chief uses of aircraft would probably be for the purposes of war or for sport. As a member of the Advisory Committee for Aeronautics I have been in a position to follow the various developments which have been made since that date, but I see no reason to alter my opinion. While the cost of carriage by air is as high as it necessarily must be at present, the commercial use of aircraft on any considerable scale seems impossible. There is no difficulty in carrying goods; the difficulty is to find any class of goods which, for the sake of halving the time of transit, will bear the increased cost of carriage. A certain small amount of postal work, with a few passengers, so long as the novelty is an attraction, or in special cases, seems to be the only opening. If the ton-mile cost could be reduced to as many farthings as it now is shillings, commercial uses on a much enlarged scale would be found.

For sport and private use (*i.e.* for air-yachts) the existing patterns of machines would have to be altered to allow of a greater range of speed and a greater facility in getting off and landing. Both these objects could be attained by the introduction of wings of variable area. It would be a great advantage also, both for storage and in other ways, if the wings could be properly folded (not merely unshipped and turned back) by the pilot from his seat. I have shown in another place how this might be done for monoplanes, and for these the necessary mechanism is simple. For biplanes it would be more difficult to design, but not impossible.

Among the more special uses of aircraft may be mentioned those of map-making and exploration in difficult countries, and of obtaining information regarding winds and other meteorological matters at various altitudes.

For exploring purposes the machine should be amphibian. In New Guinea, for instance, it is only at a few places on the coast that it would be possible to come down and get off on land not previously cleared, but many of the rivers reach far inland, and (judging from photographs) places could be found even near the mountains where there is a water-surface sufficient for the purpose, provided that the machine has great climbing capacity and a wide range of speed.

An expedition which had aeroplanes at command would have the advantage of photographic maps of the whole district it proposed to explore, and could therefore choose the best routes. Supplies also, which would take days to carry by canoes and porters, might be brought from the coast by air in a few hours; and one has only to read the accounts of previous expeditions to realise what a difference it would have made in the results had the geography of the country been known in advance and had there been no fear of scarcity of provisions.

Among the many ways in which aircraft could help in meteorology, not the least useful would be an examination of the trade winds, especially as regards their variations in altitude and their vertical components in different latitudes. At the present time not much more is known about these winds than their velocities and distribution on the earth's surface.

Exploration and meteorology are scarcely, or only indirectly, commercial matters, and comparatively few aircraft would be required for the purposes suggested, but results of great value might be obtained by their use.

A. MALLOCK.

September 21.

Minerals Hitherto Unknown in Derbyshire.

DURING the past three years I have been conducting investigations relating to the mineralogy of Derbyshire, checking and confirming (or contradicting) asserted occurrences, surveying mineral deposits, and also prospecting, with the result that several minerals —chiefly of scientific interest only—hitherto unknown in Derbyshire have been discovered. The work is not quite completed, and I have not yet issued any paper or other publication upon it, but the following observations may be worth putting on record now:

Zaratite, Nickel-ore.—Samples of this mineral, of a pale emerald-green colour, and usually containing a large quantity of hydrozincite, were recently found in old dumps of decomposed dolerite raised during the early working of a local mine driven in search of lead-ore. When following up the search for further nickel, some nickeliferous hydrozincite (or zinciferous zaratite) was found which was of a blue colour instead of the pure green of zaratite. On analysis this was found to contain *cobalt*, which probably existed as *remingtonite*, the accompanying zinc and nickel existing as their hydrous carbonates. The "mineral" is, therefore, probably a mixture of the three mineral species, hydrozincite, zaratite, and remingtonite.

Considerable difficulty attaches to the following up of such finds with the view of ascertaining the quantity available, as many of these mines are of considerable antiquity and dilapidation, having been driven in search of lead-ore when little or nothing was known of the rarer metals.

Nephrite, Jade.—Near the margin of a basalt quarry at Bonsall a somewhat lenticular nodule-shaped lump of white nephrite was found.

Diabantite.—Beautiful specimens of this uncommon member of the chlorite group of complex silicates were found at Mill Close Mine, Darley Dale, having been raised during the early working of the mine. It occurs in the much decomposed dolerite as radiated spherical aggregates (up to 2 cm. diameter) and of a dark green colour. It is usually associated with calcite in amygdaloidal cavities, has a specific gravity of 2·79, a hardness of 2·3, and is strongly pleochroic.

Cimolite.—A hydrous aluminium silicate. A thin bed of this mineral occurs near Hopton. It is quite white, amorphous, and chalk-like.

Allophane.—A hydrous aluminium silicate. Many of the numerous rake-veins in the mountain limestone of the Middle Peak region are rich in forms of limonite, but chiefly the earthy variety—ochre. In one of these veins which is cut in the Coal Hills Quarry, near Wirksworth, allophane is to be found in more than one form. The commonest form is that of a light amorphous powder; it also occurs as an opaque, white encrustation, and as a translucent, sub-crystalline encrustation of the faintest green tinge due to the presence of a minute trace of malachite.

Utahite (?).—The limestone-shale in the vicinity of Wensley contains a quantity of an insoluble basic ferric sulphate as dull, yellowish-brown films in the shale. Its mode of occurrence renders its accurate analysis difficult, but it seems to be a variety of utahite.

Native Sulphur.—"Native sulphur is said to have been found" is recorded by ancient writers, but no confirmation in recent years seems to have been made. A good specimen was recently found near Eyam. It is a greyish-yellow powder, burning readily when ignited.

Manganese-ore.—Manganese is not a new discovery; the indefinite hydrous oxide—wad—has long been known to exist in certain districts in the county. It has also been previously worked, but the present scarcity (recently mentioned in the House of Commons) led to the work of prospecting for a deposit to be mined on as large a scale as possible. This work has been successful, and arrangements are being made, by the company for which the work was undertaken, for the mining of the ore.

C. S. GARNETT.

Riber View, Oak Road, Matlock,
September 16.

Wheat-bulb Disease.

IN view of their economic bearing and of the nearness of the wheat-sowing season, the data given below should be widely known, all the more that in the latest notice I have seen regarding the life-history of the insect pest concerned (*Rev. Applied Entom.*, June, 1920, abstract of papers by R. Kleine in *Zeitschr. f. angew. Entom.*, Berlin, 1915–16) the practical conclusions given appear to be entirely misleading. These conclusions are that "wheat should be preceded by root crops" and "it is apparently useless to attempt to grow wheat or rye on ground which has not been under cultivation for some time." Now it is chiefly among root crops, especially potatoes, and on fallow ground that the insect elects to lay its eggs. This month, for example, in one infected area I find that the number of potential "wheat-bulb" larvæ in a particular potato-field ranges from six to twenty per square foot of surface, while the next field (pasture) has very few, and the neighbouring wheat-field, which was the sufferer last spring, has still fewer. Obviously to sow wheat on infected ground means laying up progressive trouble for the future. The disease has done much damage this year in the East of Scotland and elsewhere, and is evidently spreading, in this locality at any rate. Larvæ obtained from infected wheat were allowed to pupate in the laboratory here, and the flies which hatched out (*Hylemyia coarctata, vide* Theobald's "Agricultural Zoology," 1913, p. 242) were kept until they laid their eggs. (Two of them still survive, though the field Hylemyias are all apparently dead.) The distribution of the eggs in nature was then studied (so far as time allowed) by a method permitting accurate enumeration.

JAMES F. GEMMILL.

Natural History Department, University
College, Dundee, September 23.

The Iridescent Colours of Insects.

By H. ONSLOW.

I.—THE COLOURS OF "THIN FILMS."

IT is strange that the cause of the iridescent hues of insects and other animals should to a great extent still remain one of the unexplained problems of optics: theories have been advanced without end, but so far not one that is completely satisfactory. It is very significant that Prof. R. W. Wood, in speaking of certain metallic films the bright colours of which may be due to an exceedingly fine state of division, remarks: "There appears to be a large number of cases in which brilliant colours are shown which cannot be explained by any of the common laws of optics with which we are familiar. As far as I am aware, no very satisfactory explanation has ever been given of the colours of certain feathers and butterflies, and I strongly suspect there is some action of absorbing matter, in a state of very fine division, upon light waves, which is not yet completely understood."

This opinion is given in spite of the fact that no less an authority than Michelson declares that all the colours in question are surface colours; that is to say, they are due to selective metallic reflection, like the coloured surfaces of aniline dyes and metals. Nothing further is required to show how chaotic and contradictory is the present state of knowledge on this subject.

A discussion of the merits of the rival theories would not here be in place.[1] There will not, however, be much danger in venturing to predict that the almost infinite variety of iridescent colours depends upon every possible factor which can produce such colours. Neglecting the metallic films of Prof. Wood, just mentioned, and analogous cases, it is clear that the colours of insects must be caused in one of the following ways:—

(1) Pigmentation.

(2) Interference of light by "thin films" (as in the case of soap-bubbles).

(3) Diffraction of light by "gratings."

(4) Dispersion of light by prisms.

(5) The scattering of light by small particles (as in the blue of the sky).

(6) Selective metallic reflection (as in metals and aniline dyes).

In dealing with iridescent colours, the first possibility may be neglected, though pigments, such as yellow, are often found combined with structural colours, to form green and so forth.

The Interference of Light by "Thin Films."

This is well known to be the cause of the colour of soap-bubbles and oil films, and it certainly seems to offer one of the best explanations of the iridescence of insects. The late Lord Rayleigh has shown how the objections of Michelson may be met by postulating films of a peculiar structure. Also Biedermann has shown that when iridescent scales are placed in a highly refractive fluid, all colours disappear. This could not possibly occur if the colour were due to a substance resembling aniline dyes, for in these circumstances its body-colour would inevitably be seen by transmitted light. If, however, the colour were due to thin films of air separated by layers of chitin, this loss of colour is exactly what would be expected when the air-spaces were filled by a liquid; for the periodic structure would become a continuous medium. Moreover, Mallock has described how, by applying gentle pressure to scales, the colour fades, sometimes tending to return when the pressure is released. Naturally, if there are plates of chitin separated by air-films, such pressure would alter the spacing between the plates, and thus cause the colour to fade.

Since the minute structure of iridescent scales, etc., had never been examined, the present writer has carried out an extensive microscopical investigation in order to discover whether any light could be thrown on the question by this means. The varied types of the different structures found fully justified the expectation that a number of factors were involved, but though the colours of many scales could be accounted for by well-known laws, in other cases no explanation appeared adequate. A few instances will therefore be selected to illustrate the main types of iridescent colours found in insects.

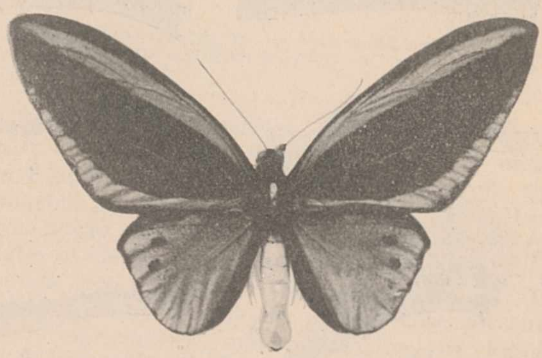

FIG. 1.—*Ornithoptera poseidon* ♂. Body yellow, wings emerald-green and black. (½ natural size.)

Morpho menelaus.—The brilliant blue-green of this wonderful insect is well known. It is given by two layers of scales—section *1a*, Fig. 2, the pale blue upper layer, which shows the anomaly of appearing blue both by transmitted and by reflected light (NATURE, vol. ciii., p. 84, April, 1919), and section *1b*, Fig. 2, the deep blue lower layer of scales, which bears a very curious periodic structure. This structure, best seen in transverse sections of the scales, is shown in Fig. 2, *1b*. The films of transparent chitin, *a*, here appear as pillars, and between them there are films of air, *af*. Seen in longitudinal section, these pillars become long,

[1] "On a Periodic Structure in Certain Insect Scales, and the Cause of their Iridescent Colours." By H. Onslow. Read before the Royal Society on January 29, 1920.

narrow strips of chitin, *a*, Fig. 2, *1c*. The chief peculiarity of these films is that they are placed at right angles, and not parallel, to the surface of the scale or wing, as may clearly be seen from the sections. This results in an obvious consequence, which goes far to prove that the plates are the true cause of colour. It has always been said that the colour of iridescent insects changes towards the violet end of the spectrum, like a flat soap film, when the wing is turned from the normal to grazing incidence. This should be true if the colour were produced by films parallel to the wing surface, but if they were at right angles to it, the reverse should be the case; that is to say, the colour should approach the red end of the spectrum as the angle reaches the grazing incidence.

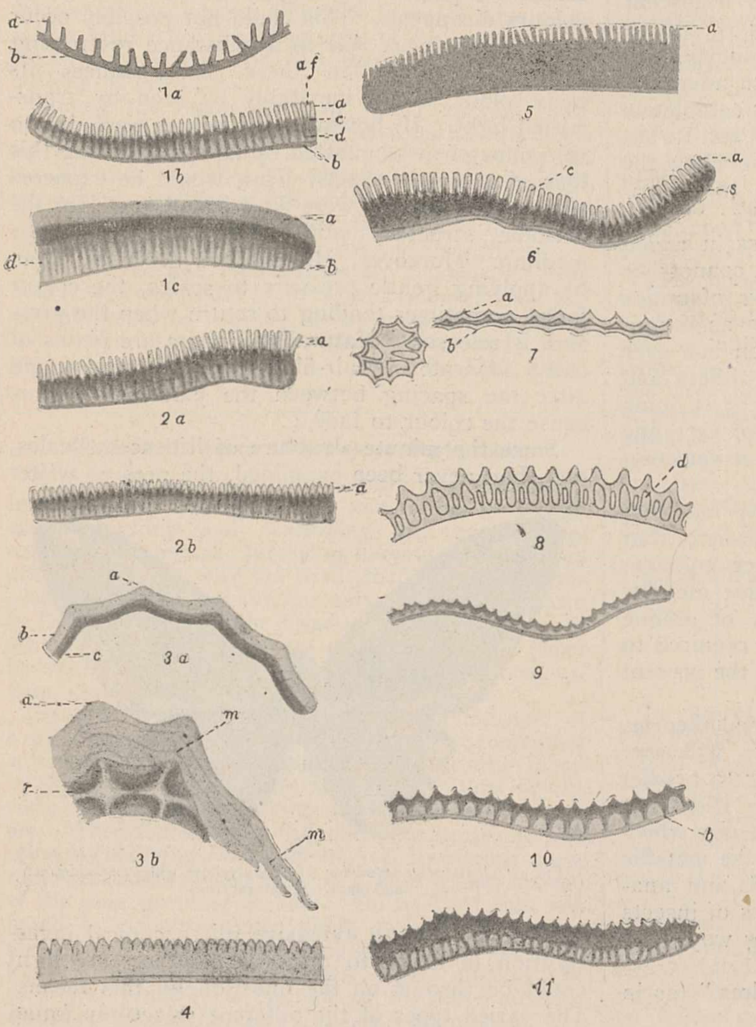

FIG. 2.

1a, Upper scale of *Morpho menelaus*. *a*, striæ; *b*, lower membrane.
1b, Lower scale of *M. menelaus*. *af*, air-film; *a*, chitin film; *c*, pigmented striæ; *d*, bands of chitin joining upper and lower membranes; *b*, lower membrane.
1c, Longitudinal section of the last. *a*, chitin film seen from the side.
2a, Central spot of *Chlorippe laurentia*. *a*, tall films of chitin.
2b, Periphery of the above, showing *a*, bosses of chitin.
3a, Scale of *Papilio ulysses* showing *a*, wave like striæ; *b*, transparent layer of chitin; *c*, pigmented layer of chitin.
3b, Diagonal section of the same. *a*, striæ; *r*, pigmented portion of striæ; *mm*, films of chitin.
4, Blue scale of *Ornithop era urvilliana*. The chitin is colourless.
5, Green scale of *O. posei..on*. The whole scale, including the chitin films *a*, contains a yellow pigment.
6, Magenta scale of *Callitaera esmeralda*, showing granular pigment *s*; and a cleft, or division *c*, in the films of chitin *a*.
7, Section through scale, and tip of scale of *Salamis parhassus*. *a*, upper membrane; *b*, lower membrane.
8, Metallic golden scale of *Dione juno*. *d*, large air-space.
9. Iridescent scale of *Lycaena icarus* stained with carbol-fuchsin.
10, Black under-scale of *Urania fulgens*. *b*, transparent, iridescent membrane.
11, Partially depigmented scale of *Euploea deione*.
All these sections were drawn to the scale μ=1·5 mm. with Zeiss 2 mm. apochromat, N.A. 1·4, and Comp. Oc.

The variation of colour in a number of insects was measured in wavelengths, and most of them were found to fall into two groups—(*a*) those with the periodic structure just described, which at grazing incidence reflected the longest waves, and (*b*) those without this structure, which reflected the shortest waves when in the same position. Further, it was possible to show that the distance between two consecutive plates of chitin was from 0·6μ to 1·0μ,[2] and since the chitin plates often show a line of cleavage, *c*, Fig. 2, section 6, so that they appear double, this space may contain two films of chitin and one of air. Thus the plates may be of the most efficient thickness for producing colour (*i.e.* one-half wavelength), which for chitin is 0·17μ, and for air 0·25μ, or 0·6μ for the three plates.

Chlorippe laurentia.—The edges of the dull green patches on this insect's wings are brown at normal incidence, but the whole area becomes a brilliant green at grazing incidence. This illustrates the effect of the height of the chitin plates on the quality and saturation of the colour. The central area, which is always green, is shown in section *2a*, Fig. 2, where the chitin plates are the usual height. In the area which is brown at normal incidence, section *2b*, Fig. 2, the chitin plates, *a*, have become merely bosses. If a ray must traverse three or four films to give a certain depth of colour, it is obvious that, in the case of section *2b*, it will do this only at very oblique incidence; whereas, in section *2a*, this will happen with rays more nearly normal to the surface.

Ornithoptera poseidon (Fig. 1).—The males of this gorgeous species, and of the even more remarkable *O. paradisea* (Fig. 3), are emerald-green, and they illustrate the effect of combining structural and pigmentary colours. The narrow plates of chitin, *a*, seen in section 5 of Fig. 2, produce a blue colour, but the body of the scale is dyed by a bright yellow pigment, the colour of picric acid. This pigment extends into the chitin

[2] 1μ=$\frac{1}{1000}$ mm. The sections in Fig. 2 were all drawn to the scale μ=1·5 mm., so that the relative distances may be seen at a glance.

plates themselves, so that they also are yellow. The addition of this pigment converts the blue into a green, and the effect of suppressing it is seen in *O. urvilliana*, a powdery blue insect, a section of which, *4*, is shown in Fig. 2. It is pale blue on the upper surface, probably because the chitin plates are broad, but underneath, where the plates are like those in section 5, and contain a little yellow pigment, it is pale green. In some other insects

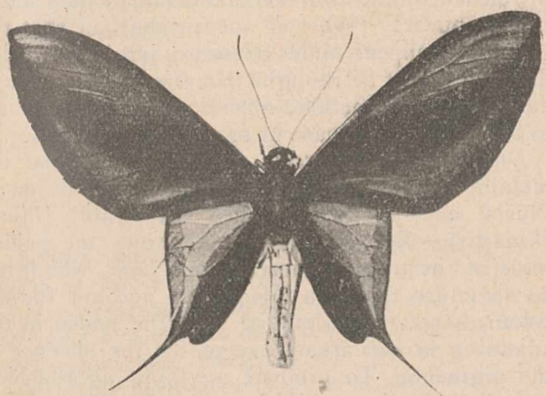

FIG. 3.—*Ornithoptera paradisea* ♂. Body and hind-wings gold fore-wings green and black. (½ natural size.)

the pigment is granular, as at *s*, in section 6, being situated in the body of the scale, but not in the chitin plates. This is the case with those Pierids which have magenta tips to their fore-wings, as well as with the beautiful purple-eyed *Callitaera esmeralda*, which has scaleless but iridescent fore-wings (Fig. 5).

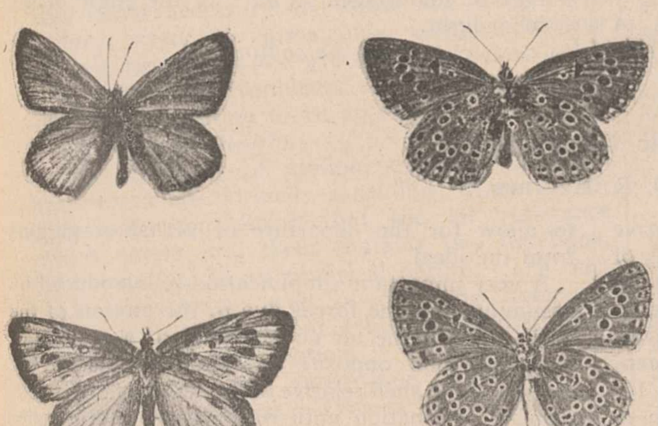

FIG. 4.—*Nomiades arion* (the Large Blue). Male and female, and under-sides of same. Natural size.)

Black is naturally a very important pigment, for it often serves the purpose of absorbing white light, which otherwise, being reflected, would greatly desaturate the colour. Thus the white spots in many insects, such as *Morpho cypris*, have exactly the same structure as the deep blue parts, except for the absence of the absorbent backing of black pigment in the lower layers of the scale.

Papilio ulysses.—The insects the colour of which changes towards the violet at grazing incidence do not have a periodic structure such as that described; but they invariably exhibit a somewhat thick superficial layer of clear chitin. The scales of many iridescent Papilios belong to this group, as, for example, the satin-blue scales of *P. ulysses*, section *3a*, Fig. 2. The layer of chitin, *b*, is clearly too thick to cause colour, and no finer structure could be made out, even with an objective capable

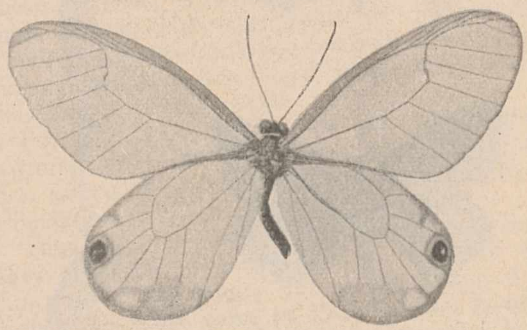

FIG. 5.—*Callitaera esmeralda.* The wings are scaleless and faintly iridescent. The eyes of the hind-wings are magenta. (Natural size.)

of separating the rulings of a grating 0·21μ apart. This is less than one-half the mean wave-length in air, which seems to preclude the existence of air-films. Nevertheless, the surface layer might contain three or four half-wave-length plates of chitin, placed exceedingly close together, though not actually in optical contact. It is, however, doubtful whether in this case pressure experiments and immersion in highly refractive fluids would produce the effects observed.

Very strong confirmation of the existence of a periodic structure, of some description, parallel to the surface, can be obtained by cutting oblique sections of *P. ulysses*. These sections, *3b* (Fig. 2), show the ragged edges of three or four layers of chitin, *mm*, which come into focus successively on lowering the objective.

Salamis parhassus.—There are some insects, like the pale pink *Salamis parhassus*, which have scales that might owe their colour to the thin double membranes of which they are composed, *a* and *b*, section 7 (Fig. 2). If these single films of chitin really cause the colour, it is difficult to account for the uniformity of shade, which ought to vary with the inevitable differences of thickness inherent in an organic film. Such variegated colours are actually found in the lower membrane of many black scales, such as those of *Urania fulgens*, *b*, section *10* (Fig. 2).

There are, however, other insects, such as many Lycænids (Figs. 4 and 6), the iridescent scales of which have membranes too thick to produce colour, though no finer structure can anywhere be made out, section 9 (Fig. 2).

Euploea deione.—There is one large group of insects of considerable interest, the colour of which cannot be accounted for in any way. This group includes the dark purples and deep, glossy blues and greens of all the most sombre iridescent insects, such as the Purple Emperor (*Apatura iris*), the Scarlet Tiger (*Callimorpha dominula*), the Purple Hairstreak (*Zephyrus quercus*), and many exotic species. Any one of these, such as the section of *Euploea deione*, *11* (Fig. 2), shows no difference from the black, non-iridescent scales immediately beneath them. They are all so densely pigmented that nothing can be made out until they are bleached, and even then a thin cuticle only sometimes appears. Were it not for the fact that the colours disappear under pressure and in refractive fluids, it might be thought that the iridescence was due to selective metallic reflection, as will be shown to be probably the case in most scaleless beetles.

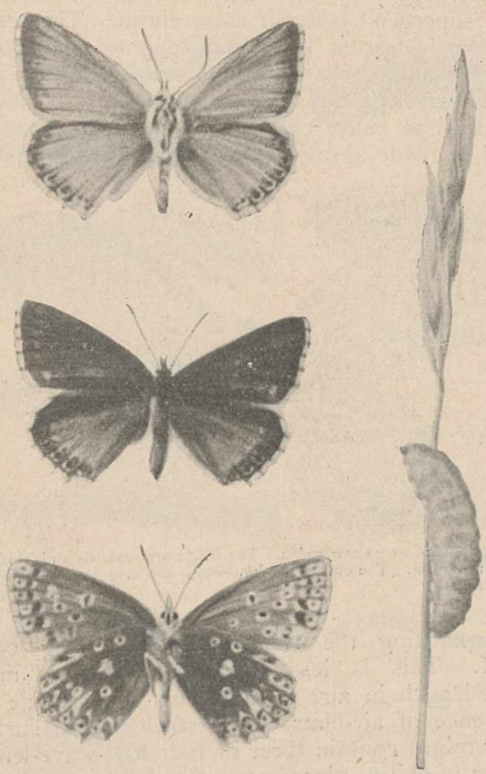

FIG. 6 *Lycaena corydon* (the Chalk Hill Blue). Male, female, under-side of female and larva. (Natural size.)

Dione juno.—Scarcely less puzzling are the metallic greenish-gold and silver scales of many Plusia, such as the Burnished Brass Moth (*Plusia chrysitis*). Section *8*, Fig. 2, shows the golden scale of the tropical insect *Dione juno,* which has no structure that can adequately account for the colour, since it is identical with the scales in the adjoining brown areas, except for the absence of the pigment. To produce anything approaching metallic reflection a highly polished surface would be necessary, as well as a large number of air-spaces not more than the diameter of a few air-molecules in thickness. The effect of a highly polished surface is seen in the scales of the Coppers, as, for instance, the Small Copper (*Chrysophanus phlaeas*), which has ordinary scales containing a granular orange pigment, yet appearing almost iridescent. The only trustworthy evidence of true iridescence is, of course, the change of colour seen on altering the angle of the incident light.

(*To be continued.*)

Ballistic Calculations.

By D. R. HARTREE.

THE purpose of the present article is to give an outline of the more important methods of numerical solution of the various problems of external ballistics—that is to say, problems connected with the resisted motion of a shell after leaving a gun. Most of the methods to be mentioned were developed during the war, either for working out range tables or other information to be used in the field, or for analysing a trial shoot.

The problems that arise may conveniently be divided into two groups, comprising what are sometimes known as primary and secondary problems, the theoretical and practical treatments of which proceed on rather different lines. The primary problems are those which involve the calculation of the performance of a gun, or rather its shell, under ideal conditions, such as still air, a standard muzzle velocity, and so on. The secondary problems are those in which we are concerned with the calculation of the corrections to be applied to the solutions of the primary problems to allow for the departure of actual conditions from the ideal.

A very important simplification is introduced by assuming that the forces due to the motion of the shell through the air consist only of a resistance in a direction opposite to the direction of the motion of the shell relative to the air. Lack of trustworthy information until recently about the other forces made this the only possible course. Some account of these forces and their effects is given in a recent issue of NATURE.[1]

Making this assumption, and neglecting the effect of earth rotation (which may be considered as a secondary problem), it appears that the trajectories concerned in any primary problem lie entirely in the vertical plane containing the initial direction of motion. For this reason they are known as "plane trajectories."

The retardation due to air resistance R acting

[1] See NATURE, June 10, "The Dynamics of Shell Flight," by R. H. Fowler.

on a shell of mass m is usually expressed by the formula :—

$$\frac{R}{m}=\frac{F(v)}{Cf(y)},$$

where v is the velocity of the shell relative to the air, $f(y)$ is the reciprocal of the density of the air at height y, $F(v)$ is an experimentally determined function of the velocity, and C depends on the size and shape of the shell.

Standard functions $F(v)$ and $f(y)$ are used in all ordinary calculations; the quantity C is determined for any particular shell by comparing the results of firing trials with trajectories calculated for the same muzzle velocity and elevations as used in the trial, and two or three values of C.

Primary Ballistic Problems.

Before the advent of the anti-aircraft gun the point of fall was the only point of a trajectory of any great practical importance, and this could be found to a certain degree of accuracy by means of approximate integrals of the equations of motion, for high-velocity guns at small elevations, and for low-velocity howitzers at high elevations, which were the two cases of importance before the war.

But when guns began to be used at higher elevations, and the muzzle velocities of howitzers were increased, these approximate solutions became unsatisfactory; also, with the development of the anti-aircraft gun, came the necessity for calculating whole trajectories, instead of merely a point on each trajectory. Later, it was found necessary to know the whole trajectory, even for guns only intended for use against targets on the ground, in order to solve certain secondary problems, such, for example, as the wind correction to be applied when the wind varied with the height.

The equations of motion, even of the plane trajectory, are formally insoluble, which is not surprising, considering that the air resistance which enters into them contains two functions, $F(v)$ and $f(y)$, of an empirical nature. The only really satisfactory way of obtaining numerical solutions is to carry out a numerical integration of the equations of motion.

To perform this integration a step-by-step method is employed. That is to say, the trajectory is divided up into a series of fairly short intervals, and the integration through each interval in turn performed by means of suitable approximate formulæ, the size of the interval being chosen to make the errors negligible. The complicated way in which the different variables are connected makes it impossible to use directly any of the ordinary integration formulæ, such as Simpson's rule.

Methods of step-by-step integration have, of course, long been known in astronomy; they seem, however, to have been regarded until recently as too laborious for ballistic work except in special cases. However, during the war those concerned with ballistic calculation were forced to use them, for reasons already mentioned, and gradually with experience methods were evolved which were both simple to carry out and not too lengthy. The use of a series of intervals of the same length, and of the finite differences of various quantities at the ends of successive intervals, both simplifies the integration and makes possible a complete check on the numerical work.

When two or more trajectories of the same gun with different elevations have been calculated by these methods, it is obviously possible to determine intermediate trajectories by interpolation. Theoretically, interpolation methods are of a subsidiary nature; in practice, if simple and accurate, they are often very useful.

For a range table, or for the graduation of sighting apparatus, either for flat or high-angle fire, interpolation from the data furnished by the calculation of trajectories is necessary.

Thus in a flat range table the elevation necessary to reach a given range is tabulated as a function of the range, but in calculating a trajectory an exact value of the elevation is taken, and the range is found. The interpolation in this case is usually done graphically.

For a high-angle range table the question is more complicated, for this table is one of double entry, giving the elevation required to reach various points in a two-dimensional region. A table obtained by graphical interpolation usually needs some smoothing. This process, though fairly simple for a single entry table, is almost prohibitive for a table of double entry. A scheme of accurate numerical interpolation was therefore evolved; this scheme as a whole is rather elaborate, but the individual calculations are very simple.

In England the greater part of the numerical work of ballistics is carried out by means of calculating machines.

Secondary Ballistic Problems.

The development of the methods of solution of the secondary problems in general arose in the first place from the necessity of finding the effect of a wind, or change of atmospheric density from standard, which varied along the trajectory. These are the most important secondary problems in practice, but the methods can be extended to others with little difficulty.

To make the problem more manageable, only "first order" effects of applied variations are considered. That is to say, it is assumed that the effects of such variations are additive, so that, for example, the effect of a given wind and a given change of atmospheric density acting together is the sum of the effects of each separately. In cases of practical importance the error is probably very small.

The problem of calculating the effect of a wind variable along the trajectory is generally divided into two parts, the determination of the effect of unit constant wind, and the determination of the "equivalent constant wind"—*i.e.* the constant wind which produces the same effect at the same time. The latter is obtained by means of a set of "weighting factors" which express the relative importance of the wind at different parts of the trajectory.

Considering the wind effect at any given point, the weighting factor for any section of a trajectory is the ratio of the effect at that point of unit wind blowing in that section only to the effect at the same point of unit wind blowing throughout the trajectory. If W is the actual wind in any section, and k is the weighting factor for that section, then the equivalent constant wind is given by the sum of the values of kW for all sections up to the point where the effect of the wind is being considered.

The same arguments apply to variations of atmospheric density from standard. An account of the application of weighting factors has appeared in a recent number of NATURE[2]; we are concerned here with the calculation of them.

The values of the weighting factors for given sections depend on the point at which the effect of a wind (or change of density) is being calculated, and on the precise effect which is being considered. For example, a wind in the plane of the trajectory produces changes in both horizontal and vertical co-ordinates of the point reached in a given time, and if the wind varies along the trajectory the constant wind which will produce the same horizontal displacement will not generally produce the same vertical displacement.

The four equations of motion of the plane trajectory express the relations between the components of velocity, the co-ordinates, and the time. From them can be obtained, by a process analogous to differentiation, four "equations of variation" expressing the relations between the changes in these quantities, for a given time, for any change in conditions which causes first order variations in the plane of the trajectory. (A cross-wind produces only second order effects in this plane, and its treatment is entirely separate.)

The equations of variation have no formal solution, and step-by-step integration is necessary for numerical work. To find wind weighting factors, the obvious method is to integrate the equations for winds blowing in the sections for which weighting factors are required; but this is not necessary, for if the integration is performed for three suitable changes of conditions, the results may be combined to give weighting factors, not only for wind, but for density changes as well.

The numerical work of the process of combining the three solutions is rather heavy and not altogether simple, and a more direct way of calculating weighting factors has been worked out. The equations of variation form a system of linear differential equations of the first order, and by using a certain property of such a system another set of equations (the "adjoint" system) can be obtained, the solutions of which give directly the effect at a given time of a constant wind (or density changes) which begins at a previous variable time. Weighting factors are obtained at once by dividing by the effect of a constant wind which begins at the origin, and differencing the results.

The equations of variation may be applied to any problem in first order variations. The subject of second order variations has not been developed, as its practical importance appears small.

[2] NATURE, June 17, "The Importance of Meteorology in Gunnery," by Dr. E. M. Wedderburn.

Obituary.

THE study of earthquakes in New Zealand and Australia has suffered a serious loss through the death of MR. GEORGE HOGBEN on April 20 last. For many years Mr. Hogben acted as secretary of the seismological committee of the Australasian Association for the Advancement of Science, and we are indebted to him for reports of this committee, and for many studies of individual earthquakes published in the Transactions of the New Zealand Institute and other journals. It was owing to his efforts that the Milne seismograph was erected at Wellington, N.Z., and that, shortly before his death, an order was given for the improved Milne-Shaw seismograph. In addition to his contributions to our knowledge of earthquakes, Mr. Hogben was interested in education generally, and was for two years president of the Wellington Philosophical Society. According to a notice issued with the Hector Observatory Bulletin (No. 28, 1920), he also issued a valuable report on proportional representation, and at the time of his death had an improved set of mathematical tables in the press.

THE *Atti dei Lincei* (vol. xxix. (1), parts 9–10) contains an obituary notice by R. Versari on the late PROF. FRANCESCO TODARO. Born at Tripi (Messina) on February 14, 1839, Todaro entered the University of Messina in 1860, but on the entry of Garibaldi he took up arms as a volunteer in the Chasseurs of Etna. On the conclusion of hostilities and of service to the wounded, he returned to the University, and was attracted by the German biologists to anatomical and physiological studies. He went for some time to study at Florence under Schiff and others, and in 1865 published his first paper on the muscular system of the human heart and the Eustachian valve. He returned to Messina as professor of human anatomy, and in 1869 gave an address on the renewal of the human body. Todaro was among the earliest to study the anatomy of the lower marine animals, and to realise, in accordance with the doctrine of evolution, the importance of comparative anatomy as throwing light on the anatomy of man. In 1870 he read a paper on the sense-tubes of Plagiostomata, and the following year was invited by Brioschi to the chair of human anatomy at Rome. Shortly afterwards he concentrated his attention on the development and anatomy of the Salpidæ, discovering many new organs. His first paper on this group appeared in 1875, and his last is in proof. Todaro also published papers on the fertilisation and segmentation of *Seps chalcides*. Being the first to advocate the introduction of gymnastics in Italian schools, he was elected president of the Italian Gymnastic Federation, in which capacity he delivered several inaugural discourses at meetings and reunions.

AMONG the many skippers and hunters of northern Norway who have taken part in Arctic exploration one of the best known was HANS CHRISTIAN JOHANNESSEN, whose death at Tromsö at the age of seventy-four is announced by the *Times*. During his sealing and walrus-hunting in the Barents Sea Capt. Johannessen many years ago visited the little-known Wiche Islands to the east of Spitsbergen and the coasts of North-east Land. At a later date he hunted off Novaya Zemlya and Franz Josef Land, penetrating westward to White Island and Spitsbergen. But Capt. Johannessen's principal work was in the navigation of the Kara Sea and the opening of a sea route between Europe and Siberia. When Baron Nordenskjöld sailed in the *Vega* in 1878 to do the North-East passage he was accompanied by the small steamer *Lena* under the command of Capt. Johannessen. Without the help of a pilot Johannessen took the *Lena* safely through the difficulties of the Lena delta, and ascended the river for more than 1700 miles to Nyuiskaya, eventually returning to Yakutsk. This was the first steamer to reach Siberia by this route. Johannessen returned overland, and the *Lena* is still in service on the river. Capt. Johannessen piloted many other vessels through the Kara Sea to the Yenisei River. In 1883, in the *Nordenskjöld*, he rescued the crew of the Dutch expedition in the *Varna*, crushed in the Kara Sea. In the *Gjoa*, which he afterwards sold to Amundsen for his North-West passage expedition, Johannessen made many successful hunting expeditions to the Far North.

DR. DUCKWORTH gives in the September issue of *Man* an account, with a full catalogue of his writings, of the eminent Italian anthropologist, MAJOR-GEN. RIDOLFO LIVI, whose death on April 12 last was a serious loss to science. Gen. Livi is best known by his great work, "Anthropometria Militare," published in 1896–98, which deals mainly with the question of physical development in relation to fitness for military service. He was also author of a manual of anthropometry of wide scope and originality, and of a treatise on domestic slavery in Italy in medieval times. Gen. Livi died at the age of sixty-three, his degrees in medicine and surgery being taken in 1878, when he entered the Army. He served in the African campaign of 1887–88 as well as in the recent war, holding at the time of his death the rank of major-general, to which he was promoted in 1917.

WE much regret to announce the death on September 27, at fifty-seven years of age, of MR. D. H. NAGEL, Vice-President and Senior Tutor of Trinity College, Oxford.

Notes.

A SPECIAL conference has been called together by the Royal Society to consider the future of the International Catalogue of Scientific Literature. The conference held its first meeting at Burlington House on September 28, Sir Joseph Thomson in the chair. The following is the list of delegates:—Sir David Prain, Sir Arthur Schuster, Mr. J. H. Jeans, Prof. H. E. Armstrong, Dr. F. A. Bather, and Dr. P. C. Mitchell, representing the Royal Society; Prof. M. Knudsen, Denmark; M. A. Lacroix, France; Dr. G. van Rijnberk, Holland; Prof. R. Nasini and Comm.-Ing. E. Mancini, Italy; Dr. H. Nagaoka, Japan; Mr. R. Laache, Norway; Baron Alströmer, Sweden; Dr. H. Escher, Dr. M. Godet, and Dr. H. Field, Switzerland; Dr. R. M. Yerkes, Dr. L. E. Dickson, Mr. L. C. Gunnell, and Dr. S. I. Franz, U.S.A.; Sir Henry Hayden and Dr. S. W. Kemp, India; Sir Thomas Muir, South Africa; Sir Edward Parrott, Queensland; Prof. E. W. Skeats, Victoria; Mr. C. B. Rushton, Western Australia; and Prof. A. Dendy, New Zealand. The delegates were the guests of H.M. Government at a dinner at the Carlton Hotel on September 29.

WE understand that Mr. Reid Moir, during his investigations of the north-east coast of Norfolk, has made an important discovery in the neighbourhood of Cromer. It appears that a flint-workshop site, apparently of Early Chellian Palæolithic age, occurs at this place at an horizon referable to one of the lower members of the Cromer Forest Bed series. The site, though limited in extent, is very rich in humanly fashioned flints, and Mr. Moir hopes in the near future to exhibit and describe the large number of specimens he has collected.

THE MINISTER OF HEALTH has appointed a Committee to investigate and report on the causes of blindness, including defective vision sufficient to impair economic efficiency, and to suggest measures which might be taken for the prevention of blindness. The members of the Committee are:—Mr. G. H. Roberts, M.P. (chairman), Mr. Stephen Walsh, M.P., Mr. N. Bishop Harman, Dr. J. B. Lawford, Mr. G. F. Mowatt, Mrs. Wilton Phipps, Mr. J. H. Parsons (representing the Royal College of Surgeons), Dr. J. Taylor (representing the Royal College of Physicians), Mr. J. C. Bridge (representing the Home Office), Dr. A. Eicholz (representing the Board of Education), Mr. J. S. Nicholson (representing the Ministry of Labour), Mr. W. M. Stone (representing the Scottish Office), Mr. E. D. Macgregor (representing the Ministry of Health), and a representative of the Medical Research

Council (to be appointed later). Dr. R. A. Farrar and Mr. P. N. R. Butcher will act as joint secretaries to the Committee, and any communications should be addressed to them at the Ministry of Health, Whitehall, London, S.W.1.

SIR FREDERICK ANDREWES, professor of pathology in the University of London, will deliver the Harveian oration of the Royal College of Physicians on Monday, October 18, at 4 p.m.

MR. J. D. FRY, lecturer on physics at the University of Bristol, and Mr. A. Hessell Tiltman have been appointed to the scientific staff of the Research Association of British Rubber and Tyre Manufacturers.

THE third annual Streatfeild memorial lecture will be delivered by Mr. J. H. Coste at the City and Guilds Technical College, Leonard Street, E.C.2, on Thursday, October 14, at 4 p.m. The subject will be "The Gases Dissolved in Water." Admission will be free.

Science for September 10 announces that it is proposed to establish in Panama an international institute for research on tropical diseases as a memorial to the late Major-Gen. W. C. Gorgas. Panama has been chosen in view of the fact that Gen. Gorgas's most noteworthy work was accomplished there.

WE learn from the *British Medical Journal* that the Hughlings Jackson lecture of the Section of Neurology will be delivered at the Royal Society of Medicine by Dr. H. Head on October 7 at 8.45 p.m. Dr. Head has chosen as his subject "A New Conception of Aphasia."

THE British Cutlery Research Association has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The secretary of this association is Mr. J. M. Denton, P.O. Box 49, Sheffield.

CERTAIN friends of Mr. W. F. Denning and admirers of his lifelong devotion to astronomy have contributed a sum of about 300*l.* to a fund which has just been established for him. Mr. Denning has been sent 50*l.* to meet his immediate necessities, and the balance remaining in hand has been paid over to Sir Frank Dyson and Col. E. H. Hills in trust for Mr. Denning, with directions to pay him the sum of 50*l.* annually. Should it be necessary, further subscriptions will be raised in order that a payment of this amount may be secured to Mr. Denning as an annuity for life.

THE Cryptogamic Society of Scotland held its first annual gathering since the war on September 21–23 at Perth. Under the leadership of the secretary, the Very Rev. Dr. D. Paul, of Edinburgh, and Mr. Jas. Menzies, of Perth, the society made excursions to Murthly on the first day and to Invermay on the second, where the dominant species found was *Tricholoma saponaceus*; here the dog-stink horn, *Mutinus caninus*, turned up again, having been recorded many years ago, since when it had not been seen; also in the woods, below a fir-tree, the curator of the Perth Museum, Mr. J. Ritchie, was fortunate in finding *Collybia ludius*, Fr., this being a new species recorded for Britain. The last day's excursion was to Methven, where the outstanding species numerically were *Lactareus vellereus* and *Craterellus cornucopoides*.

THE forthcoming general discussion on "The Physics and Chemistry of Colloids and their Bearing on Industrial Questions," which is being arranged jointly by the Faraday Society and the Physical Society of London, has been fixed for Monday, October 25, at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1. The discussion will be presided over by Sir W. H. Bragg, and it will be introduced by Prof. The Svedberg, of the University of Upsala, who will give a general survey of the subject before discussion is opened in its various branches. Non-members of the above societies desirous of attending the discussion may obtain tickets of admission from Mr. F. S. Spiers, 10 Essex Street, London, W.C.2. The Faraday Society, the Institution of Mechanical Engineers, the Institute of Metals, and probably also the Iron and Steel Institute contemplate holding early in 1921 a joint general discussion on "The Failure of Metals under Internal or Prolonged Stress."

IT is announced that the British Antarctic Expedition, which Mr. John L. Cope has been organising for some time, has left England for its base at Port Stanley, in the Falkland Islands. Other members of the expedition are Capt. Wilkins, Mr. W. T. Bagshawe (geologist), and Mr. M. C. Lester (navigator and surveyor). The *Times* states that from the Falkland Islands the expedition will be taken by a whaling vessel to the Weddell Sea, and there landed on the ice during January. The party hopes to survey hitherto unexplored regions, but no attempt will be made to reach the Pole, the aims of the expedition being purely geographical and biological. At the end of eighteen months or so the party will return to England, by which time a specially built ship and a large aeroplane will be ready for a further expedition, which is expected to be of five years' duration.

A SMALL but interesting exhibition of books, manuscripts, and relics illustrative of the life and work of Gilbert White was held on September 24–25 at the Art Workers' Guildhall, Queen Square, W.C.1. The exhibition concluded the bicentennial celebration of the birth of the Selborne naturalist organised by the Gilbert White Fellowship. A fine series of modern water-colours of Selborne and of Ringmer adorned the walls of the hall. Upon the tables there were laid out for inspection a large number of editions of "The Natural History and Antiquities of Selborne," together with somewhat rare contemporary works upon subjects discussed by Gilbert White. Microscopy also received attention, while living specimens illustrative of the life of the mosquito aroused considerable interest. In an address delivered by Dr. Gilbert White, Bishop of Willochra, North Australia, and great-grandnephew of Gilbert White, reference was made to the life and work of the naturalist as emphasising the value of a study of Nature—a study which opened out a realm of interest and knowledge untouched by changes in human life and environment.

Nature-study for its own sake was comparatively modern; the earliest writers, such as Pliny the Elder and St. Basil, looked towards the marvellous and the utilitarian, while passages by St. Gregory depicting scenery and the beauty of the country were exceptional. Gilbert White inculcated a love of Nature which might be regarded as a revelation of Divine intelligence. With reference to the "Natural History," Dr. White spoke of its many editions, exceeding in number, so it was said, that of any other book excepting the Bible and "The Pilgrim's Progress." Its popularity was continuous and progressive; it illustrated the steady and quiet devotion still being given to the study of Nature.

AT the meeting of the Association of Economic Biologists held at Kew on September 24 the subject discussed was that of immunity to fungus diseases in plants. The president, Sir David Prain, was in the chair. Mr. E. S. S. Salmon dealt with the relation of climatic factors, and directed attention to those cases where immunity broke down under certain weather conditions. His observations showed that the wild hop comprises numerous physiological forms with distinctive "constitutional" characters with regard to mildew, ranging from extreme susceptibility to immunity. The immune forms when grown in the greenhouse remained immune; when grown in the open, with warm, sunny weather, immunity is retained; with low temperatures and lack of sunshine there is a temporary loss of immunity. Climatic factors would appear to influence also the degree of immunity of certain wheats to "rust." Mr. F. T. Brooks spoke on the question of inheritance of disease resistance, and dealt chiefly with the work of Biffen and Armstrong on *Puccinia glumarum*. Although susceptibility and immunity behave as a pair of allelomorphic characters segregating in Mendelian fashion, it was pointed out that the "genetic constitution" of "immune" plants is liable to modification within narrow limits by environmental conditions, so that a family rust-free one year may be slightly affected by rust another season. Rust-resistance in wheat behaves as a simple Mendelian recessive, but there is evidence that resistance to mildew, on the other hand, acts as a dominant character. A brief analysis of the meanings attached to the use of the word "immunity" in plant pathology was made. A *résumé* of a paper by Mr. A. Howard on the importance of soil factors in bringing about epidemics was read. In the discussion Dr. N. L. Britten and Dr. E. J. Butler spoke of conditions in America and India respectively. Members were entertained to tea by the president, and afterwards visited the Botanic Gardens.

AMONG the Turkana tribe in the Sudan, according to a writer in *Sudan Notes and Records* (vol. iii., No. 3), a curious system of recording prowess in war is in force. When a man has killed an enemy a number of incisions are made on the victor's body to record the fact, those on the right side indicating that the victim was a man, those on the left a woman. A hook is inserted in the skin, a portion of which is raised, in which a cut about half an inch long is made. Fat and clay are then rubbed in until the man can endure no further pain. The endurance of this people may be measured by the fact that many of them are covered from waist to shoulder with such marks. It is only on the first occasion when an enemy has been slain that these marks are made, later deeds of valour being left unrecorded.

THE question of the origins of the Babylonian and Assyrian scripts has been again raised by M. G. C. Teloni in an article entitled "L'écriture babylonienne et assyrienne" in *Scientia* (vol. xxviii.) for 1920. After a full review of various speculations, M. Teloni thus summarises his conclusions: "Les théories exposées dans les pages précédentes, et qui sont celles qui prévalent aujourd'hui au sujet de l'origine de l'écriture babylonienne-assyrienne, se rapportent principalement aux monuments d'épigraphie sumériens et sémitiques du bassin de l'Euphrate et du Tigre. Il n'a été, jusqu'à aujourd'hui, examiné au service de cette question que bien peu d'autres inscriptions appartenant au système cunéiforme. On peut attendre beaucoup d'un examen approfondi des signes élamites (anciens et modernes), vannico-assyriens et persans; en particulier, le syllabaire élamite, rival du babylonien au point de vue d'antiquité, et le syllabaire persan cunéiforme, dont la dérivation de Babylone apparaît de jour en jour plus contestable, promettant de faire la lumière sur l'histoire générale de l'écriture cunéiforme."

AN account of a remarkable sculpture recently found on a capstone of a dolmen at Déhus, in the parish of the Vale, Guernsey, is given in the September issue of *Man* by Lt.-Col. T. W. M. de Guérin. The figures consist of a face and two hands, with the outlines of a portion of both arms. Below these is a mark possibly representing the girdle so often found on French statue-menhirs. Anthropomorphic figures very similar to that of Déhus are found in France sculptured on the props of the Late Neolithic dolmens of the valleys of the Seine and Oise, and also of Collorgues, in the Department of Gard, while very similar figures have been noticed in the grottoes of Le Petit Morin, Marne, which are believed to date from the Æneolithic period. It is now certain that the cult of the divinity represented by the figures on the Déhus dolmen and the statue-menhir of the Castel lasted from early times in Guernsey, for the second statue-menhir, now standing as a gate-post at the Church of St. Martin, is of much later date than that of Castel. It is one of the largest and best-preserved statue-menhirs in existence, far surpassing in style and execution those of south-eastern France.

SIR JAMES FRAZER in a letter to the *Times* of September 22 gives a further report of the progress of the Mackie Expedition to East Africa conducted by the Rev. John Roscoe. The expedition has been at work among the Banyoro of Lake Albert in the Uganda Protectorate. This tribe or nation is composed of two ethnical strata, the Bahuma, a ruling caste of herdsmen of Hamitic stock, and the Bairu, a subject agricultural peasantry of Bantu stock. The whole life of the Bahuma king is devoted to ceremonial observances of a priestly or magical character for the good of the people, their cattle, and their land. Consequently he is seldom, or never, able to quit the enclosure in which he resides. An interesting custom once was the annual raising of an agricultural peasant to the kingly rank, representing the real king's dead father. After a period of about a week, during which he lived at the tomb of the dead king, treating the royal widows as his own wives and blessing the real king and the country in the name of the dead man, he was taken to the back of the tomb and strangled.

THE report of the director of the New York Aquarium, reprinted from the twenty-fourth Annual Report of the New York Zoological Society, is chiefly concerned with the unsatisfactory condition of the building. Mr. Townsend has our sympathy, but he arouses our interest more by two brief paragraphs. One of these states that the large crayfish of the Columbia River was safely transported alive from California to New York in wrappings of damp paper. The other ascribes the total disappearance of the sea-horse (*Hippocampus hudsonius*) from local waters to the unusually severe winter of 1918. The report describes and illustrates ingenious gravity filters and strainers and air-compressors used when sending fishes by train or ship.

THE Davidson collection of recent Brachiopoda in the British Museum has hitherto been regarded as taking the lead, but, at all events in point of numbers, it is now outclassed by the collection in the United States National Museum, of which Dr. W. H. Dall has lately published an "Annotated List" (Proc. U.S. Nat. Mus., vol. lvii., pp. 261–377). The latter contains more than six thousand specimens, representing 181 different forms, of which thirty-three are here introduced as new. These fall into some fifty genera. The ordinary zoologist will regret to see some apparently inevitable changes in well-known names: thus *Lingula anatina* becomes *L. unguis*, Linn.; *Terebratulina caput-serpentis* having been based on a fossil of different structure, the name *T. retusa*, Linn., must be adopted for the recent species; and Liothyrina gives place to Gryphus. Among interesting facts of distribution are noted the discovery off the Californian coast of two Japanese species, *Terebratulina crossei* and *T. kiiensis.*

AN interesting discussion arises in Dr. N. Annandale's "Observations on 'Physa Prinsepii,' Sowerby" (Rec. Geol. Surv. India, vol. li., p. 50, 1920), as to the cause of extinction of this giant planorbid some time after the intertrappean (late Cretaceous) epoch in India. The genus Bullinus (formerly Bulinus, Adanson), to which this shell is now transferred, survives in Africa, the Malay Archipelago, and Australia, in conditions apparently less favourable than those surrounding the fossil forms in India. Dr. Annandale suggests that exceedingly congenial surroundings led to an overgrowth of the mollusc (which attains 76 mm. in height), and that it was unable to survive any reduction of the luxury that it had long enjoyed.

IN connection with blood-transfusion experiments during the war it was found that severe reactions sometimes followed the intermingling of the blood of certain individuals. Previous work, in which human sera were classified into four groups according to their iso-agglutinating actions, was therefore very useful in determining between which individuals transfusion could safely take place. In a short paper by Mr. J. R. Learmonth (*Journ. Genetics*, vol. v., No. 2) the author has studied the blood reactions of a number of families, and concludes that the iso-agglutinins are inherited, two pairs of Mendelian factors being concerned. But it appears from observations by Bond that iso-agglutinins which are absent from the serum of a given individual may appear after the patient has reacted to a systemic infection. It has been suggested that these serum reactions might be used as a legal proof of illegitimacy.

IN two papers in the *Journal of Genetics* (vol. x., No. 2) Mr. F. L. Engledow deals with the inheritance of the various forms of lateral florets and rachilla in barley and length of glume and grain in a hybrid wheat. A bristly rachilla is dominant to smooth, and it is suggested that the same factor governs the type of hair in other parts of the flower, and may also be concerned with the development of the root-hairs, which would affect the yield. The barleys differ in the form of their lateral florets, six-row and two-row barley differing by a single factor, the heterozygotes being intermediate with some fluctuations in expression. These fluctuations are found to be environmental in origin, and not a case of mosaic inheritance. In a cross between Polish and Kubanka wheat long and short glumes behave as a pair of characters, the F_1 being intermediate. But the interesting result is obtained that in the extracted "longs" the length of glume is reduced by nearly 25 per cent. in comparison with the long-glumed parent, and this shift or modification remains true in the F_3. Similar results were obtained with grain-length, the long grain being reduced by 12·5 per cent. in the extracted F_2's. These two pairs of characters are inseparable in inheritance, length of grain unexpectedly behaving as a maternal character, although it must be partly determined by the character of the endosperm. Possible explanations of these results are discussed.

SOME very fine views of glaciers in Canada occur in Dr. C. D. Walcott's "Geological Exploration of the Canadian Rockies: Field Season of 1919," extracted as a pamphlet from "Explorations and Field-Work of the Smithsonian Institution in 1919." The photograph of the environs of the Mount Lyell Glacier makes a folding plate nearly 3 ft. long, and includes the superb stratigraphical sections of the Mount Forbes and Mons Peak region, where Carboniferous rocks appear on the crests, succeeded downwards by Devonian, Ordovician, and Upper Cambrian strata.

DR. C. D. WALCOTT, in the Middle Cambrian Burgess Shale of British Columbia, has secured a field of remarkable palæontological richness. He remarks (Smithsonian Miscell. Coll., vol. lxvii., No. 6, 1920) that the sponges from this series comprise nearly all the siliceous sponges known to him from the Cambrian strata of America. He mentions the few other known examples described by Matthew, Bornemann, and others, and now adds several new genera and species of monactinellid, hexactinellid, octactinellid, and heteractinellid types. Chancelloria, of which the general form is preserved in spite of the absence of a strong spicular skeleton, upholds Hinde's Heteractinellida as a distinct sub-order. The form of the spicules, with four to seven horizontal rays and one vertical axial ray, is not tetractinellid, while their grouping is not that of the hexactinellid mesh. The previously known imperfect specimens of this sub-order are of Carboniferous age. The spicules in the Burgess Shale are usually preserved as pyrite, like those of the British Protospongia, the glories of which are now much diminished by its rivals.

TEMPERATURES and humidities in the upper-air conditions favourable for thunderstorm development and temperatures over land and sea have been discussed by Capt. C. K. M. Douglas. The results are published as Professional Notes No. 8 by the Meteorological Office. The flight observations were made in the north of France during 1918 in the preparation of reports and forecasts for military purposes. The most marked feature of the observations was the number of instances of an unstable condition above 8000 ft. Every thunderstorm is said to have been associated with a shallow depression or secondary, and many with the arrival of cooler surface-air. Up to a level of 10,000 ft., and possibly above, the higher the humidity the greater the chance of thunderstorms, which are not likely to develop unless there is at least one fairly damp layer as low as 6000 ft. Thunderstorms in our latitudes are not usually severe if the base of the thunder-clouds is above 8000 ft.; the cloud-base is stated to be, as a rule, at about 5000 ft. or 6000 ft. in hot weather, and lower in cool weather. The height of thunder-clouds is said to be very great, the rounded tops attaining 20,000 ft. and the false cirrus 30,000 ft. in hot weather, and 15,000 ft. and 20,000 ft. respectively in cool weather. Thunderstorms are divided into three classes: (A) those due mainly to heated surface-air in fine, sunny weather; (B) those associated with powerful upper currents from south-west, the surface-wind being light and variable or south-easterly; and (C) those associated with very low upper-air temperatures in the south-westerly or north-westerly currents of cyclonic depressions. Detailed observations and weather-maps are given of each class. The whole discussion is full of valuable suggestions which will aid alike the weather forecaster and the aeronaut.

IN the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* (May–June, 1920) will be found the second part of the experimental study of the quenching of carbon steels by MM. Portevin and Garvin. This study is mainly concerned with the conditions of formation of troostite and martensite. By means of cooling curves the authors claim to have established that the formation of troostite corresponds to a rapid transformation at about 650° C., while that of martensite is due to a relatively slow transformation at a temperature which is generally below about 300° C. The former is rendered evident by a clear break in the curve, the latter merely by a gradual change in direction. It was found possible by choosing a certain rate of cooling to prepare specimens in which both these changes occurred and where the curves showed both types of change. The authors confirm the generally held view that troostite represents the chemically stable mixture of iron carbide and α-iron in a fine state of division, but their results do not throw any fresh light on the constitution of martensite.

A VERY convenient new showroom is being opened by the Cambridge and Paul Instrument Co., Ltd., at the commodious head office into which the firm has just moved at 45 Grosvenor Place, S.W.1. As a nucleus of the fine assemblage of scientific apparatus which is being brought together there, the collection of instruments shown by the company at the Engineering Exhibition at Olympia has been provided with a permanent home. This relates more particularly to industrial apparatus, and one of the most interesting items is the firm's new CO_2 recorder, which is entirely electrical in its principle. It depends for its action on resistance measurements revealing the difference in the rates of cooling of two platinum helices, one exposed to air saturated with water-vapour, and the other to the flue-gases to be tested. The indicating instrument is arranged so as to read direct in percentage of CO_2, and can be at a considerable distance from the gas-chambers. Continuously recording apparatus can be used, or one indicator can be arranged to be plugged on to any one of a number of CO_2 meters. A variety of patterns of both resistance and thermo-electric thermometers and pyrometers are included in the collection, as well as temperature measuring apparatus on other principles, pressure-gauges, measuring microscopes, fuel calorimeters, and electrical testing apparatus.

AN interesting report of tests on a 1500-kilowatt Ljungström steam turbine conducted by Capt. H. Riall Sankey appears in *Engineering* for September 10. The turbine had been in regular service for fifteen months at the date of the test in the works of Messrs. Marshall, Sons, and Co., Ltd., Gainsborough, and was constructed by the Brush Electrical Engineering Co., Ltd., at Loughborough. No overhaul of the turbine or any special preparation was made for the trials. The principal result, corrected to the guarantee figures of 190 lb. per sq. in. stop-valve pressure, 634° F. stop-valve temperature, and 28·75 in. vacuum at the turbine exhaust, was 11·95 to 12·00 lb. of steam per kilowatt-hour, as measured at the switchboard. The result is slightly below the original guarantee, and indicates that there can have been no serious wear of the blading during the period of service of the turbine. The heat supplied per minute per kilowatt ranged from 258·0 to 257·0 thermal units, and the overall efficiency ratio varied from 68·0 to 68·4 per cent.

THE steaming trials of the armoured cruiser H.M.S. *Raleigh* have just been completed on the Clyde, and form the subject of an article in

Engineering for September 24. The cruiser was built by Messrs. William Beardmore and Co., Ltd., from designs prepared in 1915. The leading consideration was suitability for ocean work in any part of the world, so that a large radius of action was necessary. Her overall length is 605 ft., beam 65 ft., and draught 17 ft. 3 in., with a displacement of 9700 tons. The speed of 30 knots at load draught required a shaft-h.p. of 60,000; she carries 1600 tons of oil-fuel and 800 tons of coal. During construction it was decided to increase the power to 70,000 shaft-h.p. Actual trials have been carried out at powers ranging from 3000 to 71,350 shaft-h.p., and at full power a speed of 31 knots was attained. A remarkable feature of the machinery performance (geared turbines) was the fact that at 35,000 shaft-h.p. a speed of 28 knots was measured. The machinery ran remarkably well and the noise of the gearing was not obtrusive.

WE have received from the firm of Mr. Charles Baker, of High Holborn, a classified list of his second-hand scientific instruments. The catalogue is divided into twelve sections, ten of which are devoted to physical and other appliances and instruments, *e.g.* the first contains particulars of apparatus and materials for microscopic work; the third, instruments used by astronomers; and the tenth is devoted to photographic apparatus. Section xi. contains a list of second-hand scientific works, including a number of bound volumes of periodicals which are for sale; while section xii. is a list of instruments which the firm is desirous of purchasing.

SIR J. A. EWING and Sir Joseph Larmor are editing, for publication by the Cambridge University Press in the spring of next year, the scientific papers of the late Prof. Bertram Hopkinson, of whom the volume will contain a memoir. The Cambridge University Press promise for the end of the present year "The Origin of Man and of His Superstitions," by Carveth Read. Portions of the work have appeared in the *British Journal of Psychology*, but they have been extended and largely rewritten for this first appearance in book form.

THE UNIVERSITY OF LONDON PRESS, LTD., announce a book by Dr. E. E. Slosson entitled "Creative Chemistry," the aim of which is to show how indigo and other coal-tar colours are made, and to arouse the interest of its readers in the practical application of modern science and so induce them to give further attention to the subject. Another book to be issued by the same publishers is "The Psychology of the Six Great Periods of Human Life," by Benchara Branford. It will be published in The New Humanist Series.

MR. F. EDWARDS, 83 High Street, Marylebone, has just circulated a finely illustrated Catalogue (No. 405) of Rare and Beautiful Books which is worthy of perusal. Among the six hundred odd works offered for sale we notice a first edition of Gerarde's "Herball," two black-letter editions of Hakluyt's "Principal Navigations, etc.," and a number of scarce gardening books.

Our Astronomical Column.

EPHEMERIS OF PALLAS.—Now that the Nautical Almanac no longer gives the places of the four bright asteroids, an ephemeris of Pallas may be of use. It is from Marseilles Circular No. 389, and is for Greenwich midnight. Perturbations were not allowed for, but the places are corrected approximately by observations during August. Opposition takes place on October 25, when the magnitude is 7·8, but the beginning of October is more favourable for observation owing to the rapid motion southward.

	R.A. h. m. s.	S. Decl. ° ′		R.A. h. m. s.	S. Decl. ° ′
Sept. 29	2 16 24	13 51	Oct. 19	2 3 18	19 33
Oct. 9	2 10 42	16 49	29	1 55 18	21 45

TEMPEL'S PERIODIC COMET.—The Japanese *Astronomical Herald* for June confirms the conjecture that the R.A. of the above comet when detected by Mr. Kudara on May 25 was 22h. 55m. 7s., not 20h. as telegraphed. This is implied in its statement that the time of perihelion passage deduced from the observation was 1920 June 10. It is seldom that an error in a single digit of a message has such serious consequences, which were the loss of two months' observation of the comet in Europe and America. Many observers searched for it, but the error of 30° in the place prevented them from finding it.

ECLIPSE OBSERVATIONS AT MONTE VIDEO.—The National Meteorological Institute of Uruguay has published an attractive volume, illustrated with numerous photographs, dealing with the observations made during the eclipses of December 3, 1918, and May 29, 1919, which were respectively annular and partial there. The co-ordinates of the Central Observatory are 3h. 44m. 51s. W. Greenwich, 34° 54′ 33″ S. The observed contacts, and comparison with those calculated from "Conn. des Temps" data, are as follows:

G.M.T. d. h. m. s.	Phase	Earlier than calculated time s.	Notes
Dec. 3 1 27 3·07	First contact	11·58	
3 12 24·34	Second ,,	16·78	
3 15 29·95	Third ,,	40·33	Uncertain, very cloudy
May 28 22 57 8·21	First ,,	10·00	
29 0 38 30·05	Second ,,	8·05	

On December 3 clouds prevented observation of Baily's Beads, stars, shadow-bands, etc. The thermometer fell from 20·4° C. before first contact to a minimum of 17·9° C. twenty minutes after mid-eclipse. The other meteorological and magnetic data are carefully recorded, but show no obvious variation due to the eclipses. But on each occasion there was a very distinct improvement in the clearness with which wireless signals from distant stations were received during eclipse—a phenomenon which has been abundantly verified elsewhere.

On December 3 an interesting record of the variation in the general illumination was obtained by exposing slips of sensitised paper to the sky for 1½ minutes at uniform intervals. The result shows a fairly smooth curve, the irregularities being due to clouds. In view of the fact that there will be an annular eclipse of the sun in Scotland next April, many useful hints for observation of the accompanying phenomena may be derived from this volume.

Fossils and Life.*

By F. A. BATHER, M.A., D.Sc., F.R.S.

I PROPOSE to consider the relations of palæontology to the other natural sciences, especially the biological; to discuss its particular contribution to biological thought; and to inquire whether its facts justify certain hypotheses frequently put forward in its name. If I subject those attractive speculations to cold analysis, it is from no want of admiration, or even sympathy, for in younger days I too have sported with Vitalism in the shade and been caught in the tangles of Transcendental hair.

The Differentia of Palaeontology.

Palæontology is often regarded as nothing more than the botany and zoology of the past. True, the general absence of any soft tissues and the obscured or fragmentary condition of those harder parts which alone are preserved make the studies of the palæontologist more difficult, and drive him to special methods. But the result is less complete; in short, an inferior and unattractive branch of biology. Let us relegate it to Section C!

Certainly the relation of palæontology to geology is obvious. It is a part of that general history of the earth which is geology. To the scientific interpreter of earth-history the importance of fossils lies, first, in their value as date-markers, and, secondly, in the light which they cast on barriers and currents, on seasonal and climatic variation. Conversely, the history of life has itself been influenced by geologic change. But all this is just as true of the present inhabitants of the globe as it is of their predecessors. It does not give the *differentia* of palæontology.

That which above all distinguishes palæontology, the study of ancient creatures, from neontology, the study of creatures now living, that which raises it above the mere description of extinct assemblages of life-forms, is the concept of Time. The bearing of this obvious statement will appear from one or two simple illustrations.

Effect of the Time-concept on Principles of Classification.

Adopting the well-tried metaphor, let us imagine the tree of life buried except for its topmost twigs beneath a sand-dune. The neontologist sees only the unburied twigs. He recognises certain rough groupings, and constructs a classification accordingly. From various hints he may shrewdly infer that some twigs come from one branch, some from another, but the relations of the branches to the main stem are matters of speculation, and when branches have become so interlaced that their twigs have long been subjected to the same external influences he will probably be led to incorrect conclusions. The palæontologist then comes, shovels away the sand, and by degrees exposes the true relations of branches and twigs. His work is not yet accomplished, and probably he never will reveal the root and lower part of the tree, but already he has corrected many natural, if not inevitable, errors of the neontologist.

* * *

Effect of the Time-concept on Ideas of Relationship.

Etienne Geoffroy-Saint Hilaire was the first to compare the embryonic stages of certain animals with the adult stages of animals considered inferior. The idea grew until it was crystallised by the poetic imagination of Haeckel in his fundamental law of the reproduction of life, namely, that every creature tends in the course of its individual development to pass through stages similar to those passed through in the history of its race. This principle is of value if applied with the necessary safeguards. If it was ever brought into disrepute, it was owing to the reckless enthusiasm of some embryologists who unwarrantably extended the statement to all shapes and structures observed in the developing animal, such as those evoked by special conditions of larval existence, sometimes forgetting that every conceivable ancestor must at least have been capable of earning its own livelihood. Or, again, they compared the early stages of an individual with the adult structure of its contemporaries instead of with that of its predecessors in time.

Such errors were beautifully illustrated in those phylogenetic trees which, in the 'eighties, every dissector of a new or striking animal thought it his duty to plant at the end of his paper. The trees have withered because they were not rooted in the past.

A similar mistake was made by the palæontologist who, happening on a new fossil, blazoned it forth as a link between groups previously unconnected—and in too many cases unconnected still. This action, natural and even justifiable under the old purely descriptive system, became fallacious when descent was taken as the basis.

The so-called "generalised types," combining the features of two or three classes, and the "annectant types," supposed to unite lines of descent which had diverged many ages before, are conceptions still with us. But they are hopelessly inconsistent with any genealogy either proved or probable.

As bold suggestions calling for subsequent proof these speculations had their value, and they may be forgiven in the neontologist, if not in the palæontologist, if we regard them as erratic pioneer tracks blazed through a tangled forest. As our acquaintance with fossils enlarged, the general direction became clearer and certain paths were seen to be impossible. In 1881, addressing this Association at York, Huxley could say: "Fifty years hence, whoever undertakes to record the progress of palæontology will note the present time as the epoch in which the law of succession of the forms of the higher animals was determined by the observation of palæontological facts. He will point out that, just as Steno and as Cuvier were enabled from their knowledge of the empirical laws of co-existence of the parts of animals to conclude from a part to a whole, so the knowledge of the law of succession of forms empowered their successors to conclude, from one or two terms of such a succession, to the whole series, and thus to divine the existence of forms of life, of which, perhaps, no trace remains, at epochs of inconceivable remoteness in the past."

Descent not a Corollary of Succession.

Note that Huxley spoke of succession, not of descent. Succession undoubtedly was recognised, but the relation between the terms of the succession was little understood, and there was no proof of descent. Let us suppose all written records to be swept away and an attempt made to reconstruct English history from coins. We could set out our monarchs in true order, and we might suspect that the throne was hereditary; but if on that assumption we were to

* Opening address of the President of Section C (Geology), delivered at the Cardiff Meeting of the British Association on August 24. Greatly abridged. Only the larger excisions are indicated by asterisks.

make James I. the son of Elizabeth—— Well, but that's just what palæontologists are constantly doing. The famous diagram of the evolution of the horse which Huxley used has had to be corrected in the light of fuller evidence. Palæotherium, which Huxley regarded as a direct ancestor of the horse, is now held to be only a collateral, as the last of the Tudors were collateral ancestors of the Stuarts. The later Anchitherium must be eliminated from the true line as a side-branch—a Young Pretender. Sometimes an apparent succession is due to immigration of a distant relative from some other region—"the glorious House of Hanover and Protestant Succession." It was, you will remember, by such migrations that Cuvier explained the renewal of life when a previous fauna had become extinct. He admitted succession, but not descent. If he rejected special creation, he did not accept evolution.

Descent, then, is not a corollary of succession; or, to broaden the statement, history is not the same as evolution. History is a succession of events. Evolution means that each event has sprung from the preceding one. Not that the preceding event was the active cause of its successor, but that it was a necessary condition of it. For the evolutionary biologist a species contains in itself and its environment the possibility of producing its successor. The words "its environment" are necessary, because a living organism cannot be conceived apart from its environment. They are important because they exclude from the idea of organic evolution the hypothesis that all subsequent forms were implicit in the primordial protoplast alone, and were manifested either through a series of degradations, as when thorium by successive disintegrations transmutes itself to lead, or through fresh developments due to the successive loss of inhibiting factors. I say "a species contains the possibility" rather than "the potentiality," because we cannot start by assuming any kind of innate power.

Huxley, then, forty years ago, claimed that palæontologists had proved an orderly succession. To-day we claim to have proved evolution by descent. But how do we prove it? The neontologist, for all his experimental breeding, has scarcely demonstrated the transmutation of a species. The palæontologist cannot assist at even a single birth. The evidence remains circumstantial.

Recapitulation as Proof of Descent.

Circumstantial evidence is convincing only if inexplicable on any other admissible theory. Such evidence is, I believe, afforded by palæontological instances of Haeckel's law, *i.e.* the recapitulation by an individual during its growth of stages attained by adults in the previous history of the race. You all know how this has been applied to the Ammonites; but any creature with a shell or skeleton that grows by successive additions and retains the earlier stages unaltered can be studied by this method. If we take a chronological series of apparently related species or mutations, a^1, a^2, a^3, a^4, and if in a^4 we find that the growth-stage immediately preceding the adult resembles the adult a^3, and that the next preceding stage resembles a^2, and so on; if this applies *mutatis mutandis* to the other species of the series; and if, further, the old age of each species foreshadows the adult character of its successor, then we are entitled to infer that the relation between the species is one of descent. Mistakes are liable to occur for various reasons, which we are learning to guard against. For example, the perennial desire of youth to attain a semblance of maturity leads often to the omission of some steps in the orderly process. But this and other eccentricities affect the earlier rather than the later stages, so that it is always possible to identify the immediate ancestor, if it can be found. An admirable example of the successful search for a father is provided by R. G. Carruthers in his paper on the evolution of *Zaphrentis delanouei*. Surely when we get a clear case of this kind we are entitled to use the word "proof," and to say that we have not merely observed the succession, but have proved the filiation.

* * *

The "Line-upon-Line" Method of Palaeontology.

You will have observed that the precise methods of the modern palæontologist, on which this proof is based, are very different from the slap-dash conclusions of forty years ago. The discovery of Archæopteryx, for instance, was thought to prove the evolution of birds from reptiles. No doubt it rendered that conclusion extremely probable, especially if the major premise—that evolution *was* the method of Nature—were assumed. But the fact of evolution is precisely what men were then trying to prove. These jumpings from class to class or from era to era by aid of a few isolated stepping-stones were what Bacon calls anticipations, "hasty and premature," but "very effective, because as they are collected from a few instances, and mostly from those which are of familiar occurrence, they immediately dazzle the intellect and fill the imagination" ("Novum Organon," i., 28). No secure step was taken until the modern palæontologist began to affiliate mutation with mutation and species with species, working his way back, literally inch by inch, through a single small group of strata. Only thus could he base on the laboriously collected facts a single true interpretation; and to those who preferred the broad path of generality his interpretations seemed, as Bacon says they always "must seem, harsh and discordant—almost like mysteries of faith."

I have long believed that the only safe mode of advance in palæontology is that which Bacon counselled, namely, "uniformly and step by step." Was this not, indeed, the principle that guided Linnæus himself? Not until we have linked species into lineages can we group them into genera; not until we have unravelled the strands by which genus is connected with genus can we draw the limits of families; nor until that has been accomplished can we see how the lines of descent diverge or converge, so as to warrant the establishment of orders. Thus by degrees we reject the old slippery stepping-stones that so often toppled us into the stream, and foot by foot we build a secure bridge over the waters of ignorance.

The work is slow, for the material is not always to hand, but as we build we learn fresh principles and test our current hypotheses. To some of these I would now direct your attention.

Continuity in Development.

Let us look first at this question of continuity. Does an evolving line change by discontinuous steps (saltations), as when a man mounts a ladder; or does it change continuously, as when a wheel rolls uphill? The mere question of fact is extraordinarily difficult to determine. Considering the gaps in the geological record, one would have expected palæontologists to be the promulgators of the hypothesis of discontinuity. They are its chief opponents.

Again I must leave the facts and their interpretation, merely reminding you of such cases as the heart-urchins or Micrasters of the Chalk. Here, where we have a fairly continuous succession of many hundred feet of similar rock, we do find a slow and gradual change, such that no clean line can be drawn between one form and its successor.

Whatever may be the explanation, the facts do seem to warrant the statement that evolutionary change can be, and often is, continuous. I propose to speak of it as "transition."

* * *

The Direction of Change.

Those who attempt to classify species now living frequently find that they may be arranged in a continuous series, in which each species differs from its neighbours by a little less or a little more; they find that the series corresponds with the geographical distribution of the species; and they find sometimes that the change affects particular genera or families or orders, and not similar assemblages subjected, apparently, to the same conditions. They infer from this that the series represents a genetic relation, that each successive species is the descendant of its preceding neighbour; and in some cases this inference is warranted by the evidence of recapitulation—a fact which further indicates that the change arises by addition or subtraction at the end of the individual life-cycle. For this appearance of successive differences we may here use the brief and non-committal term "seriation."

The comparison of the seriation of living species and genera to the seriation of a succession of extinct forms as revealed by fossils was first made by Cope, who in 1866 held the zoological regions of to-day to be related to one another "as the different subdivisions of a geologic period in time." This comparison is of great importance. Had we the seriations of living forms alone, we might often be in doubt as to the meaning of the phenomenon. In the first place, we might ascribe it purely to climatic and similar environmental influence, and we should be unable to prove genetic filiation between the species. Even if descent were assumed, we should not know which end of the series was ancestral, or even whether the starting-point might not be near the middle. But when the palæontologist can show the same, or even analogous, seriation in a time-succession, he indicates to the neontologist the solution of his problem.

Restricting ourselves to series in which descent may be considered as proved or highly probable, we find then a definite seriation—not merely transition, but transition in orderly sequence such as can be represented by a graphic curve of simple form. If there are gaps in the series as known to us, we can safely predict their discovery; and we can prolong the curve backwards or forwards so as to reveal the nature of ancestors or descendants.

Orthogenesis: Determinate Variation.

The regular, straightforward character of such seriation led Eimer to coin the term "orthogenesis" for the phenomenon as a whole. If this term be taken as purely descriptive, it serves well enough to denote certain facts. But orthogenesis, in the minds of most people, connotes the idea of necessity, of determinate variation, and of predetermined course. Now, just as you may have succession without evolution, so you may have seriation without determination or predetermination. Let us be clear as to the meaning of these terms. Variation is said to be determinate or "definite" when all the offspring vary in the same direction. All the changes are of the same kind, though they may differ in degree. For instance, all may consist in some addition, as a thickening of skeletal structures, an outgrowth of spines or horns; or all may consist in some loss, as the smaller size of outer digits, the diminution of tubercles, or the disappearance of feathers. A succession of such determinate variations for several generations produces seriation; and when the seriation is in a *plus* direction it is called progressive, when in a *minus* direction retrogressive. Now, it is clear that if a single individual or generation produces offspring with, say, *plus* variations differing in degree, then the new generation will display seriation. Instances of this are well known. You may draw from them what inferences you please, but you cannot actually prove that there is progression. Breeding experiments under natural conditions for a long series of years would be required for such proof. Here again the palæontologist can point to the records of the process throughout centuries or millennia, and can show that there have been undoubted progression and retrogression. I do not mean to assert that the examples of progressive and retrogressive series found among fossils are necessarily due to the seriation of determinate variations, but the instances of determinate variation known among the creatures now living show the palæontologist a method that may have helped to produce his series. Once more the observations of neontologist and palæontologist are mutually complementary.

Predetermination.

So much for determination; now for predetermination. This is a far more difficult problem, discussed when the fallen angels

> reasoned high
> Of providence, foreknowledge, will, and fate,
> Fixed fate, free will, foreknowledge absolute,
> And found no end in wandering mazes lost,

and it is likely to be discussed so long as a reasoning mind persists. For all that, it is a problem on which many palæontologists seem to have made up their minds. They agree (perhaps unwittingly) with Aristotle that "Nature produces those things which, being continuously moved by a certain principle inherent in themselves, arrive at a certain end." In other words, a race once started on a certain course will persist in that course, no matter how conditions may change, no matter how hurtful to the individual its own changes may be, progressive or retrogressive, uphill and downhill, straight as a Roman road, it will go on to that appointed end. Nor is it only palæontologists who think thus. Prof. Duerden has recently written: "The Nägelian idea that evolutionary changes have taken place as a result of some internal vitalistic force, acting altogether independently of external influences, and proceeding along definite lines, irrespective of adaptive considerations, seems to be gaining ground at the present time among biologists."

The idea is a taking one, but is it really warranted by the facts at our disposal? We have seen, I repeat, that succession does not imply evolution, and (granting evolution) I have claimed that seriation can occur without determinate variation and without predetermination. It is easy to see this in the case of inanimate objects subjected to a controlling force. The fossil-collector who passes his material through a series of sieves, picking out first the larger shells, then the smaller, and finally the microscopic Foraminifera, induces a seriation in size by an action which may be compared to the selective action of successive environments. There is, in this case, predetermination imposed by an external mind, but there is no determinate variation. You may see in the museum at Leicester a series beginning with the *via strata* of the Roman occupants of Britain, and passing through all stages of the tramway up to the engineered modern railroad. The unity and apparent inevitability of the series conjure up the vision of a world-mind consciously working to a foreseen end.

An occasional experiment along some other line has not been enough to obscure the general trend; indeed, the speedy scrapping of such failures only emphasises the idea of a determined plan. But closer consideration shows that the course of the development was guided simply by the laws of mechanics and economics and by the history of discovery in other branches of science. That alone was the nature of the determination, and predetermination there was none. From these instances we see that selection can, indeed must, produce just that evolution along definite lines which is the supposed feature of orthogenesis.

The arguments for orthogenesis are reduced to two: first, the difficulty of accounting for the incipient stages of new structures before they achieve selective value; and, secondly, the supposed cases of non-adaptive, or even—as one may term it—counter-adaptive, growth.

The earliest discernible stage of an entirely new character in an adaptive direction is called by H. F. Osborn a "rectigradation" (1907), and the term implies that the character will proceed to develop in a definite direction. Osborn gives as instances the first folding of the enamel in the teeth of the ancestral horses and the first slight elevation on the skull of the older Titanotheres, foreshadowing the large nose-horns of those strange Tertiary mammals. He contrasts rectigradations with the changes in shape and proportion of some pre-existing structure, and calls the latter "allometrons." Further, he claims that some predetermining law or similarity of potential governs the appearance of rectigradations, because they arise independently on the same part of the skull in different lineages at different periods of geological time.

Osborn maintains, then, that rectigradations are a result of the principle of determination, but this does not seem necessary. In the first place, the precise distinction between an allometron and a rectigradation fades away on closer scrutiny. When the rudiment of a cusp or a horn changes its form, the change is an allometron; the first swelling is a rectigradation. But both of these are changes in the form of a pre-existing structure; there is no fundamental difference between a bone with an equable curve and one with a slight irregularity of surface. Why may not the original modification be due to the same cause as the succeeding ones? The development of a horn in mammalia is probably a response to some rubbing or butting action which produces changes first in the hair and epidermis. One requires stronger evidence than has yet been adduced to suppose that in this case form precedes function. As Jaekel has insisted, skeletal formation follows the changes in the softer tissues as they respond to strains and stresses. In the evolution of the Echinoid skeleton any new structures that appear, such as auricles for the attachment of jaw-muscles and notches for the reception of external gills, have at their inception all the character of rectigradations, but it can scarcely be doubted that they followed the growth of their correlated soft parts, and that these latter were already subject to natural selection. But we may go further; in vertebrates, as in Echinoderms, the bony substance is interpenetrated with living matter, which renders it directly responsive to every mechanical force, and modifies it as required by deposition or resorption, so that the skeleton tends continually to a correlation of all its parts and an adaptation to outer needs.

The fact that similar structures are developed in the same positions in different stocks at different periods of time is paralleled in probably all classes of animals; Ammonites, Brachiopods, Polyozoa, Crinoids, and Sea-urchins present familiar instances. But do we want to make any mystery of it? The words "predisposition," "predetermining law," "similarity of potential," "inhibited potentiality," and "periodicity" all tend to obscure the simple statement that like causes acting on like material produce like effects. When other causes operate the result is different. Certainly such facts afford no evidence of predetermination in the sense that the development must take place willy-nilly. Quite the contrary; they suggest that it takes place only under the influence of the necessary causes.

The resemblance of the cuttle-fish eye to that of a vertebrate has been explained by the assumption that both creatures are descended, *longo intervallo* no doubt, from a common stock, and that the flesh or the germ of that stock had the internal impulse to produce this kind of eye some day when conditions should be favourable. It is not explained why many other eyed animals, which must also have descended from this remote stock, have developed eyes of a different kind. Nevertheless, I commend this hypothesis of Prof. Bergson to the advocates of predisposition. To my mind, it only shows that a philosopher may achieve distinction by a theory of evolution without a secure knowledge of biology.

When the same stock follows two quite different paths to the same goal it is impossible to speak of a predetermined course. [An instance of this was given.]

(To be continued.)

The Constitution of Cellulose.

In an illuminating lecture delivered before the French Chemical Society on May 21, Prof. A. Pictet, of Geneva, described the results obtained by his pupils and himself on distilling cellulose at a low pressure, and showed how these can be interpreted so as to throw much new light on the constitution of this complicated substance.

When cotton cellulose is heated gradually in a distilling apparatus under a pressure of 10–15 mm. decomposition begins at 210° and an oil distils over equal in weight to 45 per cent. of the original cellulose, which soon solidifies, and consists of lævoglucosan. This is considered to be an anhydride derived from β-glucose, and to have the constitution

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CH(OH) . CH . OH
|         |
CH—O—CH
|         |
O—CH2 . CH . OH.
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Previous work has shown that cellulose furnishes on acetolysis a disaccharide, cellobiose, which probably contains an α-glucose and a β-glucose group. Also, with hydrobromic acid, cellulose gives bromomethylfurfurol. The origin of the latter, a hydrofuran nucleus containing two side-chains, the author terms the chitose grouping. Prof. Pictet therefore regards cellulose as containing two β-glucose groups, one chitose grouping, and probably an α-glucose group, represented thus:

$$\frac{\beta \mid \mathrm{Ch}}{\beta \mid \alpha ?}$$

By acetolysis the α-glucose group and a β-glucose group together form cellobiose (50 per cent.), and in the decomposition with hydrobromic acid the chitose grouping furnishes bromomethylfurfurol (25 per cent.), the other three groups being converted into the black mass which is always formed in the reaction. Finally, on dry distillation under reduced pressure the β-glucose groupings split off to give lævoglucosan (50 per cent.), and the others, which are not volatile without decomposition, furnish water, furfurol, carbon, etc.

In the molecule of cellulose the various groups are probably united together in consequence of the opening of the ring at an oxygen atom which does not form the furan ring, and in this way the cellulose molecule, forming a vast cyclic network, may bear some analogy to those of the albuminoids, in which the linking agents are nitrogen atoms.

Joseph Black and Belfast.

UNDER the title of "Joseph Black: His Belfast Friends and Family Connections" Mr. Henry Riddell has recently published in the Proceedings of the Belfast Natural History and Philosophical Society (vol. iii., 1919–20, p. 49) an interesting account of Joseph Black's connection with Belfast. As is well known, the famous chemist was born at Bordeaux, where his father, John Black, was a factor and wine merchant, but his ancestors for many generations back were Ulstermen, and he himself received his school education either in the old Latin School in Belfast, endowed by Earl Donegall in 1666, or at the hands of a Mr. Sprott, a schoolmaster of repute in that city. Up to the age of twelve Black was educated by his mother, Margaret Gordon, who is described as a woman of great force of character and many accomplishments. She was the daughter of Robert Gordon, a merchant of Aberdeen, and was married to John Black in 1716, by whom she had issue eight sons and five daughters, Joseph Black, who was born in 1728, being the fourth son.

The Blacks were of Scottish extraction, and were said to be descended from a member of the Clan Lamont who was known as Gillie-dhu on account of his remarkably black hair. Some of his sons, on the invitation of James I., passed over to Ulster, which had been laid waste and depopulated by the wars among the Irish chiefs and their clans. Their descendants, or some of them, settled in Belfast and anglicised their name to Black. One of them, John Black, the great-grandfather of the chemist, fought as a trooper against Cromwell. His son, also John Black, born in 1682, was a burgess of Belfast, and had a family of five sons, all engaged in "merchandysinge" in various parts of the Continent. The various members married into some of the leading Ulster families—the Eccles, Wilsons, Banks, Legges, Clarkes, and others. Jane Eccles, the grandmother of the chemist, was the daughter of John Eccles of Cranmore, who entertained William III. on his way from Carrick to Drogheda. The chemist's eldest brother, John, married Jane Banks, a member of one of the best-known families in Belfast. One of their granddaughters, Maria, became the wife of Lord Downs, and from them sprang two girls, Ann and Charlotte, who married respectively Lord Clonmel and Lord Seaton. Isobel Black, the sister of the chemist, married James Burnett, of Aberdeen; their daughter became the wife of Adam Ferguson, the moral philosopher and colleague, intimate friend, and cousin of Joseph Black. A descendant of one of his other sisters, Katherine, became the wife of Prince Waldeck and Pyrmont.

Two of Joseph's brothers, Samuel and George, returned to Belfast and took a prominent part in the municipal life of the town, holding the office of "Sovereign" (mayor) between them no fewer than seven times between 1772 and 1789.

Joseph Black, after a good grounding in classics and mathematics, left Belfast for Glasgow in his eighteenth year, entering the University, therefore, considerably older than the usual run of matriculants at that period. He came almost immediately under the influence of two remarkable men, Dick, professor of natural philosophy, and Cullen, professor of medicine and lecturer on chemistry. The fact that Black was considerably senior to the majority of his fellow-students may have induced Cullen to offer him the position of lecture-assistant, and it was probably this fortunate circumstance that determined his career.

The great chemist, who died in 1799, was never married, and left no immediate descendants. It is evident from this short statement that he belonged to a family of noteworthy mental peculiarities, many members of which were characterised by remarkable powers and capacity. Joseph Black, so far as is known, is the only one who showed any striking predilection towards scientific pursuits, and there are special circumstances in his case which may serve to explain the direction of his inclinations. If, as the late Sir Francis Galton contended, high reputation is a pretty accurate test of high ability, Joseph Black certainly ennobled his ancestry. But an examination of their individual history seems to show that he is no less a debtor to those who went before him, and that his eminence is in no small degree due to qualities implanted in him by his Ulster upbringing and associations. T. E. THORPE.

The Sakura-jima Eruption of 1914.

PROF. OMORI has recently made two additions to his valuable series of memoirs on the eruption of the Sakura-jima (South Japan) on January 12, 1914. The fourth memoir deals with the continued changes of elevation in the neighbourhood of the volcano, and the fifth with the numerous earthquakes which preceded and followed the eruption (Bull. Imp. Earthq. Inves. Com., vol. viii., 1920, pp. 323–51 and 353–466). Until 1914 the Sakura-jima was an island in the Bay of Kagoshima, the inner bay to the north of it being a basin 12½ miles long from east to west and 7½ miles wide. A comparison of two series of levels made a few years before the eruption and in April and May, 1915, revealed a depression of not less than 20 in. in the northern part of the bay, and of from 1 ft. to 5½ ft. round the coast of the former island, the centre of which was elevated in two places by as much as 30 ft. and 41 ft. In the winter of 1918–19 a new series of levels was made along the west and north coasts of the bay, from which it is seen that the depression of the inner bay gave place to an elevation, the mean rise from February, 1915, to December, 1918, being about 4 in. In 1917 a series of soundings was also made in the bay, and these show that there are three depressions (of maximum depth 85, 113, and 79 fathoms), the first being separated from the others by a submarine ridge running north from the volcano, and apparently due to the eruptions of A.D. 764, 1468–76, and 1779. Comparing the new soundings with those made in 1906, there are seen to be three areas of fresh depression (from 3 to 4 fathoms) coinciding with the three depressions, and two areas of new elevation, the more important one (of 3 fathoms) being near the submarine ridge. Prof. Omori estimates that the total resultant depression of the district amounts to about one-quarter of a cubic mile, and the volume of lava and ashes ejected to slightly more than one-half of a cubic mile, and he suggests that this difference may account for the defect of gravity sometimes observed in the neighbourhood of a volcano.

The records of the Sakura-jima earthquakes at Kagoshima (6½ miles from the volcano), Nagasaki

(92 miles), and Osaka (348 miles) leads to the following conclusions:—(1) The frequent occurrence of earthquakes, both unfelt and strong, terminated at or immediately before the opening of the eruption; (2) the principal centre of the after-shocks coincides roughly with the centre of elevation of the sea-bed to the north of the Sakura-jima, which is 8·9 miles from Kagoshima; (3) the mean duration of the preliminary tremor at this place was 1·94 seconds, corresponding to a focal distance of 8·9 miles, from which it follows that the focal depth was very small; and (4) in the after-shocks the first distinct displacement was usually directed towards or from the source of disturbance, while the mean directions of the maximum vibrations were parallel and perpendicular to the line joining the craterlets on the two flanks of the volcano. C. D.

University and Educational Intelligence.

AN introductory public lecture to a series of seven courses of lectures on the history of science will be given by Sir W. H. Bragg at University College (University of London) on Thursday, October 7, at 5 p.m. The courses arranged are as follows:—The General History and Development of Science, Dr. A. Wolf; The More Important Developments in Physical Science during the Nineteenth Century, Sir W. H. Bragg, Prof. E. J. Garwood, Mr. D. Orson Wood, and others; Egyptian Science, Prof. Flinders Petrie; The History of the Biological and Medical Sciences from Early Times to the Eighteenth Century, Dr. Charles Singer; The History of the Biological Sciences since the Eighteenth Century, Prof. J. P. Hill; Elementary Astronomy, treated Historically, Prof. L. N. G. Filon; and The History of Mathematics up to the Eighteenth Century, Mr. T. L. Wren.

IN the annual report for 1919–20 of the Coventry Public Libraries several points are worthy of notice. Figures are given showing the number of issues which have been made during the past and the previous year. Of the total of 380,170 issues of books in 1919–20, 167,758 were of technical and literary books, while 144,296 were works of fiction. The figures are significant of the use to which the library is put by the inhabitants. As compared with the previous year, the number of issues of technical works has increased by 26,976, while the increase for fiction was only 2087. These figures indicate the revival of study which was to be expected with the return of students to peaceful occupations. In the issues of the home-reading libraries similar figures were observed, the increase in the demand for works on the arts and sciences being 6449. On the other hand, research work, by which is meant the study of the accumulated data of a subject before proceeding with investigations, has declined since the armistice. Only one-twelfth of the 82,245 volumes in stock are classed as fiction. The libraries are intended chiefly for the use of students, and their continued popularity shows that they are appreciated as such.

THE President of the Board of Education has addressed a letter to the Vice-Chancellor of the University of London (Dr. Russell Wells), under date September 24, with reference to the Government offer of a site for the University behind the British Museum, explaining that, with the consent of the vendor (the Duke of Bedford), it is possible for the offer to remain open until the Senate's meeting on October 20, but no longer. Mr. Fisher expresses general approval of the proposed conditions to be attached to acceptance of the offer which were discussed by the Senate in July, save that respecting freedom from debt as regards the new buildings before the old buildings are vacated. He suggests a revision of the wording of this condition, but admits that the Government fully shares the view as to the undesirability of the University and King's College entering upon the occupation of their new buildings under an embarrassing load of debt. Mr. Fisher further explains that the Government offer is not available for any alternative site, since on a review of all the circumstances the Government has come to the definite conclusion "that the site behind the British Museum is the most suitable and the only one which they would feel justified in acquiring for offer to the University." In conclusion, Mr. Fisher expresses his earnest hope that the Senate will decide to accept the offer which the Government has made.

THE educational system of Japan (Bulletin No. 57, 1919, of the United States Bureau of Education) is the result of a fusion of the traditional training in national humanistic studies with that in modern science. Progress is possible on the latter side only. Technical education of an elementary type is given in the vocational schools, to which students who have passed through the elementary schools are admitted. In 1915–16 the number of technical schools attached to such vocational institutes was 9001, an increase of 533 over the preceding year; while that of the private technical schools was 366, an increase of 20. Approximately 95,000 pupils were enrolled in all schools of this kind, exclusive of continuation schools. The technical continuation schools admit students who have passed the standard of the elementary schools, though the individual school authorities have power to admit or refuse any candidate. In the year 1915–16 407,600 male pupils and 89,601 females were enrolled in these schools, an increase of nearly 50,000 over the numbers joining during the previous year. Within the next six years it is proposed to spend some four and a half million pounds on higher education. The technical and high schools already in existence will accommodate 14,000 students only, while during the year 1917–18 about 56,000 applied for admission. This money will therefore be devoted to the building of ten new high schools and eighteen new technical and commercial institutes. Great prominence is given to the rapid but efficient training of teachers of all grades.

Societies and Academies.

PARIS.

Academy of Sciences, August 30.—M. Henri Deslandres in the chair.—G. **Humbert**: An arithmetical link between the real ternary quadratic forms and the indefinite forms of Hermite.—H. **Deslandres**: The recognition in stars of the successive layers of their atmosphere and the periodic variations of these stars. From the study of the calcium lines in the solar spectrum the existence of three layers in the solar atmosphere has been deduced. The same method can be applied to the fixed stars, and an account is given of the results obtained up to the present by various observers.—E. **Ariès**: The specific heat of saturated vapours at low temperatures. Reply to a communication by G. Bruhat.—J. **Andrade**: The regulating organs of chronometers.—E. **Jouguet**: Waves of shock in solid bodies.—M. **Galbrun**: The deformation of a helical spring.—M. **d'Azambuja**: The spectrum of the new star in Cygnus. On August 25 and 28 the spectrum of the new star presented the appearance usual with novæ in the course of the first stage of their evolution.—M. **Burson**: The spectrum of Nova Cygni.

—C. **Raveau**: The thermodynamical properties of fluids in the neighbourhood of the critical state.—MM. **Orékhoff** and **Tiffeneau**: The hydrobenzoin transposition. The influence of the paramethoxy-substitution on the dehydration of the triarylglycols.—G. **Zeil**: The ascending movements of the earth's crust and the recurrences of subterranean erosion.—E. **Aubel**: The influence of the nature of the carbon compounds present on the utilisation of nitrogen by *Bacillus subtilis.*

September 6.—M. Léon Guignard in the chair.—A. **Lacroix**: The regular grouping of two different minerals constituting certain ores of iron and titanium.—M. **Laubeuf**: A small submarine for oceanographic work. Details of design and equipment of a small submarine, 18·8 metres in length and of 50 tons displacement, for use in oceanography. It would sustain the pressure of water at depths of 80 to 100 metres, and, it is estimated, would now cost 600,000 francs to build, although in 1907, when the plans were first drawn up, it could have been built for less than a third of that sum. The work suggested for this submarine includes collecting samples from the ocean-floor, water at various depths, plankton, and observations on temperature and transparency of water and the direction and velocity of the currents.—P. **Humbert**: Hypercylindrical functions.—C. **Nordmann**: Observations of the new star in Cygnus, made at the Paris Observatory with a heterochrome photometer. In this apparatus the ratio of the intensities of the star studied and a known star is compared in various regions of the spectrum by equalising by means of Nicol prisms the brightness of the star under examination and that of an artificial star observed simultaneously through a coloured screen. It was found that the magnitude of the new star changed from 3·43 on August 27 to 4·01 on August 29. The brightness of the new star is, therefore, rapidly decreasing. On the first date the star had an effective temperature of 6100° C., which on the later date had increased to 7800°. Attention is directed to the fact that the increase of effective temperature is accompanied by a diminution in the brightness, contrary to what would have been expected.—H. **Grouiller**: First observations of Denning's nova made at the Lyons Observatory. Measurements of the magnitude of the star on August 23, 24, 25, 26, and 27. The brightness passed through a maximum on August 24 and then rapidly decreased.—J. **Guillaume**: Observations of the sun made at the Lyons Observatory during the first quarter of 1920. Observations were possible on sixty-eight days, and the results are summarised in three tables showing the number of sunspots, their distribution in latitude, and the distribution of the faculæ in latitude.—J. **Rouch**: Inversions of temperature in the lower atmospheric layers in the Antarctic.

WASHINGTON, D.C.

National Academy of Sciences (Proceedings, vol. vi., No. 3, March).—S. **Flexner**: Encephalitis and poliomyelitis. A short sketch of the present state of knowledge relative to these two diseases.—A. F. **Kovarik**: A statistical method for studying the radiations from radio-active substances and the X-rays, and its application to some X-ray problems. A continuation of the work of Kovarik and McKeehan. The author finds 7×10^{10} γ-rays from radium B and C per second per gram of sodium instead of 3×10^{10} formed by Lawson and Hess.—L. B. **Loeb**: The nature of the heat production in a system of platinum black, alcohol, and air. Of the two theories that the heat is due (1) to the adsorption of alcohol and (2) to the oxidation of the alcohol at the platinum surface, the latter is substantiated.—H. **Noguchi**: *Leptospira icteroides* and yellow fever. A special organism, *Leptospira icteroides,* has been detected in certain cases of yellow fever. Guinea-pigs have been inoculated with it by Stegomyias, but until further studies have been made its standing as the inciting agent of yellow fever cannot be regarded as certain.—S. **Hecht**: Human retinal adaptation. A binocular reaction is involved; in all essentials the mechanism underlying the initial phase of retinal sensitivity in dim light is the same as involved in the initial process of photoreception in Mya and Ciona.—L. **Page**: A kinematical interpretation of electromagnetism. The equations of electrodynamics are shown to be simple kinematical relations between the moving elements which constitute lines of force.—A. A. **Michelson**: The laws of elastico-viscous flow, ii. A criticism of the formula which combines the laws of Larmor and Maxwell; an elaboration with many data of a previous paper of the same title.—H. **Shapley**: A note on a simple device for increasing the photographic power of large telescopes. A short-focus lens is placed in the converging beam at an appropriate distance in front of the photographic plate, giving high speed and reducing the scale on the photograph.—L. R. **Sullivan**: Anthropometry of the Siouan tribes. Of interest (1) because accurately describing and defining the Siouan type and showing its relationship to American Indian tribes already described, and (2) because of the intermixture of two widely separated races represented by this series of individuals.—F. M. **Guyer** and E. A. **Smith**: Transmission of eye-defects induced in rabbits by means of lens-sensitised fowl-serum. The defects have been transmitted to the sixth generation.—H. G. **Barbour** and J. B. **Hermann**: The mechanism of fever reduction by drugs. Antipyritic drugs increase the blood-content of dextrose. In fevered animals this is accompanied by dilution of the blood, with resulting fall in temperature.—E. H. **Hall**: Inferences from the hypothesis of dual electric conduction: The Thomson effect. A tabulation of a great variety of data correlated with theory under either of two hypotheses of electron equilibrium in metals unequally heated.—C. L. E. **Moore** and H. B. **Phillips**: Note on geometrical products. Development of a series of geometrical products, independent of the dimensions of space, intermediate between the progressive and the inner product.

Books Received.

The Manufacture of Sugar from the Cane and Beet. By T. H. P. Heriot. (Monographs on Industrial Chemistry.) Pp. x+426. (London: Longmans, Green, and Co.) 24*s.* net.

Children's Dreams. By Dr. C. W. Kimmins. Pp. 126. (London: Longmans, Green, and Co.) 5*s.* net.

Margarine. By W. Clayton. (Monographs on Industrial Chemistry.) Pp. xi+187. (London: Longmans, Green, and Co.) 14*s.* net.

Weeds of Farm Land. By Dr. W. E. Brenchley. Pp. x+239. (London: Longmans, Green, and Co.) 12*s.* 6*d.* net.

Geologie des Meeresbodens. Band ii., Bodenbeschaffenheit, Nutzbare Materialien am Meeresboden. By Prof. K. Andrée. Pp. xx+689+7 Tafeln. (Leipzig: Gebrüder Borntraeger.) 92 marks.

Insect Adventures. By J. H. Fabre. Pp. xii+308. (London: Hodder and Stoughton, Ltd.) 8*s.* 6*d.* net.

The Psychology of Dreams. By W. S. Walsh. Pp. xi+361. (London: Kegan Paul and Co., Ltd.) 12*s.* 6*d.* net.

Among the Ibos of Nigeria. By G. T. Basden.

Pp. 315. (London: Seeley, Service, and Co., Ltd.) 25s. net.

Anæsthetics: Their Uses and Administration. By Dr. D. W. Buxton. Sixth edition. (London: H. K. Lewis and Co., Ltd.) 21s. net.

Among the Natives of the Loyalty Group. By E. Hadfield. Pp. xix+316. (London: Macmillan and Co., Ltd.) 12s. 6d. net.

Mind-Energy: Lectures and Essays. By Prof. H. Bergson. Translated by Prof. H. Wildon Carr. Pp. x+212. (London: Macmillan and Co., Ltd.) 10s. net.

Higher Mechanics. By Prof. H. Lamb. Pp. x+272. (Cambridge: At the University Press.) 25s. net.

Ministry of Finance, Egypt. Survey of Egypt. Geological Survey. Palæontological Series, No. 4. Catalogue des Invertébrés Fossiles de l'Egypte. By R. Fourtau. Terrains Tertiaires. 2de Partie: Echinodermes Néogènes. Pp. vii+100+iv+xii plates. (Cairo: Government Press.) 40 P.T.

A Practical Handbook of British Birds. Part ix., vol. ii. Pp. 80+1 plate. (London: Witherby and Co.) 4s. 6d. net.

Experiment Station of the Hawaiian Sugar Planters' Association. The Leguminous Plants of Hawaii. By Prof. J. F. Rock. Pp. x+234. (Honolulu, Hawaii.)

Die Entstehung und Bisherige Entwicklung der Quantentheorie. By Max Planck. Pp. 32. (Leipzig: J. A. Barth.) 4 marks.

The Romance of the Microscope. By C. A. Ealand. Pp. 314. (London: Seeley, Service and Co., Ltd.) 7s. 6d. net.

Animal Ingenuity of To-day. By C. A. Ealand. Pp. 313. (London: Seeley, Service and Co., Ltd.) 7s. 6d. net.

The History of Social Development. By Dr. F. Müller-Lyer. Translated by Elizabeth C. Lake and H. A. Lake. Pp. 362. (London: G. Allen and Unwin, Ltd.) 18s. net.

Experimental Science. By S. E. Brown. I., Physics; Section v., Light. Pp. vii+273-424. (Cambridge: At the University Press.) 6s. net.

The Lure of the Hive. By H. Clark. Pp. 24. (Leicester: P. Stevens.) 4d.

Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1919-20. (Cmd. 905.) Pp. 120. (London: H.M. Stationery Office.) 1s. net.

The Tomb of Antefoker, Vizier of Sesostris I., and of his Wife, Senet. By N. de Garis Davies. (Theban Tombs Series, No. 60.) Second Memoir. Pp. iii+40+48 plates. (London: G. Allen and Unwin, Ltd.) 2 guineas net.

The Foundations of Character. By A. F. Shand. Second edition. Pp. xxxvi+578. (London: Macmillan and Co., Ltd.) 20s. net.

The Carbohydrates and Alcohol. By Dr. S. Rideal and Associates. Pp. xv+219. (London: Baillière, Tindall and Cox.) 12s. 6d. net.

A Treatise on Chemistry. By Sir H. E. Roscoe and C. Schorlemmer. Vol. i., The Non-Metallic Elements. Fifth edition, completely revised by Dr. J. C. Cain. Pp. xv+968. (London: Macmillan and Co., Ltd.) 30s. net.

The Atlas Geographies: Preparatory. Scotland. By T. S. Muir. Pp. 32. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 1s. net.

Union of South Africa. Department of Agriculture. The Seventh and Eighth Reports of the Director of Veterinary Research. Pp. v+734+7 plates. (Pretoria, P.O. Box 593: Director of Veterinary Research.) 10s.

Forestry Commission. Bulletin No. 2, Survey of Forest Insect Conditions in the British Isles, 1919. Pp. 35+3 plates. (London: H.M. Stationery Office.) 1s. 6d. net.

Forestry Commission. Bulletin No. 3, Rate of Growth of Conifers in the British Isles. Pp. 86. (London: H.M. Stationery Office.) 3s. net.

Field Observations on British Birds. By A Sportsman Naturalist. Edited by H. Balfour. Pp. xvi+229+vi plates. (London: Selwyn and Blount.) 25s. net.

Warfare in the Human Body. By Morley Roberts. Pp. xiii+286. (London: Eveleigh Nash Co., Ltd.) 18s. net.

Diary of Societies.

THURSDAY, OCTOBER 7.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30—Maj.-Genl. Sir F. H. Sykes: Civil Aviation.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. C. W. Kimmins: The Handwriting of the Future.

MONDAY, OCTOBER 11.

BIOCHEMICAL SOCIETY (at King's College).

WEDNESDAY, OCTOBER 13.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 8.—Sir Henry Fowler: Presidential Address.

THURSDAY, OCTOBER 14.

INSTITUTION OF AUTOMOBILE ENGINEERS (at 28 Victoria Street), at 8.—Graduates Meeting. Messrs. Chatterton and Watson: Factors affecting Power Output.

FRIDAY, OCTOBER 15.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: Demonstration on the Contents of the Museum.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—T. M. Ainscough: British Trade with India.

SATURDAY, OCTOBER 16.

PHYSIOLOGICAL SOCIETY (at Guy's Hospital).

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