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A Suggested Institute of Human Sciences.

IN the human sciences—those sciences which deal with the origin, the characters (physical, mental, and moral), and the activities of man: in other words, the anthropological sciences in the broadest sense of the term—co-ordination and co-operation are more essential than in almost any other branch of scientific research. This is due partly to the extent of the ground covered, and partly to the character of the subject-matter, which is frequently based upon a mass of data collected from a wide area. This necessity for co-operation, acting in conjunction with man's perennial interest in himself and his past, has led to the formation of a host of societies, each dealing with one or more branches of the subject. Some cover certain special aspects only—archæological, sociological, linguistic, psychological, and the like; others study man on a regional basis, and of these some cover the whole field more or less completely, as in the case of Asia and Africa; while still others confine themselves almost entirely to the archæological aspect, as in the case of the societies which deal with Egypt, Palestine, and the Mediterranean area.

The function of these learned societies in the main is fourfold. The societies serve as a gathering place for workers at which the latest results of research can be announced and discussed; they provide libraries which in theory contain books and periodicals not otherwise readily accessible to their members; they act as the publishers of the work of their members, which, on the ground either of its specialist character or of its brevity, is not suitable for publication elsewhere or in book form, thereby assisting further in disseminating the results of scientific investigation; and, lastly, they further the interests of their subject by the promotion and organisation of research and by pressing its claims to support upon the public. There has been considerable variation in the measure of success with which these functions have been performed; but, speaking generally, as the affairs of the principal learned societies which deal with human studies are in the hands of those who have attained distinction in their subjects, they lead the way and exert a not inconsiderable influence upon the lines of development of further investigation.

Those, however, who are concerned with the administration of these societies are well aware that the position is not entirely satisfactory. There is very little co-operation between societies, although a few welcome, but tentative, steps in this direction have been taken. Not only does this restrict undertakings which for financial or other reasons are beyond the resources of a single society, but it also leads to a certain amount of overlapping. Most societies have a library; where several societies deal with cognate subjects, in certain sections the same books and periodicals appear in each. This is a waste of both space and money, whether the library is augmented entirely by purchase or in part by exchange. There is also a waste of the time, energy, and money of the worker. A paper dealing with a certain specific subject may appear in any one of half a dozen or more publications, and it is impossible to know in which of a number of libraries a certain book may be found. In one case a scientific worker who wished to make use in his laboratory of a certain book long out of print visited nearly every scientific society in London before he ran it to ground. He then had to join that society in order to borrow the book.

There is also the question of catalogues and bibliographies. Owing to the cost of printing, any catalogue which is to be of use to the members who live at a distance, and cannot visit the library, is an impossibility, while a bibliography of current literature on comprehensive lines seems equally impossible without greater co-operation than has been secured up to the present.

In addition to the cost of maintaining libraries, under the present system heavy expenditure is imposed upon each society by the necessity for providing suitable and adequate accommodation for meetings and lectures.

It is unnecessary to labour these points, which must be familiar to many. The difficulties do not date from to-day or yesterday, but at the moment they are more acutely felt. Under financial stress the activities and usefulness of scientific societies are being restricted. Increases in subscriptions do not counterbalance increase in costs. Individual workers also suffer; in many cases they have to confine their membership to the society to which their work is most closely related, thus restricting their outlook and their knowledge of current work.

It would, therefore, seem desirable to cast about for some remedy which might remove or mitigate these disabilities. This might be found in the union of a number of societies dealing with this group of studies to form an Institute of Human Sciences, housed in one building and governed by a supreme council, each society retaining such a measure of autonomy under its own committee as is consistent with the common aim. Considerable economies could then be effected by pooling the respective libraries, thus avoiding unnecessary expenditure on duplicating books, and to a certain extent by pooling the staff. The amount saved might be applied to increased expenditure on the library, on cataloguing, or on bibliographical work, for which the facilities would be greatly extended by the collection of the greater part of the material and the association of a number of specialists in various branches of study within the four walls of one building. The extent to which the various societies would be fused into one institution must depend upon circumstances; but it would probably be a gain if the publications were standardised and issued in series. It would not follow as a matter of course that each member would receive all the series; the issue would be confined to such only as he required. In fact, the issue of publications might well serve as a basis for regulating the amount of the subscription payable over and above the common fee of the institute admitting to the privilege of attendance at meetings, the use of the library, and other services.

That such an institute would greatly increase the resources at the disposal of the scientific worker is self-evident. Not only would he be brought more closely into touch with those investigating different aspects of the same problems as he himself is investigating, but he would also benefit in other ways. Although scientific investigation is becoming increasingly a matter of specialisation, yet in the anthropological sciences the interrelation of the different branches of study is becoming closer as the need for synthetic treatment is more fully appreciated. No student of the human sciences can afford to neglect results obtained in fields other than his own. Under the present system few have the time at their disposal to attend the meetings of all the societies with the work of which they should be acquainted, or to go through all their publications, even if these are accessible. Given an institution under one roof, organised to meet this need of the worker, with a common library and a common staff, and provided with an adequate bibliographical system, and he should have no excuse if he failed to obtain all that he required.

By a combination such as is indicated science would benefit in at least two directions. Under the control of a supreme council, which from its constitution would be in a position to survey the whole field, research could be organised on a scale and with a certainty of direction which have not yet been attained, while the financial assistance which such an association of interests might hope to command would be considerable. Further, the influence which this body could bring to bear upon public opinion would be such as far to outweigh anything of which the individual societies appear capable at present, however desirable or necessary the objects which they urge from time to time in connection with matters of public interest.

In education it is now becoming generally recognised that, in addition to the study of physical and mental characters, the data of the human sciences have an important bearing upon many of the subjects of the curriculum of both universities and schools, and can be applied with advantage in teaching even quite small children. At present the educationist or the teacher who is not acquainted with the results of specialist research outside the four corners of his own subject is at a loss in which direction to turn for trustworthy guidance. Such guidance it would be one, and that not the least important, of the functions of the institute to provide.

Finally, although this scheme of amalgamation, for obvious reasons, must, with possibly a few exceptions, be confined to societies now housed in London, there is every reason to hope that local societies throughout the country could participate to some degree. The local archæological societies have done good work, but in the present state of our knowledge there is great need that their work should be standardised and given direction on a more or less common basis. This object might be attained by a system of affiliation and co-operation, more close than any now existing, with some central body such as the institute here suggested.

Astrology.

(1) *The Mediaeval Attitude toward Astrology, particularly in England.* By Theodore Otto Wedel. (Yale Studies in English. No. lx.) Pp. vii+168. (New Haven: Yale University Press; London: Humphrey Milford: Oxford University Press, 1920.) 10s. 6d. net.

(2) *Opera hactenus inedita Rogeri Baconi, Fasc. v. Secretum Secretorum cum glossis et notulis; Tractatus brevis et utilis ad declarandum quedam obscure dicta.* By Fratris Rogeri. Nunc primum edidit Robert Steele. Accedunt versio Anglicana ex Arabico edita per A. S. Fulton. Versio retusta Anglo-Normanica nunc primum edita. Pp. lxiv+317. (Oxford: Clarendon Press.) 28s. net.

THE attitude of man towards Nature may be said to have two stages—the "magical" and the "scientific." In the former, man lives in a world surrounded by other ill-defined beings and powers. From time to time he finds, or thinks he finds, some way to make these subserve his will, but he has as yet no apprehension of a constant relation of cause and effect. In the later, scientific stage—which first presents itself clearly to our view in the Ionian philosophers of the sixth century B.C.—a belief has arisen in natural law, in an invariable relation of cause and effect. Perhaps the most important step in the journey towards this belief was the discovery of the regularity in the movements of the heavenly bodies. The laws that these movements exhibit had long been the subject of organised observation in the Mesopotamian civilisations from which the Ionians inherited a wealth of data. But the Greeks had a passionate, almost an instinctive, belief in natural law, though few such laws had been demonstrated. Perceiving the majestic and regular recurrence of heavenly phenomena, they learned to predict them. They saw, too, that winter and summer, seed-time and harvest, day and night, and all the other broadly cyclic events of life, could be brought into some sort of relation with the heavenly cycle. Outside and beyond these there were, indeed, innumerable less regular and unpredictable phenomena, for there was as yet no biology, no chemistry, practically no physics, and scarcely any mathematics. What more reasonable than to attribute a relation between the phenomena observed to be cyclic and those the laws of which were yet unknown? Natural laws there must be, and the field of the known was but extended into the unknown. Thus astrology was born.

Later a definite geocentric spherical system of the universe was introduced—a system that held its own right down to Copernicus and Galileo and beyond. The earth was surrounded by those mysterious concentric spheres in which the stars and planets held their place—the heavenly bodies considered by the greatest of the philosophers to be eternal and divine. Spatially the universe was limited; outside the outmost sphere was nothing; within the inmost sphere was the little world on which we live. To such a view the theory of astral and planetary control of our world was attractive, satisfying, well-nigh inevitable. It needed only verification, but verification was not the strong point of the scientific system of antiquity, still less of the Dark and Middle Ages which followed. The belief in the value of astrology thus remained almost universal from Greek times until the seventeenth century. It is unfair to regard it as a superstition. It is but a discarded and untenable scientific hypothesis.

Astrology, however, had a foe, and that foe was the Church, or rather the Churches. But the opposition of the Churches must not be accounted to them for scientific righteousness; rather it was the other way. The Churches were ever insistent on man's dependence on God. How, then, could man's existence be regulated by the action of the stars that were but God's creatures? Yet as time went on the opposition of all religions, Christian and other, gradually weakened. It became evident that even God Himself worked through agents, and why should not these agents be the stars that He had made? Thus room was made for the acceptance of astrological belief, which from patristic times onward gained steadily on men's minds. In the twelfth and thirteenth centuries, as the great Arabian revival of learning penetrated to the West, astrology became a highly elaborate science; by the fifteenth century, with the ebb of the scholastic movement, it had become a widespread obsession that infected alike the university, the council chamber, the law court, and the physician's consulting-room.

(1) The general history of this extraordinary

error is outlined by Mr. Wedel with a wealth of learning and an aptness of illustration that are a credit to American scholarship. His little volume betrays an enormous amount of research presented in an attractive and succinct manner that is a model for work of this kind. Especially praiseworthy is the logical and efficient distinction between material necessary for his narrative and the equally important material, needed by the specialist for verification and reference, that is rightly relegated to his ample notes; it is a distinction which is all too rarely made. Mr. Wedel is to be congratulated on a very able and readable contribution to the embryology of science.

(2) A much more difficult, though perhaps less thankful, task has been performed by Mr. Robert Steele. His edition of the version of the pseudo-Aristotelian "Secretum Secretorum" used by Roger Bacon, with notes by the father of English science himself, is a definitive contribution to our knowledge of the medieval attitude towards phenomena. This volume forms the fifth and largest fascicule of Mr. Steele's fundamental and valuable series of the hitherto unedited works of Roger Bacon. These works appeal perhaps to few readers, yet they are of permanent value as among the earliest documents of the re-birth of science.

With our present standards of historical and textual criticism it is at first incomprehensible that a great intellect like Bacon's could have taken this debased Arabian work for a treatise of Aristotle. With our standards of scientific verification it is equally incredible that such data as this work presents could make any appeal save to a confused and obfuscated intellect. Yet an appeal it did make, and for precisely that reason the work is of great interest, for by studying it and works like it we may reasonably hope to learn something of the mental processes with which "science" in our sense made its appearance in the modern world. These notes of Bacon were made at the turning point of his career, just before he passed from the pre-scientific to the scientific stage. He never freed himself from his belief in astrology, nor could any man entirely reject this doctrine while the geocentric theory held full sway. But Roger enunciated principles of observation and experiment which, in other hands, ultimately rendered astrological theory untenable. He never developed an adequate standard of textual criticism, but he made a strong appeal for the systematic study of languages, he formulated methods for such study, and he made remarkable and interesting attempts at grammatical analyses. These efforts of his, in other and more fortunate hands, led to a scientific treatment of languages and of texts.

Roger Bacon stands as one of the heralds of the dawn of science, yet he has suffered much, and still suffers, from misunderstanding and neglect. Some of his most interesting works are still unprinted, and their publication is one of the several important pieces of work that must be achieved before any adequate and continuous history of science can be written. Yet the editing of such works is by no means easy, for it requires, on the one hand a very special training, and on the other a wide range of different kinds of knowledge that are very rarely combined in one individual. It further demands a degree of patient endurance of toil that is rare even among professional scholars; and, lastly, it calls for an indifference to the material reward for such prolonged labours that is perhaps rarest of all. Every one of these qualities the editor of this fascicule exhibits in abundant measure; his introduction and notes are scarcely less valuable than the text itself. We can but hope that Mr. Steele will be spared to complete the task that he has undertaken—a task for which very few besides himself are properly equipped.

It would be ungracious not to mention also the valuable translation from the Arabic text by Mr. Fulton with which the volume is enriched. The book is a peculiarly fine example of the skilful, accurate, and scholarly printing which the Clarendon Press has taught us to expect from it.

CHARLES SINGER.

Physical Chemistry, Pure and Applied.

(1) *A System of Physical Chemistry*. By Prof. W. C. McC. Lewis. (In three vols.) Vol. ii., *Thermodynamics*. Third edition. (Text-books of Physical Chemistry.) Pp. viii+454. (London: Longmans, Green, and Co., 1920.) 15*s*. net.

(2) *The Determination of Hydrogen Ions*. By Dr. W. Mansfield Clark. Pp. 317. (Baltimore: Williams and Wilkins Co., 1920.) 5.50 dollars.

(3) *The Physico-Chemical Properties of Steel*. By Prof. C. A. Edwards. Second edition, thoroughly revised. Pp. xii+281. (London: Charles Griffin and Co., Ltd., 1920.) 21*s*. net.

(4) *Die Reaktionen des freien Stickstoffs*. By Prof. W. Moldenhauer. Pp. viii+178. (Berlin: Gebrüder Borntraeger, 1920.) 26 marks.

(1) PROF. LEWIS'S "System of Physical Chemistry" has been reviewed in these columns on two previous occasions, in September, 1916, and in May, 1919. Only a brief notice is

therefore required of the third edition of the second volume of the series. The principal additions that have been made deal with the e.m.f. method of determining the transport number of an ion, as employed by MacInnes and Parker, the work of Richards and Daniells on thallium-amalgam cells and of Tolman on centrifugal cells, American work on ionic activity, experimental work in support of Donnan's theory of membrane-equilibrium, and the work of McBain on colloidal electrolytes. Much of this new material is described in the words of the original investigators, as has already been done in earlier parts of the book.

(2) The determination of hydrogen-ions has become a very important section of physical chemistry, especially in its application to biological problems. The fact that Dr. Clark's book on this subject has been produced from the Research Laboratories of the Dairy Division of the U.S. Department of Agriculture is one indication of the practical application of the various methods of measurement which the author describes. These include the use of indicators, of hydrogen and calomel electrodes, and a few supplementary methods. The applications of these methods are so numerous that it is almost impossible to describe them adequately in any single volume; the chapter which deals with these applications has therefore been written in the form of a classified bibliography, the detailed references for which occupy 64 pages of the text.

A noteworthy feature of the book is a chart showing the colour of eight different indicators at nine hydrogen-ion concentrations, covering in each case the change from the alkaline to the acid coloration. The frontispiece is a photograph of Prof. Sorensen. The book is likely to prove of great value either to the physical chemist or to the biochemist who wishes to take up the very fascinating and fertile branch of study with which it deals.

(3) The appearance of the second edition of Prof. Edwards's "Physico-Chemical Properties of Steel" affords an opportunity of directing the attention of the readers of NATURE to a valuable book which has not been reviewed previously in these columns. A book with this title may be criticised either as a contribution to metallurgy or as an application of physical chemistry to a group of technical problems. As the author is a metallurgist, the reader will expect to find the technical side of the work well developed, and he will not be disappointed.

The physical chemistry is more open to criticism: thus a paragraph on "allotropy" (a generic term covering at least three distinct phenomena) is not a satisfactory substitute for a clear description of the phenomena of isomorphism and polymorphism; the idea of "crystal bricks" is so far obsolete that it should surely be replaced by some account of the theory of space-lattices; it is impossible, even on the authority of Ewing, to accept the suggestion that rotating the "bricks" through an angle of 180° could possibly give rise to twinning—perhaps an angle of 90° was meant.

A few verbal errors have escaped correction in this edition, and the lettering of some of the diagrams has been reproduced by a process which leaves much to be desired in the matter of legibility. The micrographs, on the other hand, are a most attractive feature of the book, and none of them are more effective than those which the author has produced to show the formation of twinned crystals and of slip-bands as a result of mechanical strain in metals.

For the physical chemist Prof. Edwards has provided a mine of valuable information, bearing on the application to metallurgy of his branch of chemistry. Even the student is now generally familiar with the iron-carbon diagram and the general relationship of this diagram to the properties of the carbon-steels; but it is equally true that the parts played by sulphur and phosphorus are not generally known, even to the teacher of physical chemistry. It is a great convenience to have the available information put together in a concise form by one who is thoroughly familiar with the practical and not always harmful effects of these important impurities. The effects produced by manganese, chromium, tungsten, aluminium, silicon, and vanadium are also described, as well as the properties of special steels, such as high-speed tool steels and a number of ternary steels. The two new chapters in the second edition deal with the more important methods of making hardness-tests, and the influence of constitution on electrical resistivity.

Whilst the reviewer is not competent to assess the value of this book as a contribution to metallurgy, he can assert confidently that no physical chemist who has to teach students of engineering or metallurgy can afford to be without it, and that the information which it gives will broaden the outlook of any student of physical chemistry who may read it.

(4) Prof. Moldenhauer's book on the reactions of free nitrogen does not profess to deal with physical chemistry, and an apology is perhaps needed for including it in this category; but the nature of the subject is such that the main chapters of the book are necessarily physicochemical in character, dealing as they do with

the "fixation" of the element in the form of ammonia, cyanamide, cyanides, or oxidised compounds of various kinds. These processes, which occupy the latter half of the book, have formed the subject of an extensive literature in recent years, and no great novelty of subject-matter or treatment is to be looked for.

The earlier half of the book traverses less familiar ground, and it is a great convenience to have the data in reference to the activities of a very inert element collected together in a systematic form. The facts that lithium and magnesium form exothermic nitrides and that cerium and uranium burn with incandescence in nitrogen represent the kind of information that can be given to illustrate the properties of a gas which usually receives but scanty treatment even when the behaviour of hydrogen, oxygen, and chlorine is fully described. T. M. L.

The Realm of Man.

Principles of Human Geography. By E. Huntington and S. W. Cushing. Pp. xiv+430. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 21s. net.

The Principles of Economic Geography. By Dr. R. N. Rudmose Brown. (Pitman's Economic Library.) Pp. xv+208. (London: Sir Isaac Pitman and Sons, Ltd., 1920.) 10s. 6d. net.

THE almost simultaneous appearance of two educational works on geography bearing very similar titles is not without significance. It shows the pressure of circumstances leading to the further elimination from geographical teaching of the mere enumeration of facts which has long been felt to be a desideratum, and to substitute an exposition which may claim to be regarded as a statement of principles. The result is, at any rate, the publication of two very good books, which may be welcomed as forming an important contribution to the definition of geography as it is coming more and more to be apprehended in the higher teaching of the subject. They may both be looked upon as going far towards supplying what the present reviewer has long felt to be a want among geographical text-books—a physical geography in which the main stress is laid upon influences, direct and indirect, on human life connected with place, rather than upon that aspect of the subject which looks to geology as its natural development; that in which almost the entire emphasis is laid on the operations by which the earth's crust undergoes modification.

This conception of the meaning of the designation "Principles" in both books is more apparent in the larger of the two, that of American origin, the chapters of which all have titles, such as "Man's Relation to Physical Environment," "Man's Relation to Location," "Man's Relation to the Climate," etc., bearing this out. Both works, indeed, involve the statement of a good many mere facts of geographical distribution, but it would be pedantic to take exception to this as not in accordance with the titles. The selection of the facts given shows regard to principle in the singling out of those which it is most important to think of from the point of view maintained by the authors.

While both books may be described as, in a large measure, physical geographies of the kind indicated, they are, of course, not wholly so. Neither would adequately answer to its title if it were, for in both it is recognised that when influences on human life are considered as having the place relation that demands their inclusion in geography, facts derived from many sciences have to be reckoned with and focussed in varying degrees in different cases on particular problems. Further, it should be added that both books are written in a style of admirable clearness.

But it does not follow from what has just been said that no exception can be taken to the exposition of principles by the authors. The eagerness to substitute principles for isolated facts sometimes leads to rather hasty generalisation, which, it must be confessed, has long been an evil in geography. The failing may arise from an insufficiently disciplined desire to place geography on the footing of a science, which, it is thought, it cannot claim without having its own stock of this kind. It might, on the other hand, be pointed out that the very fact that it is so hazardous to frame generalisations aiming at strictly geographical content, and that the function of geography is rather to maintain the habit of looking round in all directions for influences connected with place, has the advantage of making each case a subject for special and comprehensive thought, which surely gives great educational opportunity. At any rate, the tendency to lack of due care in generalising cannot be denied, and there are, especially in the American work, too many evil consequences thereof. Probably most of the hasty statements of which complaint is made would mislead no competent teacher. Most of them result, one may be sure, from no misconception on the part of the authors, who have simply, while using plain language, failed to express exactly what they mean, or in some cases made too summary statements, which may be accepted as true when the necessary qualifications are supplied.

One illustration may be given. Comparing the climate of the Lofoten Isles with that of Verkhoyansk in the same latitude, "and no farther apart than Portland, Maine, and Portland, Oregon," the authors ascribe the differences solely to the influence of the ocean. One cannot but ask, if that is so: How are we to explain the great differences especially between the winter climates of Portland, Maine, and Portland, Oregon, or the fact that the average mean January temperature of Cape Hatteras (46° F.) is just the same as that of the Scilly Isles 15° farther north, although the Gulf Stream proper passes close by the cape with a mean winter temperature of 72° F., while the winter temperature of the water round the Scilly Isles is only about 50° F.? One has to go well into the book to find any recognition of the agency of the winds as an intermediary influence on temperature.

One of the excellent features of the book is the number of ingenious and thought-provoking exercises at the end of each chapter, but a good teacher might find it profitable also to supplement those exercises by asking his students to fill up the gaps in the generalisations which are, without doubt, complete in the minds, but not in the text, of the authors.

The smaller book, by Dr. Brown, has no illustrations, but the other has, in addition to views, numerous instructive diagrams and maps.

GEO. G. CHISHOLM.

Calculus for Students.

An Elementary Course of Infinitesimal Calculus. By Prof. H. Lamb. Third edition, revised. Pp. xiv+530. (Cambridge: At the University Press, 1919.) 20*s.* net.

THE merits of Prof. Lamb's text-books are so well known and appreciated that it is unnecessary to analyse or commend the present one, especially as it appears in its third edition. As the work of an experienced teacher, revised in the light of modern mathematics, the book affords a model, and suggests a few observations. Naturally, the influence of recent research is most evident in the first chapter, "Continuity." This contains a discussion of sequences, upper and lower limits, limiting values and infinitesimals, which we may presume to be the author's idea of what is suitable for the average student before starting upon the infinitesimal calculus. In the light of present knowledge it is a kind of indispensable minimum; but it will probably be found as much as can be comprehended by the type of student for whom the book is mainly designed. In any case, the inclusion of such a chapter is a significant mark of progress in the practical aims of mathematical teachers.

There are two points to which the author himself directs attention. The first of these is that, in dealing with series, he has confined himself mainly to power-series, and omitted the discussions of uniform convergence previously included. Remembering that this is an *elementary* course, we may acquiesce, if with some reluctance, in the author's judgment. The second point is that $\exp x$ is defined as a particular solution of the differential equation $dy/dx=y$. This is Clifford's procedure in his "Elements of Dynamic," and has everything to be said in its favour—assuming that the student begins the calculus at the proper time in his general course. All the properties of the function and its inverse can be deduced with great ease, and in a way that needs no amendment when the variable is complex. We rather regret that Prof. Lamb has omitted the complex variable altogether; Clifford's graph of $\exp i$, and its connection with the radian, do, in fact, interest quite average students when they are working at de Moivre's theorem and its consequences.

It would be easy to point out many features of the book which show the advantages accruing from the fact that the writer is an applied as well as a pure mathematician. One of these is the excellence and instructiveness of the diagrams; another is the variety of the examples; and as a third we may take the discussion of the linear differential equation $y''+ay'+by=0$ and those closely associated with it. It is possible to make the discussion as dull and mechanical as the most old-fashioned solution of a quadratic by completing the square; here we have a treatment which is really instructive, and illustrated by the right sort of examples.

It is curious to notice that nobody seems to have suggested a "standard" sequence of theorems in elementary differentiation, though every argument urged for such a thing in elementary geometry applies here with at least equal force.

G. B. M.

Our Bookshelf.

Map Reading. By G. H. C. Dale. Pp. vii+170+xx plates. (London: Macmillan and Co., Ltd., 1921.) 7*s.* 6*d.* net.

IT is stated in the introduction to this book that a map is at times as valuable as a rifle. One might go further and say that a knowledge of local topography may be as valuable as a battalion. Unquestionably the best of topographical educations is surveying on the ground, which should form part of the instruction of all candidates for commissions in the Regular Army. Unfortunately such instruction has not always been given, and is, perhaps, out of the question for Territorials. Even so, instruction in map reading should be given mainly on the ground. There are, however, examinations to be passed in which questions are based mainly upon certain specified maps and conventional signs. Mr. Dale's book will be found of great assistance in this matter. It is clear and practical, and accompanied by good examples and questions.

The sequence of the book would have been improved by combining parts of chaps. i. and vi. in a separate chapter on finding position. A compass is rarely used for this purpose by an experienced map reader if the map in question shows much detail. This chapter might also have included grids, margins, and co-ordinates both geographical and rectangular. Such information as is given on these points is not very enlightening. For example, the position of the origin of co-ordinates and the direction and order in which they are given may, and doubtless will, vary according to circumstances.

The British soldier may have to accustom himself to many different styles of cartography. He should not be asked to memorise any particular conventional signs, but to study such different maps as he may have to use, and, above all, to educate his eye for country. Artificial and arbitrary differences such as those made in chap. iii. between "hills" and "knolls" would then be unnecessary.

Faune de France. No. 1. *Echinodermes*. By Prof. R. Kœhler. Pp. 210. (Paris: Paul Lechevalier, 1921.)

WITH the aid of a subvention from the Paris Academy of Sciences, a new fauna of France, of which the first part has been issued, has been prepared by the Fédération Française des Sociétés de Sciences Naturelles. Its object is to furnish naturalists with a handy means of identifying their captures. To this end each group is preceded by a key to the species, and the descriptions which follow are just enough to enable the first result to be verified. The fauna comprises land and fresh-water forms from France (including Corsica), Belgium, the Rhine province, and Western Switzerland, and marine forms within the limits of the continental plateau to a depth of about 300 metres and the corresponding pelagic region from the Sound to the Straits of Gibraltar, including the British Isles and the Western Mediterranean. The work, therefore, should be found useful by British naturalists.

For the Echinoderms no better authority could be desired than Prof. Kœhler, of Lyons. His nomenclature is up to date, his descriptions are to the point, and his illustrations, being, as a rule, from photographs of the actual specimens, are sufficiently indicative for a work within these limits. Some of the half-tone blocks are, it must be confessed, not very clear, and some of the borrowed diagrams are credited to wrong sources; thus Fig. 10, of a starfish, is not from Goodrich, but from the British Museum Guide; Fig. 68, showing the fascioles of a sea-urchin, is one of the numerous figures taken by Delage and Hérouard from the Echinoderm volume in the "Treatise" edited by Lankester. At the special request of the editors, Dr. Kœhler has gallicised the ordinal names. The historical confusion that has arisen from this common French custom is well known, and we have never grasped why such a name as "Les Forcipulosées" is any more intelligible than "Forcipulata"; it is not even French.

The Place-Names of Northumberland and Durham. By Prof. Allen Mawer. (Cambridge Archæological and Ethnological Series.) Pp. xxxviii + 271. (Cambridge: At the University Press, 1920.) 20s. net.

PROF. MAWER'S work on the place-names of Northumberland and Durham has an interest which transcends its geographical limitations. Unlike most workers on this subject, he does not confine himself entirely to the linguistic side of the evidence. He is prepared to turn to topography, ethnology, or history for assistance or confirmation. For instance, he has tested, by a careful examination of topographical conditions, the theory that names ending in *ington* occur on high ground where the geological formation favours the finding of springs. As a result, he finds that the theory holds good in East Northumberland only, but that in the west of the county the water supply is dependent upon other factors. The tendency of the lines of investigation followed by Prof. Mawer will inevitably be to bring the study of place-names into closer relation with cognate problems in ethnology and history, and to break down the isolation which has characterised even some of the best work on the subject in this country.

As a result of Prof. Mawer's very careful survey of the evidence for names recorded before the year 1500, and identifiable on the map, it would appear that the vast majority are Anglian. River names are Celtic, but "Cheviot" is the only recorded Celtic hill-name of note. Prof. Mawer concludes that the Anglian conquest was complete. The distribution of names with a Scandinavian element does not afford strong evidence of settlement except in two, or possibly three, cases. It suggests rather a movement from the sea up the great river valleys or from the more distinctively Scandinavian areas which lie to the south. Prof. Mawer's book lends added force to the plea for an organised survey of English place-names as a whole which he has made elsewhere.

Nuova Navigazione Astronomica: Le Rette di Posizione. Teoria—Applicazioni—Tavole. By Prof. G. Pes. Seconda edizione. Pp. lxxxiii+127. (Genova: Regio Istituto Sordomuti, 1921.)

THE position-line method in navigation was first introduced by Capt. Sumner; it has greatly grown in favour, since it exhibits in a convenient manner all the information that a single observation of altitude is capable of affording. There have been a large number of nautical tables published with the idea of simplifying the application of the method to determine the position-line of the ship. The "Altitude Tables" of the Rev. F. Ball give the altitude for every degree of latitude, declination, and hour-angle. Other tables by Aquino are in wide use in America. Mr. Herbert Bell proposed some useful modifications of the plan of the latter in a paper in M.N.R.A.S., vol. lxxx., p. 72.

The tables of Prof. Pes are of a different form; the principal table is one of haversines (*i.e.* half versed sines), both the natural and logarithmic values being given to five decimals. The author assumes a point on the earth's surface near the estimated position of the ship, and calculates the hour-angle P, and the meridian zenith distance z_m of the observed body, the declination of which is δ. He finds an auxiliary angle θ from the formula (ϕ is the latitude of the assumed point)

$$\text{hav}\ \theta = \cos\phi \cos\delta\ \text{hav}\ P.$$

Then

$$\text{hav zen. dist.} = \text{hav}\ \theta + \text{hav}\ z_m.$$

A set of four small tables with easily derived arguments enables the direction of the position-line to be determined.

The ship lies on a parallel line separated from the former by the difference between the observed and computed zenith distances.

Opinions will differ as to the relative merits of these rival methods of reduction, but at least it may be said that the method given in this volume is sound and fairly short. A. C. D. C.

A Textbook of Botany for Medical and Pharmaceutical Students. By Prof. J. Small. Pp. x+681. (London: J. and A. Churchill, 1921.) 25*s.* net.

THERE has been little attempt at selection in this book, with the result that a great deal of material has been brought together, some of which the beginner will scarcely be able to use. Nevertheless the book is written with independent views, and will doubtless be of service to many. The illustrations are a prominent feature, but some of them are on too small a scale to be satisfactory; *e.g.* Fig. 67, the legend of which also contains inaccuracies, as well as the figure itself. Such figures as 330 and 913 leave much to be desired. The work touches on every phase of botany, with frequent reference to economic applications. The advisability of including in an elementary text-book such a highly speculative subject as the author's theory of geotropism is very questionable, especially since the statolith theory has received strong experimental confirmation from the work of Bose. In the chapter on heredity it is a mixing of conceptions to apply the term reduplication to the crossing-over of chromosomes. This book will probably find its greatest use as a work of reference for pharmaceutical students and as an accessory text for others. Notwithstanding the above criticisms, it is a welcome addition to botanical text-books.

Stella Maitland; or, Love and the Stars. By H. P. Hawkins. Pp. viii+249. (London: Simpkin, Marshall, Hamilton, Kent, and Co., Ltd., n.d.) 6*s.* net.

IN a foreword the writer intimates that her object is "to create a deeper interest in the fascinating subject of astronomy, under the conviction that, if once aroused, it can never fail to yield one of the greatest delights which it is possible for the human soul to experience." The aim is commendable enough, but whether it will be promoted by this rather crude mixture of science and romance must be a matter of opinion. There is no subtlety in the characterisation, and the powder is administered baldly in the form of star-lessons. M. Camille Flammarion's "Stella" appears far more successful, considered as a work of art. But it is a *genre* in which success is scarcely to be expected. It suffers from all the handicap of the novel with a purpose in its most acute form, and it can make an appeal only to minds of an unsophisticated type.

Vocational Chemistry: For Students of Agriculture and Home Economics. By Prof. J. J. Willaman. (Farm Life Text Series.) Pp. ix+294. (Philadelphia and London: J. B. Lippincott Co., 1921.) 8*s.* 6*d.* net.

BOYS and girls in American agricultural high schools are the readers for whom this book is intended. The first part is devoted to the fundamental facts and principles of chemistry, whilst the second deals with the main chemical facts concerning plant and animal growth, cooking and cleaning, and with milk and its products. The early portion of the book is superficial, and not free from inaccuracies and ambiguities. There are many illustrations, some of which are rather trivial—*e.g.* "an open fire-place," "a herd of beef cattle"—and some are on pages far removed from the description in the text, no references being given.

The Moral and Social Significance of the Conception of Personality. By the late A. G. Heath. Pp. viii+159. (Oxford: At the Clarendon Press, 1921.) 7*s.* 6*d.* net.

THIS essay was awarded the Green moral philosophy prize in 1914. The author fell in the war. The book is now published by his friends with the desire, we can well understand, to raise to a comrade a *monumentum aere perennius.* It shows wide reading and clear thinking, if it possesses no striking originality.

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.]*

Biological Terminology.

ACTUALLY we are now talking about biological method. In his last letter (NATURE, July 28, p. 680) Sir Archdall Reid makes three appeals to me. My own contribution to the discussion has been confined to a defence of systematic biology, and I have no authority to answer for any "sect of biologists." But surely most of us accept the principles of scientific work that he lays down; most of us realise that our interpretations are mere working hypotheses; and most of us are always on the look-out by observation or experiment for those crucial facts which shall confirm or upset our hypotheses. My own difficulty has been either to devise a question that should be universally accepted as crucial, or, having devised one, to elicit the relevant facts. Biologists who can experiment with their material are certainly in a better position to perform both these operations than is one who can only observe portions of extinct animals. The distinguished author whom Sir Archdall Reid quotes merely uses a little more force in making essentially the same remark. But he can defend himself—if he cares to.

If, then, there are "sects" among biologists, I should be inclined to ask: Which of them does not employ—or, rather, attempt to employ—crucial testing? Apparently Sir Archdall Reid does not study the periodicals with which I am familiar; but possibly, as a medical man, he reads *Parasitology*. I, too, happened to look at its last number, and I observed an inquiry by Mr. P. A. Buxton into the specific distinctness of the mites responsible for three forms of mange. A form known as Norwegian crusted scabies has been the subject of divergent views, and "it is," says Mr. Buxton, "much to be desired that someone who is fortunate enough to see a case should infect a few volunteers in order to discover whether ordinary itch or the crusted variety is induced, and whether, after one or two generations, the mites can in any way be distinguished from typical *S. scabiei* var. *hominis*." This is an application of the crucial test; but Sir Archdall Reid may retort that it is only another of the lakes in an Africa of malpractice, and since I cannot swamp your pages with all the other lakes I must leave him to wander in the desert.

Sir Archdall Reid offers to help me on the question of recapitulation; but I would ask him first to explain his "glaring truism." He writes, "Variation is the sole cause of non-inheritance, etc." Surely "variation" in this sense is but another name for "non-inheritance," and the rest of his sentence therefore merely states that the offspring resembles the parent when it does not differ from it. But if there is any other meaning in the sentence, then I would remind him that whether "like exactly begets like when parent and offspring develop under like conditions" is just one of the questions that divide biologists. A germinal change would be a change of the conditions, and is therefore excluded. Either "the glaring truism" is an identical proposition, or it is a statement actually disputed. In neither case is it the same as the statement that, "apart from variations, offspring tend to recapitulate the development of their parents." If Sir Archdall Reid thinks that it really is the same, he is scarcely the man to dispel our difficulties. Those difficulties are not implicit in either of his "truisms."

F. A. BATHER.

August 14.

The Fauna of Scottish Lochs.

IN Mr. B. B. Woodward's interesting letter on the occurrence of *Pisidium Clessini* in Loch Ness (NATURE, August 4, p. 715) he does not mention the depth at which his specimens were found. Loch Ness, in the deeper parts of which Pisidium has been dredged on more than one occasion, is a very deep lake in which different zones of life undoubtedly occur. In Lake Biwa, in Japan, the Palæarctic *P. casertanum* is found only at considerable depths (17–30 fathoms), and it is probable that in Scotland *P. Clessini* lives still deeper.

Last month (July) I spent investigating the fauna, and especially the molluscs and sponges, of two comparatively shallow lakes in Perthshire, Loch Lubnaig and Loch Vennachar. No evidence was obtained in either lake of the occurrence of a deep-water fauna or of the existence of molluscs at greater depths than 70 ft., at which a Pisidium (probably not *P. Clessini*) was fairly common; but the area below 100 ft. is there very small. The only other molluscs common in the two lakes were *Limnaea peregra* and "*Ancylus fluviatilis*," both of which also occur in the streams that flow out of them. The facies and habits of the Limnæa in the two lakes are different. I hope to discuss the reasons why elsewhere.

Thirteen years ago I directed attention to our ignorance of the fresh-water sponges of Scotland. Since then nothing further has been published, though Mrs. Scharff (Miss Jane Stephens) has given us an admirable account of the Irish species. In Loch Lubnaig the abnormally low water of last month afforded unusual opportunities for the study of these interesting organisms. Three species (*Spongilla lacustris*, auct., *S. fragilis*, Leidy, and *Heteromeyenia Ryderi*, Potts) were found, mostly in the form of small, thin films on the lower surface of stones that would have been almost inaccessible in ordinary circumstances.

I may also mention another interesting observation made at Loch Vennachar, namely, that a Tubificid worm common at the edge of the lake has the habit of encysting in the earth when the water retreats. Each cyst contains from one to twelve individuals closely coiled and in a state of apparent torpor. When the cysts are placed in water the wall bursts and the worms emerge in a lively condition.

N. ANNANDALE.

Isle of Ulva, Argyllshire.

Magnetic Double Refraction in Smokes.

THE letter from Prof. Elihu Thomson on "A Novel Magneto-optical Effect" which appeared in NATURE of June 23, p. 520, suggested to me that the phenomena were associated with magnetic double refraction.

I used a Nernst lamp with a vertical wire; a parallel beam of light, polarised through a Nicol with the principal section at 45°, passed along a diameter close to the superior plane of a circular plate coil disposed horizontally; and, finally, a second Nicol crossed with the first.

At the bottom of the coil was arranged in a convenient way an arc lamp with metallic electrodes, able to give large quantities of smoke when carrying 30 amperes and 140 volts. A copper pipe, coaxial on the top with the coil, conveyed the fumes on the side of the magnetic field crossed by the polarised light, and was disposed so as to prevent disturbing light from the arc in the observation space. The coil had an internal diameter of 16 cm., an external diameter of 28 cm., and a height of 6 cm., and it was possible to obtain a magnetic field of many tens of gauss.

Rising from the copper pipe, the yellowish smokes (obtained with iron electrodes by condensation of iron vapour) showed a thick layer of fumes where traversed by polarised light. In these conditions, putting on the magnetic field, light appears through the crossed Nicols and remains until the field is cut off.

In preliminary experiments I was able to determine the following characters of the observed phenomena:—

(1) Turning conveniently the analysing Nicol, chromatic polarisation is obtained.

(2) With monochromatic light it is not possible to reach extinction by turning the analyser. Using a Babinet compensator, a suitable displacement of fringes, with field excited, was observed, and appeared as positive birefringence.

(3) With light polarised in a parallel or normal plane to the direction of the field the phenomenon is not manifest.

Moreover, if the coil is arranged in a vertical position the phenomena appear if the axis of the coil is normal to the polarised luminous beam, but not if the same axis is parallel to it.

Tests made with copper electrodes gave quite negative results with the above-described arrangement. This may be explained by the weakness of the field, as by employing a powerful electromagnet the effect appears also with smoke from copper electrodes.

L. TIERI.

The Physical Institute, University of Rome, August 1.

The Exploitation of Irish Peat.

PROF. RYAN in his article under the above title in NATURE of August 4 (p. 728) states that the labour difficulty is a serious obstacle in so far that the work is seasonal. I should like to suggest that this can be overcome by adopting the method employed for the production of moss-litter (used for bedding for animals) as now practised in Scotland and elsewhere. This method allows the men employed to be engaged in cutting peat in the earlier part of the winter and whenever the weather does not permit other operations. It follows that a great quantity of the wet peat lies throughout the winter exposed to the weather, and by the alternate freezing and thawing which it experiences the texture is very much opened up. Consequent on this, when the peat is built up in the spring it dries very much more quickly than material newly cut.

It is true that this method is not practised by crofters and others who depend on peat for fuel for domestic consumption, because the resulting product is not the hard, dense, compact body which is most suitable for burning in an open fire. However, for the exploitation of peat on a large scale this should not be necessary, since the peat is bound to be burned in closed furnaces with a strong draught. So far as my experience goes, it leads to the conclusion that the texture only, and not the composition, is altered by exposure during winter.

The adoption of this method would solve one of the most important labour problems, namely, the constant employment of the necessary able-bodied men. It would not permit the employment of women throughout the whole year, but would require their services to be dispensed with for about three months during the worst part of the winter. Whether such an industry could furnish an adequate wage for the workers in it is a question that can be considered only with reference to the specific conditions of surrounding industries and consumers.

ALEXANDER FLECK.

26 Manor House Road, Jesmond, Newcastle-upon-Tyne, August 8.

Scarcity of Swallows.

THE following may not throw light upon the scarcity of swallows in England this year, as noted in NATURE of July 14, p. 628, but will explain a shortage in another part of the world, and may be of interest and suggestive.

I live in the Gran Chaco of Paraguay, South America. In July, 1920, there was a succession of dull days extending over a week, accompanied by fine rain and a temperature varying between 20° and 10° C., strong winds also prevailing. On the fourth day of these conditions the swallows sought refuge in the buildings of the Mission Station, where I reside, and for three days dead bodies of the birds were picked up, and afterwards no more birds were seen. A few days later I had to make a journey which took me in a direct line for 120 miles, during which I did not see a single swallow. Managers of four cattle farms through which I passed reported a mortality of swallows at their establishments similar to that seen at the Mission Station. From other reports I concluded that the whole area of the Gran Chaco had been affected by the bad weather, and as in the month of July swallows are always more numerous than in other months and pass in flocks northward, I fear the mortality to swallows in South America must have been very great. The deaths were the result of the lack of insects rather than of the cold.

ANDREW PRIDE.

3 Town Bank Road, Ulverston, July 26.

Earthworms Drowned in Puddles.

ANGLERS use earthworms, and worms found in the little heaps of mud-scrapings on country roads are specially valued as being of a fine, delicate pink colour, clean and tough. I have heard anglers in North Wales say that no worms were so good, especially for sea-trout. But since road-tarring became so general the phenols (=carbolic acid) dissolved out of the tar by rain destroy the worms. Unfortunately, in numberless cases the trout have also been destroyed, adult fish as well as fry, and American experiments have proved that the spermatozoa of fish are killed by carbolic acid from tar even when so diluted as to be almost undetectable by any test.

R. B. MARSTON.

19 Adam Street, Strand, August 7.

The Neglect of Science.

A LADY called on me to-day saying she had been sent by the sanitary inspector of a large town a few miles from Manchester with specimens of a little winged beetle (*Niptus hololeucus*), which she and the inspector thought might be bed-bugs.

Is it not extraordinary that those who are placed in posts of great responsibility in sanitary matters are so ignorant of their job that they cannot distinguish a flat wingless bug from a harmless and almost spherical beetle?

I wonder how much money has been wasted in unnecessary fumigation and the destruction of bedding by the crass ignorance displayed by sanitary inspectors of the elements of the natural history of their calling.

SYDNEY J. HICKSON.

The University, Manchester, August 11.

The Determination of Sex.

By PROF. R. GOLDSCHMIDT, Kaiser Wilhelm-Institut für Biologie, Berlin-Dahlem.

IN this communication it is proposed to give an exposition of the subject of the determination of sex presenting chiefly the line of argument which the writer has been able to develop from recent work on the question. In doing so it will be convenient to confine our attention to one line of thought, though this will compel us to omit mention of much important work upon the problem. Further, it is proposed to limit the account to the writer's own field of work—namely, the animal kingdom. For a more complete account we refer the reader to the author's book, "Mechanismus und Physiologie der Geschlechtsbestimmung" (Borntraeger, Berlin, 1920).

The situation in regard to sex which is typical in nature is that out of a number of fertilised eggs of a given species about equal numbers of male and female individuals are developed. The problem of the determination of sex, then, presents itself in the form of two principal questions: first, what is the mechanism which, at a certain moment, separates the flow of development into two different streams—those of female and male differentiation; and secondly, what is the material difference in the two sets of individuals thus separated, and how does the supposed difference act physiologically in order to direct individual development along female or male lines? We may call the first of these questions the problem of the mechanism of distribution of the two sexes; while the second is the problem of the physiology of sexual determination.

It will be clear to every student of biology that the first problem in question is part of the general problem of the mechanism of heredity—*i.e.* it is concerned with the transmission of genetic properties from parent to offspring and their distribution among offspring. Therefore the study of the mechanism of distribution of the sexes has formed an integral part of modern work in genetics, and partaken of its triumphal progress. We may safely say that to-day, in the light of Mendelism and the work accomplished in the realms of cytology, the problem is solved as completely as the methods of biology permit.

The first successful attack upon the problem was made when Doncaster and Raynor discovered and studied the famous case of sex-linked inheritance in the currant-moth, and Bateson and Punnett furnished the Mendelian analysis of the case. By following the hereditary distribution of a somatic character closely linked with the distribution of sex, the inference could be drawn that one sex must be heterozygous for a Mendelian factor connected with sexual differentiation, and the other sex homozygous. Thus one sex produces two kinds of gametes in respect to the factor in question, the other sex only one kind. The resulting situation is, therefore, the same as in a back-cross between a hybrid *Aa* and the pure recessive form *aa*; both types reappear again in the offspring in equal numbers. Since then an immense number of cases of sex-linked inheritance have been analysed, all with the same general result; one sex is homozygous in regard to a sex-differentiator, and produces one type of gametes —*i.e.* it is homogametic; the other sex is heterozygous, and produces two types of gametes—*i.e.* it is heterogametic. There is one complication so far as certain groups of animals are concerned: in mammals and in most of the insects the male is the heterozygous sex, whereas in moths and birds it is the female which produces the two kinds of gametes. The possible meaning of these two types is, however, a question of detail which does not concern us here.

Almost simultaneously with the solution of the problem of the mechanism of distribution of sex in terms of Mendelian symbolism, McClung announced that the odd chromosome found in the sperm-cells of certain Orthoptera and Hemiptera might act as a differentiator of sex. Since then the study of the sex-chromosomes has progressed with a rapidity and success which have rivalled Mendelian discoveries regarding sex. The simple result which stands out to-day as one of the basic facts of cytology is this: all the cells of the body of many animals contain in one sex either an odd chromosome, called an X-chromosome, or an unequal pair of chromosomes, called an X–Y group. The cells of the other sex contain, instead, two X-chromosomes. As is well known, all sex-cells undergo a reduction division which reduces the somatic number of chromosomes to one-half; this reduction is brought about by a pairing of each maternal with a corresponding paternal chromosome and subsequent disjunction of whole chromosomes during the meiotic division. An odd X-chromosome, whether it has a Y-partner or not, must, therefore, pass undivided to one of the daughter-cells during the meiotic division. The result is the production of two mature sex-cells, one with X, the other without X. In other words, the sex containing the odd X (or the X–Y group) forms two kinds of gametes, which are with and without X respectively—*i.e.* it is heterogametic. The other sex, however, with its two X's, produces only gametes with X, and is therefore homogametic. In fertilisation, then, an X-gamete of the latter sex may unite either with a Y-gamete, or with an X-gamete of the heterogametic sex. The result is XX- and XY-zygotes—*i.e.* the two sexes.

The close parallelism between the genetic and cytological facts led Gulick, Morgan, and the writer to venture the opinion that the genetic facts of sex-linked inheritance could be completely explained, if it were assumed that Mendelian factors which are inherited in that peculiar way are carried within the X-chromosomes. Such an assumption would lead to the view that the Mendelian explanation of sex-linked inheritance and distribution of sex is only a symbolical way of representing what actually happens when the mechanism of the X-chromosomes is set to work; or, as we put it occasionally, both sets of facts express the same thing in different language.

Recent work has proved the correctness of such assumptions. We need mention only that in the fly Drosophila, where breeding work showed the male to be the heterozygous sex, cytological investigation also demonstrated the existence of an X–Y group in the male (Morgan and collaborators); in moths, where genetic proof exists that the female is the heterozygous sex, the existence of an odd X-chromosome in the female was conclusively shown (Seiler). But what we may regard as final proof was furnished by Bridges when he analysed cases in which unexpected genetical behaviour of sex-linked characters was shown to be explicable on the assumption of a non-disjunction of sex-chromosomes during the meiotic division, and when he was able to add cytological evidence of such an event to the genetic proofs. Thus we are led to believe that the mechanism of the distribution of the two sexes among the offspring is perfectly known; it is furnished by the distribution during meiotic division of the sex-chromosomes, carrying, among other factors, the sex-differentiators. We are confident that the little opposition which is still encountered occasionally will soon vanish before the weight of facts in favour of such conclusions.

A knowledge of the mechanism at work is a safe basis from which we may attack the second part of the problem of sex and so find an answer to the question: How does the one-X–two-X mechanism act physiologically in order to secure the differentiation of one or the other sex? The first attack upon this problem has been made by analysing a phenomenon which we have termed "intersexuality," and the main line of the facts and the analysis in question are given below.

The work was done with the gipsy-moth, in which the female is the heterogametic sex and the mechanism of the distribution of sex is perfectly normal. The phenomenon of intersexuality occurs, then, as breeding experiments show, without any disturbance of this mechanism. Intersexes—*i.e.* individuals which show definite mixtures of the characters of both sexes, and, as a whole, appear to occupy a definite position between the two sexes—are produced regularly and at will in crosses between different geographic races of the gipsy-moth. If, for example, a female of the Japanese race from Tokyo is crossed with a South European male, all the offspring are normal; in the reciprocal cross, however, all males are normal, but all would-be females intersexual. Or, again, if we cross a female of a Japanese race from Hokkaido with a male from Fukuoka, all the offspring are normal, but in the reciprocal cross all females are normal and all would-be males intersexual.

If we fix our attention, for the sake of simplicity, only on the intersexual females—*i.e.* intersexes with the factorial and chromosomal constitution of a female—we may state that the majority of the different races belong to one of two categories—first, what may conveniently be termed weak races; and secondly, strong races, which are those the males of which, if crossed with the female of a weak race, produce normal males and intersexual females. In testing the different strong races at our disposal in crosses with females of any particular weak race, we find among the strong races a graded series according to "strength." The males of one strong race produce with the weak female a low type of intersexuality, individuals which exhibit only slight addition of maleness to their female constitution. Another strong race produces with the same race of females a higher type of intersexuality; still another may produce a high grade of intersexual females; while a fourth may finally transform all would-be females into males, which cannot be distinguished (except by breeding tests) from genetic males. If we test the different weak races by crossing their females with any particular race of strong males, we find again a series of degrees of weakness as shown by the lower or higher type of resulting intersexuality. From such experiments it follows that female intersexuality is produced if a female of a weak race is crossed with a male of a strong race; further, that the grade of intersexuality depends upon two variables—viz. the relative degrees of weakness and strength of the parental races; in other words, it depends upon a quantitative relation of what we have termed weakness and strength.

By applying breeding tests it was shown further that strength follows in inheritance the distribution of the X-chromosomes or the sex-factor. Strength must therefore be regarded as a property of the well-known Mendelian sex-factor located in the X-chromosome. What we have termed weakness, however, is inherited purely maternally. This may mean that it is transmitted within the protoplasm or the Y-chromosome, and in any event it must be equally present in every egg. All these facts show clearly that an explanation on ordinary Mendelian lines is not possible. Something has to be added to ordinary Mendelian symbolism in order to account for the facts, and this addition is the assumption that the factors in question are possessed of a definite valency which acts in a quantitative way.

The X-chromosome contains the factor for maleness, whereas the factor for femaleness is inherited maternally. The quantity of the latter is constant for each egg, whereas the quantity of the former is double in the male (XX), single in the female (X). If there exists such a normal relation that the one male quantity is less efficient than the female quantity, while two male quantities act more strongly than the constant female quantity, and, further, if it be assumed that the higher quantity controls sexual differentiation, it is obvious why normally one or the other sex is produced, although each egg might, as experiments show, develop into a female, a male, or something between. Finally, if it be assumed that the strong races are possessed of sex-factors of a higher absolute quantity, the production of intersexuality in the crosses is also explained—the big dose of a male factor confronted as the result of crossing with a dose of the female factor which is relatively too small determines the character of the offspring even in the one-dose (X) state. As a matter of fact, all the breeding experiments devised to test such views have given results in accordance with theory.

Fortunately, the analysis of the intersexual individuals could be pushed one step further towards a physiological understanding. It could be demonstrated by a very large number of really amazing morphological and embryological facts that intersexual females are individuals which had developed up to a certain moment as females, when suddenly the sex had changed and development was finished as a male. Similarly, intersexual males begin as males and end as females, and the different types of intersexuality were proved to be the consequence of the position of the turning point in development. A late turning point means that only certain organs, which have not completed their development, can be forced into the line of differentiation of the other sex; the result is an intersex of low grade. An earlier position of the turning point consequently leads to the production of the higher grades of intersexes, and a still earlier position to the complete reversal of sex. The degree of intersexuality is inversely proportional to the position of the turning point in the progress of development. The position at this point of the analysis is this: on one hand we have the presence of characteristic doses of substances called sex-factors in definite quantities; on the other, there is a period of varying duration (the time of development up to the turning point), the length of which is proportional to the difference in the quantities of the two sex-factors. This points emphatically to the idea that the sex-factors are substances which cause, take part in, or accelerate a reaction in proportion to the quantity present. The result may then be represented in the graph (Fig. 1): on the abscissa is plotted the time of development, the line *t–t* being the end of embryonal and larval differentiation. The ordinate indicates the amount of that product of the activity of the sex-factors which carries differentiation in the direction of one sex. The curve F shows the rate of production of the female-determining substances, which is constant for each egg of a given race. M*m* is the curve for the male-determining substances in the female (one dose, X); MM in the male (two doses, XX). In normal reproduction the F and M curves do not intersect in development. M_1m, M_2m, etc., are the curves of the male-determining substances produced by the larger quantities of M substance in the X-chromosomes of the strong races. Their points of intersection with the F curve (in the case of hybrid combination) occur during development, and represent the turning point where sex changes from femaleness to maleness. The graph then gives the physiological solution of the case of intersexuality; simultaneously it answers the question which led to the consideration of the work on intersexuality—viz.: How does

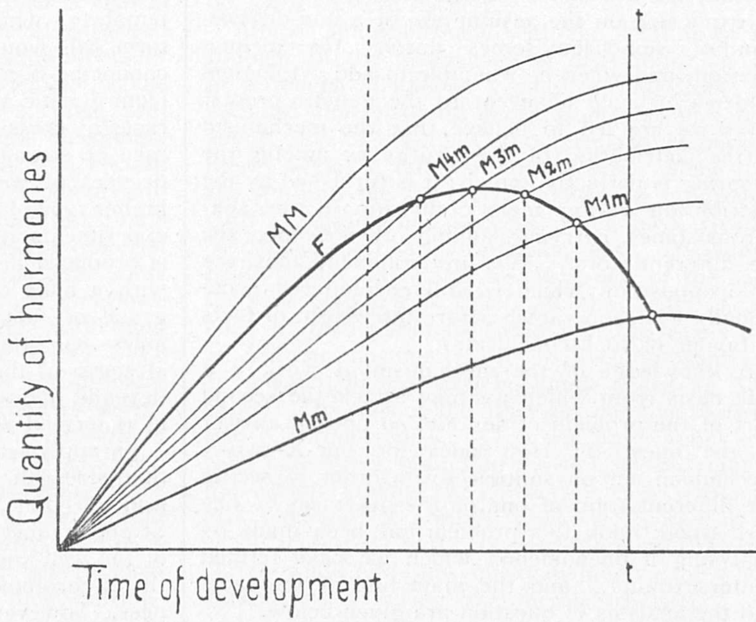

FIG. 1.

the presence of one or two X-chromosomes containing sex-factors act physiologically in order to induce the differentiation of one or the other sex? The answer is: The mechanism which produces germs with two and one X respectively is an ideal mechanism to secure the higher velocity to one or the other of two simultaneous and competing reactions, namely, the male and female reaction, by starting it with the greater quantity of reacting substance.

But there is a limit to our analysis so far as the work on intersexuality is concerned. We can see no means of ascertaining in moths in what this reaction, the velocity of which is influenced by the concentration of the reacting substances, really consists. The answer can be given, we believe, by the facts of hormonic intersexuality.

It is well known to every student of biology and physiology that in the higher vertebrates, at least in birds and mammals, the endocrine function of the sex-gland plays an important *rôle* in the development of secondary sex-characters.

Early castration in mammals prevents the normal development of the visible characters, and results in the assumption even of female secondary characters by male birds. Early and successful transplantation of the heterologous gonad makes either sex assume, to a more or less complete degree, the characters of the other sex (Steinach, Goodale, etc.). We might term this the production of hormonic intersexuality, but, of course, changes appear only in those organs which are able physiologically to change under the influence of hormones, irrespective of the genetic constitution in regard to sex. But the methods which have to be used exclude a complete experiment in intersexuality, where the entire body, including sex-glands, ducts, etc., must react. Fortunately, Nature has performed such an experiment for us, as the recent analysis of the case of the "freemartin," which we owe to the work of Keller, Tandler, and Lillie, has revealed. Among twin calves, cases of normal male and female are very rare. If both are not of the same sex, in most cases a normal male is accompanied by an abnormal hermaphrodite female, the freemartin. It is now known that this freemartin is a typical case of hormonic intersexuality. The authors quoted above have been able to show independently that in this case—but in this case alone—an anastomosis between the blood-vessels of the twins occurs, so that the same blood flows through both. In the male partner the testis, with its interstitial tissue, develops first, and before the ovary of the female has reached the stage of endocrine function. So the female comes under the influence of the male hormones, the ovary stops differentiation, and all the sex-characters develop in the male direction. The result is the freemartin, a calf with female external sex-organs, almost male sexual ducts, and a sex-gland containing sperm tubules which are incapable of spermatogenesis. Most interesting corroboration of this interpretation has recently been furnished in Lillie's laboratory by Minoura, who was able to produce hormonic intersexuality experimentally by transplanting gonads into developing chickens' eggs.

If we compare this case of true hormonic intersexuality with the zygotic intersexuality of the moths, we see at once that the "turning point" from which sexual differentiation changes in the intersexual moth corresponds exactly to the moment when the male hormones are poured into the blood of the female in the case of the freemartin. Comparing the facts carefully, we feel justified, therefore, in giving the following answer to our former question: What is this reaction which is accelerated by the action of the sex-substances with a velocity proportional to their concentration? The reaction is the production of the specific hormones of sexual differentiation. In insects this occurs in every cell of the body as an irreversible consequence of the combination in fertilisation. In the higher vertebrates the reaction becomes more or less centralised within the interstitial tissue of the sex-glands.

That this solution of the problem of sex comes near the truth is rendered probable by the ease with which even the most complicated sexual phenomena fall in line with the theory. The questions of parthenogenesis and sex, sex-mosaics or gynandromorphs, sexual polymorphism, inheritance of secondary sex-characters, and the different types of hermaphroditism, all find simple solutions, or, at least, appear capable of such. This may be demonstrated in the interesting case of the Gephyrean worm Bonellia, well known for its extreme sexual dimorphism, the male being a rudimentary microscopic worm which lives as a parasite in the oviduct of the large female. Baltzer made the discovery that part of the larvæ, developed from fertilised eggs, become attached to the proboscis of an adult female, and live there for some time in a semi-parasitic way before developing into males. Larvæ, however, which undergo development without the parasitic stage remain for some time undifferentiated, and then develop into females. If larvæ which are fixed to the proboscis of a female are removed after a shorter or longer period, intersexes of different type are produced. Let us now suppose that we could devise an experiment to prove directly the correctness of the quantitative view of sex-determination as represented in the above graph. We might perform it successfully by finding a method of accelerating or retarding the rate of differentiation without influencing the rate of the production of the sex-hormones. In the event of success we ought to be able to shift the point of intersection of the F and M curves back into the time when differentiation was still in progress. The result would be intersexuality. It seems that Bonellia is able to perform this experiment by means of the excretion of her proboscis. The F and M curves of the larvæ seem to have such a relation that the male hormones are being produced quickly, and the female hormones slowly. The normal rate of differentiation is slow—so slow that sexual differentiation begins only when the phase of action of the male hormones has passed, and females are produced exclusively. The secretion of the proboscis, however, accelerates the rate of differentiation in a way analogous to the action of the thyroid in accelerating metamorphosis in amphibians. In the case of parasitism of the larvæ, therefore, differentiation takes place during the phase of action of the male hormones. Interruption of the influence of the secretion naturally causes intersexuality. Finally, we may state that recently we were successful to a certain extent in imitating this experiment with moths. By employing low temperatures we could put back the turning point for females of pure races of the gipsy-moth and thus produce intersexuality.

Ever since genetics assumed its modern form the problem of sex has been closely linked with the general problem of heredity. The Mendelian study of sex formed part of the general study of genetic factors, while the cytological study of sex was closely connected with the chromosome-theory of Mendelian heredity. It therefore appears rather tempting to apply the quantitative views of sexual differentiation to the theory of heredity in general. Recently an attempt has been made by the writer in "Die quantitativen Grundlagen von Vererbung und Artbildung" (Berlin, J. Springer, 1920) to attack the problem of the physiology of heredity from this point of view. A discussion of this would, however, be beyond the scope of this contribution.

Further Remarks on Relativity.[1]

By SIR OLIVER LODGE, F.R.S.

III.

Changes of Frequency.

ACCORDING to the usual presentation of relativity, clocks appear to go slow to a relatively moving observer; quite irrespective of any Doppler effect, which can readily be allowed for. Their rate would have to be multiplied by the fraction $1/\beta$ or $\sqrt{(1-u^2/c^2)}$; which means that a clock on the sun seen from the earth, say on December 31 or July 1 when the motion is exactly transverse, would lose one second in two hundred million, or about sixteen seconds per century.

But, for testing purposes, we cannot change the motion appreciably, and so we cannot hope to tell if the clock would seem to go quicker if we stopped. Reversal of motion, even if it could be accomplished, would be no good; the difference to be observed—unlike the Doppler effect—is between motion and rest, or between rapid motion and slow, not between *plus* and *minus* motion. If we had a clock which we could fix at relative rest to ourselves, and yet be sure that it kept time with the one we were observing on some relatively moving body, the comparison might be made. And the revolution or vibration of a radiating atom, (*a*) on earth, and (*b*) on sun or star, appears to satisfy the conditions. If source and observer were moving together, there would be compensation; but if either was moving without the other, there should be an effect, such as by long accumulation might be detected. The Mercury effect allowed accumulation for a century or more. The spectrum effect does not allow any accumulation; whatever can be seen there must be seen instantly, it must depend on what happens in a single period. It is true that a certain train of waves is needed for visibility, and some succession is necessary for interference; but so short is the series required for interference that position in the spectrum is practically dependent on individual wave-length.

The value of u^2 for the earth's orbit, considered circular, is equal to the sun's gravitational potential at the earth's distance under the inverse square law, say $-V$; or twice that potential under the direct distance or centrifugal-force law. Hence the slowness to be expected, $\sqrt{(1-u^2/c^2)}$, may be written either $1+V/2c^2$ or $1+V/c^2$; and the second term is the displacement towards the red which is being looked for. Only, of course, it is being looked for where the potential is strongest, viz. close to the sun; for there it is two hundred times stronger than in the neighbourhood of the earth (the radius of the earth's orbit being two hundred times the radius of the sun). It seems, however, that a small fraction of the gravitational effect ought to be produced as the result of the earth's motion, even if the sun were nothing but a central source of light.

The occurrence of the factor 2 is curious, and corresponds with a similar factor in the ray-bending calculation. But I do not now discuss it, because a spectral shift due to transverse motion is doubtful. Space-measuring rods shrink, it is true, but in the direction of motion, not in the sun's direction; so the measured velocity of light from the sun would be constant without any time-correction. Yet it is not easy to see how a clock-discrepancy can be dependent on the direction of motion, apart from the ordinary allowance for light-speed.

Changes of Inertia and Weight.

That an electric charge possesses the fundamental material quality of inertia, by reason of the magnetic field which inevitably is generated when it moves, was first calculated by Sir J. J. Thomson so long ago as 1881. That this electrical inertia is a function of speed, so that as the speed of light is approached it ought to undergo a rapid increase of value, was predicted, and its amount reckoned, by both J. J. Thomson and Oliver Heaviside. That the facts of observation were in accord with the prediction, was verified, first by Kaufmann and then by others; while that this subordinate dependence of inertia on speed applies even to neutral atoms of matter, is a consequence of the fairly ascertained electrical nature of their constitution. On the theory of relativity the variation of inertia appears to follow, without any electrical theory at all, as a result of changing the frame of reference to moving axes. The additional mass corresponds to the kinetic energy of the moving matter divided by c^2. Which suggests that the whole mass is probably a demonstration and a result of fine-grained ætherial rotational energy with velocity c.

It is legitimate, anyhow, to assume as a working hypothesis that the mass of a body is not really constant, but that at the speed u it becomes $m=\beta m_0$ or $m_0/\sqrt{(1-u^2/c^2)}$.

The speed necessary to display this effect is usually attained only by electrons and positive nuclei in a vacuum tube, or by aid of spontaneous radio-activity; but the refinements of astronomy are so great that the planet Mercury is moving fast enough to exhibit some result dependent on

[1] Continued from p. 751.

this variation of inertia, if it were allowed to accumulate for a century. If the speed were constant it could not be detected; but the speed is not constant. The orbit is elliptical, for one thing; and the solar system is in motion, for another. Sometimes, therefore, the solar drift will be added to the orbital speed of Mercury, sometimes it will be subtracted from it.

Here then is a definite problem: to trace the consequences of this variation of inertia on the form or details of its orbit; and this problem I attacked in the *Philosophical Magazine* for August, 1917, and found that it must lead to a cumulative apsidal revolution unless there were some compensating cause. The paper was followed up by Prof. Eddington in September and October 1917 and June 1918, by Mr. G. W. Walker in April 1918, and by myself again in December 1917 and February 1918.

We found that if the solar drift were sufficient, both in magnitude and in direction, to give the proper value for the perihelion progress of both Mercury and Mars—as it easily might be—a smaller effect could not be denied to some of the other inner planets; and there would be accompanying small eccentricity changes, not corresponding with observation. The best solar drift is one with the speed $1{\cdot}7 \times 10^{-4}\, c$, and longitude 173°, for its component in plane of ecliptic. This will suit Mercury, both for apsidal revolution and for eccentricity. The perturbations that ought theoretically thus to be caused in the other inner planets are tabulated below; and, to compare with these calculated values, the table gives also the actual estimated or observed outstanding secular variations per century, both for the perihelion progress, $d\varpi$, and for the change of eccentricity, de. (See *Phil. Mag.*, February, 1918, pp. 148 and 154.)

Outstanding Perturbations per Century.

Solar drift assumed: *Speed*, 1·7 × earth's orbital vel. *Direction*, 173° long. and 0° lat.	Calculated.		Observed.	
	$ed\varpi$	de	$ed\varpi$	de
	"	"	"	"
Mercury	+8·34	−0·91	+8·48	−0·88
Venus	+1·46	+1·52	−0·05	+0·21
Earth	+1·04	+0·32	+0·10	+0·02
Mars	−0·12	−0·46	+0·75	+0·29

The discrepancies between theory and practical estimate, though small, are considered to be beyond anything that can reasonably be attributed to errors of modern observation; and if that is the final verdict of astronomers, after reconsideration of the figures, it becomes a question what is the compensating cause that prevents fluctuations of inertia from taking effect. The only cause that has suggested itself is a variation in the Newtonian gravitation constant, due to its being a function of velocity; so that weight is modified, somewhat in the same sort of way as electrostatic forces are modified, by rapid motion. (*Phil. Mag.*, February, 1918, p. 156.)

Prof. Eddington has now agreed (see his admirable book, "Space, Time, and Gravitation," p. 125) that the result of the whole discussion is to prove that gravitation has "joined the conspiracy," and has succeeded in concealing any effect of uniform motion.

But, on Eddington's improved theory (*Phil. Mag.*, October, 1917), it achieves this result in an odd way, and apparently does not sustain Einstein's "Equivalence" thesis, that inertial mass and gravitational mass are the same in all circumstances; or, briefly, that weight is always proportional to mass. Some caution is here required; for the proportionality of weight and inertia seems to be interfered with at high speeds. Their product, not their ratio, appears to be involved in a planetary perturbation, regarded from the point of view of the electrical theory of matter; and hence, if one increases, the other must decrease.

Galileo's experiment on the Tower of Pisa, roughly, and Newton's pendulum determinations, more exactly, established the proportionality of mass and weight; and recently Prof. Eötvös, followed by Prof. Zeeman, has confirmed Newton's conclusion to a high degree of accuracy, so far as ordinary circumstances and slow motions are concerned. (See the excellent new edition of Clerk Maxwell's wonderful little book, "Matter and Motion," brought out last year by Sir Joseph Larmor (S.P.C.K.), pp. 34 and 143.) But the astronomical evidence cited above seems to require that the Newtonian gravitational constant shall diminish at high speeds, being multiplied by the factor $1 - u^2/c^2$. Only thus can it compensate the inevitable increase of inertia $(1 - u^2/c^2)^{-\frac{1}{2}}$; at least if the increase of inertia sustains its full increment of weight. If the increase of inertia due to motion is *not* subject to gravity, then $\sqrt{(1 - u^2/c^2)}$ will suffice as the factor of the gravitation constant. (*Phil. Mag.*, February, 1918, pp. 143, 145, 155.)

Assuming that so it will turn out, after further detailed scrutiny, it is clear that weight is affected by high-speed locomotion. For the increased mass of a fast-revolving planet would by itself undoubtedly cause a minute apsidal progression sufficient to be observed; and the fact that for several of the inner planets the outstanding perturbations are less than the calculated, shows that compensation must somehow occur. It is to be hoped that the peculiar nature of the compensation, here suggested, may ultimately throw light on the gravitational structure of the æther. Meanwhile, unless some error is detected, it appears in conflict with the universal proportionality of mass and weight.

We shall now proceed to a few remarks on points connected with the more general theory of relativity.

ERRATUM.—In the first article of the present series (NATURE, August 4), on p. 718, 1st col., l. 6 of 2nd para., *delete* the words "in v if it is opposed to u"; and *substitute* "when the observer reverses his motion."

(*To be continued.*)

Cohesion.

By Dr. Herbert Chatley.

When one turns from an account of the discovery of a "dark star" by celestial dynamics to an investigation of the properties of the excessively minute whirling electrons in an atom, the impression is gained that within these limits at least there is but little more than relatively unimportant detail to learn. Such a notion is quite erroneous. More is known of the mechanism of plants on one hand and of electrons on the other than of the most ordinary and apparently simple mechanical phenomena. The most expert physicist can make only a near guess as to the motion of a billiard ball under given conditions as to stroke, weight, etc., since there is an imperfectly known factor, friction, in the problem. Similarly, although he can calculate with great precision the force with which one piece of iron attracts another when they are a foot apart, he cannot say with any accuracy from first principles what is the tensile strength in each piece of iron. Engineers similarly have made countless experiments and have also obtained very many data from constructional experience which give average values from which, by allowing a liberal margin for uncertainty, structures can be safely designed; but that is all.

Doubt still prevails as to the nature and laws of the force or forces causing cohesion. Lord Kelvin concluded that Newtonian gravitation would explain cohesion if it be supposed that the particles are exceedingly close. Sutherland and Nernst have regarded cohesion as identical with chemical affinity, and therefore with electrostatic force. Tolver Preston believed it was due to some mysterious dynamic action arising from the oscillation of the particles. Crehore, an American physicist, deduces it from a residual electromagnetic effect of the omnipotent electrons. Most recent students, following Sutherland, regard it as a residual electrostatic effect of the opposed charges in the atoms which, although in electrical equilibrium, are not coincident in space; some, however, prefer to consider it as largely electromagnetic.

The only satisfactory method of commencing a scientific investigation is to state all the known particulars and formulate hypotheses on the basis of the apparent facts. Proceeding so, we may note that:—

(1) All solids, being such, cohere to an extent which changes with their composition, physical structure, and temperature. Broadly speaking, cohesion varies with density and decreases with increase of temperature. It is quantitatively of the order of one millionth of a dyne per molecular pair.

(2) The range within which cohesion is effective is very small, not greatly exceeding one molecular diameter. Two pieces of material when pressed together cohere only when great force is used, if they are very highly polished or if they are so soft that they readily interpenetrate. Solids, with very few exceptions, break by tension when stretched 25 per cent. of their length, implying that the particles need to be separated only by less than one-and-a-quarter times the usual distance from centre to centre for cohesion to become inappreciable. Even the exceptional substances, such as rubber, break when stretched but little more than twice their length, and do not change much in volume. Solids at the fusing point become liquid with negligible change of temperature and only from 5 to 10 per cent. increase of volume.

(3) Solids in general, with the exception of the so-called plastic materials, extend with tension and shorten with compression proportionately to the force employed within certain "elastic limits," and are stable within those limits. The volumes increase slightly up to the elastic limits.

(4) Beyond the elastic limits the tensile and compressive strengths increase but slightly, and when the strain (extension or compression) becomes appreciable the strengths decrease.

(5) Liquids and gases show a slight "molecular pressure" or internal attraction, varying approximately as the inverse fourth power of the distances between the centres of the molecules.

It should perhaps be pointed out that an inconsistency is involved in the notion of "failure by compression." It is obvious that compression can do nothing but bring the particles into closer proximity, and if lateral expansion is prevented ultimate failure is inconceivable unless there are internal voids. Ordinary compression causes failure either by oblique sliding ("shear") or by lateral expansion.

It is required, then, to find a force which has no external resultant under natural conditions (save perhaps the normal gravitational attraction), resists tension and compression proportionately to the displacement of the particles for small ranges, and has but a limited power to resist tension which ceases at a moderate range and a great power of resisting compression. It is difficult to conceive of one force having all these properties, but perfectly simple to imagine an attraction and repulsion combined that will do so, provided that *the attraction decreases more slowly with separation than the repulsion.* A series of papers by the present writer to the Physical Society of London (1915–19) and a paper in the *Phil. Mag.* (August, 1920) attempt to deal with the problem on these lines. When the solid is at rest the attractions and repulsions balance. If a tensile force is applied the particles are separated, but since the attraction diminishes less rapidly with separation than the repulsion, there is a surplus of attraction which provides a tensile resistance. If the applied force is increased, the resistance will also increase up to a certain value, depending on the rates at which the attraction and repulsion respectively change. Further strain causes failure. On the other hand, if a compressive force is applied the particles are brought together and there is a surplus of repulsion which, like the surplus of attraction, varies with the amount of the strain, but differs in that it may be indefinitely great for very high proximity of the particles.

As to the rationale of the process little can be said. The dynamic energy of the oscillating particles and the consequent rigidity of the atoms and molecules seem to provide a kinetic basis for the repulsion. As is well known, most solids contract when they lose heat, and, since heat is electronic, the fact that most solids increase in cohesion when cooled would be quite consistent with atomic and molecular oscillation or rotation, provided that such motion is the cause of repulsion.

Whether the attraction is electrical, chemical, dynamic, or unique is not fully determinate, but since there is a fairly consistent hypothesis in terms of electrical theory, a bias in that direction is natural so long as no practical objections occur. Kelvin's gravitative theory seems to be baseless, for it leads to inconsistent results when the actual spacing of molecules is considered: but there is no intrinsic objection to an hypothesis which would make gravitation the residual of cohesive attraction. The writer has developed an empirical formula on these lines which gives a continuous expression for cohesion and gravitation. Newton's great discovery was that gravitation varies as the product of the masses concerned divided by the square of the distance between their centres, and the success of this law in explaining the motions of the heavenly bodies proves with overwhelming certitude its accuracy for all distances but the smallest, and possibly also the enormously great. When, however, the distance is comparable to the usual distance between the centres of the atoms or molecules in a solid a strong doubt as to the applicability of Newton's law arises, for it would appear that when two molecules are separated to twice their usual distance in a fluid the mutual attraction in the second position falls away much more rapidly than Newton's rule implies, and the attractions are quantitatively enormously greater. We may of course suppose, as did Sutherland, that gravitation has nothing to do with cohesion, but this does not satisfy the craving for continuity.

Here, then, is a field for investigation of the highest practical importance. If cohesion can be properly connected to other physical properties it is conceivable that new compounds of great strength, due to a critical state of cohesion artificially produced, would be found. Chemistry, crystallography, metallurgy, and engineering would all benefit by such an advance in knowledge of the ordinary properties of matter. Somewhat paradoxically it would appear that a complete solution of the macroscopic properties of matter would also solve the question of the inner structure of the molecules and atoms.

International Conference of Chemistry.

THE International Conference of Pure and Applied Chemistry held at Brussels at the end of June was nominally the second of these conferences, that at Rome in 1920 being the first; but there were at least two earlier assemblies in London and Paris which led up to the organisation, which seems now to be firmly established.

More than twenty countries are included in the organisation, Germany, Sweden, and Austria being the principal ones which are not yet represented. A number of well-known chemists took part in the conference:—Profs. Chavanne, Crismer, Swartz, and Timmermans (Belgium), Billmann (Denmark), Conant and Mackall (United States), Moureu, Béhal, Matignon, and Urbain (France), Pope and Lowry (England), Garelli and Nasini (Italy), Halvorsen (Norway), Holleman and Kruyt (Holland), Guye and Pictet (Switzerland), and several representatives of industrial chemistry, including M. Kestner, to whose energy and determination the organisation is so much indebted.

Each of the countries concerned has a council corresponding to the British Federal Council for Pure and Applied Chemistry, and the various national councils appoint members of the International Council and send in addition delegates to the annual conferences. So far as Great Britain is concerned, the Federal Council has invited its president, Sir William Pope, Prof. Philip, Dr. M. O. Forster, Mr. E. V. Evans, and the two honorary secretaries, Prof. H. E. Armstrong and Dr. Stephen Miall, to serve on the International Council for the next three years.

The work of the International Conference is divided among a number of commissions dealing with specific subjects or proposals of an international character. Among these the Commission on Chemical Elements will replace the former Commission on Atomic Weights. It was felt that the exact determination of atomic weights and their publication to several places of decimals has now lost a good deal of its scientific significance in view of the work of Dr. Aston and others, and that exact atomic weights are now becoming factors of analytical calculation rather than features of a chemical hypothesis. The isotopes or atomic numbers are taking the premier place, and the atomic weights—often representing merely the average of a mixture of isotopes—will be of practical rather than theoretical interest. The commission has therefore enlarged its jurisdiction, and will publish the constants of atomic weights, isotopy, and radio-activity; moreover, instead of being composed almost exclusively of analysts of exceptional ingenuity and manipulative skill, it will include recognised experts on isotopes and atomic pedigrees.

The questions of international nomenclature, contractions, abstracts, and standards were discussed and reports adopted, but the main work on most of these topics is still to be done, and the various committees appointed to consider these matters have a huge mass of detailed investigation before them. In connection with abbreviations in chemical literature Dr. Pondal made the gratifying announcement that the Argentine Chemical Society would bear the necessary expenses.

A list of pure research chemicals manufactured in Great Britain was submitted by the Association of British Chemical Manufacturers, and a further list containing many additional products is in course of preparation. M. Marie, whose name is well known in connection with tables of constants, submitted a report on this subject.

A commission was appointed to consider international patents, and its work is not yet completed. It appears that a considerable mass of evidence is necessary before a report can be drafted, and it is hoped that those who have given consideration to this problem will communicate with the Federal Council for Pure and Applied Chemistry at the offices of the Chemical Society at Burlington House.

The question of industrial hygiene is coming into prominence, and a commission was appointed to deal with this subject. During recent months papers on industrial hygiene have been read before the Society of Chemical Industry, the Royal Society of Arts, the British Medical Association, and other societies, and the hygiene section of the International Labour Office constituted by the Treaty of Versailles has undertaken an immense task in relation to diseases of occupation. It is time the whole question was examined scientifically and carefully, but the problem is one of considerable complexity. Very few of the medical experts have accurate knowledge of the chemical and engineering factors involved, and but few of the manufacturers or employees most concerned are able to form a sound judgment from a perusal of the pamphlets written by experts maintaining with no little heat their various opinions. If the international commission can study the problem so far as it concerns industrial chemistry, it will perform a most useful and timely service.

It has been decided to hold the next conference of the International Union in France, and there is a suggestion to have the meeting at Lyons, which will be a very convenient locality for most of the countries concerned.

Obituary.

PROF. G. LIPPMANN, For.Mem.R.S.

FRENCH science has suffered a very great loss in the person of Prof. Gabriel Lippmann, who died at sea on July 13 while returning from Canada, where he had taken part in the mission of Marshal Fayolle. Prof. Lippmann was born in 1845 at Hollerich, in the Grand Duchy of Luxemburg, of French parents, who soon after his birth settled in Paris. He passed through the higher normal school, and devoted his life to teaching and research. He became professor of physics at the Faculty of Sciences in Paris in 1878 and director of the laboratory for physical research at the Sorbonne in 1886, and was elected a member of the Paris Academy of Sciences in the same year. Of an original and independent mind, Prof. Lippmann left his personal mark on all questions he touched. The philosophical and general side of scientific conceptions claimed his attention particularly, and he saw clearly the connecting links between differing phenomena. His work on electro-capillarity dates from the time when electricians began to see the power and flexibility of the new instrument. He saw at a glance the future of electricity. Every physicist knows his capillary electrometer and the connection he established between the constant of Laplace's formula and the potential difference: but he showed as well how mechanical work could be obtained from an electro-capillary motor. At the time he made these discoveries and stated the principle of the conservation of electricity he published other work in which he played the *rôle* of pioneer. In his note in the *Comptes rendus* of the Paris Academy of Sciences for 1875 on the properties of an electrified water surface, he earthed a mass of water by a wire ending in a Wollaston electrode, and showed that if a stick of rubbed resin was brought near, oxygen was set free at the electrode, while hydrogen remained in solution. Ostwald, in his "General Chemistry," begins his treatment of ionic theory with a description of this experiment. On the publication of Rowland's discovery Prof. Lippmann showed, in June, 1879, that the phenomena ought to be reversible and that electricity ought to have inertia. This idea of reversibility was a frequent subject of his thoughts, and he often reverts to it in his celebrated treatise on thermodynamics. Prof. Lippmann also published in 1889 some calculations on induction in resistance free circuits, which twenty years after were confirmed by the experiments of Prof. Kamerlingh Onnes. In 1891 he communicated to the Academy of Sciences the principles of the discovery with which his name is immediately associated: that is, colour photography by interference. The accurate solution of the problem of the reproduction of colour is thus obtained from the thin laminæ which had such an attraction for the mind of Newton. Prof. Lippmann was a man of few words. So long as he was unable to give to a problem a form which would lead him to a solution satisfactory to himself, those who knew him little might believe him indifferent. He would gather himself together, and in a few words would show how far his thoughts had taken him into the fundamentals of the subject. During the last year of his life he devoted much attention to relativity, and on his last voyage from Havre to New York he spent most of his days discussing it with Prof. Michelson. The work Prof. Lippmann leaves behind him is of capital importance; but it represents only a part of the thoughts of a man of science with views acute and deep whom the search for perfection and a reserved temperament kept far from noise and strife.

CAPT. W. E. ROLSTON.

THE sudden death, on August 9, at forty-five years of age, of Capt. W. E. Rolston will be greatly regretted by many old students of the Royal College of Science, South Kensington, where he received his scientific training. Capt. Rolston was the founder and managing editor of the *Cologne Post*—the admirable daily paper published by the British Army on the Rhine—but he was well known in astronomical circles by his work with Sir Norman Lockyer, and at Cambridge. He entered the Royal College of Science as a Teacher in Training, and for about a year assisted in the demonstrations in the course of astronomical physics there, gaining also some experience in solar physics work. In 1899 Rolston took up a teaching post, but returned again to the Solar Physics Observatory at South Kensington in 1901, and remained on the staff of the observatory until he joined the Buffs in 1915. He was with Sir Norman Lockyer for twelve years before the transfer of the observatory to Cambridge in 1913, where he continued to be a member of the staff.

After some preliminary work in the general routine of the observatory, Rolston became mainly responsible for several specialised branches of the investigations in progress. One of the most important of these was an attempt to apply the principles of Stokes's Law of Radiation to the determination of the relative temperatures of stellar atmospheres. A fundamental feature of Sir Norman Lockyer's Kensington classification of stellar spectra required the recognition of different temperature levels, and to investigate this a special prismatic camera, with quartz-calcite optical train, was obtained and mounted on one of the equatorial telescopes. Pairs of stars were photographed on the same plate under conditions as nearly identical as possible, with controlled exposures designed to give equal photographic intensity for the region H_β-H_γ. By then measuring the relative intensity of the red and violet regions respectively, it was possible to arrange the various spectra in order of temperature level. These observations extended over about three years, and the results were communicated in a paper to the Royal Society in 1904 on the "Temperature Classification of Stars." In addition to taking a share in the observational routine work, both day and night, on solar and stellar spectra, Rolston repeated much of the reduction work on old observations of widened lines in sunspot spectra, and brought the summaries up to date.

From 1907 to 1912 Rolston was chiefly occupied with the reduction of orientations, and with stone circles and temples in various parts of the world, these being regarded as having originally been designed by their constructors to serve for the determination of time and season in the regulation of the economic and religious life of the early communities. The results of these researches were extremely suggestive, and were communicated by Sir Norman Lockyer to the Royal Society.

During the last two years before the transference of the observatory to Cambridge Rolston was engaged in preparing a comprehensive account of the observations of novæ from the discussion of all available material, and this was published as a separate volume entitled "Phenomena of New Stars." After transference to Cambridge he took charge of the Huggins spectroscopic equatorial, and also assisted in the reductional work on stellar spectra.

Throughout his connection with the Solar Physics Observatory Rolston took great interest in the dissemination of scientific knowledge, and was most successful as a writer and as a popular lecturer. For a number of years before the war he wrote the notes for Our Astronomical Column, and also contributed numerous articles and reviews. The experience thus obtained was turned to excellent account when in March, 1919, he founded the *Cologne Post,* the unique daily newspaper which has had such valuable influence in revealing British thought to Germany. His success showed the value of a scientific training to business management and literary balance, and the frequent articles and notes on scientific and educational subjects published in the columns of his journal commanded both attention and respect. Rolston was, indeed, a man of sterling worth and sound knowledge, and all who knew him will deplore that he has been taken from them in the prime of life.

SAMUEL ALFRED VARLEY.

BY the death on August 4 of Mr. S. A. Varley, at eighty-nine years of age, we have lost almost the last of those pioneers who were associated with the application of electricity. A younger brother of the late Cromwell Varley, F.R.S., and an early student and disciple of Michael Faraday, Mr. Varley was a notable inventor even comparatively early in life, when in the service of the Electric Telegraph Company. His name and fame will always be especially associated with dynamo-electric machinery, the first example of which he produced in 1866. This was a self-exciting machine with soft iron magnets. Ten years later Mr. Varley patented the original compound-wound dynamo. This afterwards became the subject of litigation, when Mr. Varley's claims to priority were in the end completely established. The machine may be seen amongst the historical apparatus at the South Kensington Museum. His other inventions included a lightning protector for telegraph lines and cables, a polarised needle telegraph instrument, and the time-ball as now used at Greenwich Observatory and elsewhere.

Mr. Varley, following Lord Kelvin, contributed a highly useful paper, in 1858, to the Institution of Civil Engineers on the electrical qualifications requisite in long submarine telegraph cables, as well as another on the same subject to the Society of Arts. In setting forth here the true electrical qualifications for the working of a submarine cable, he showed in a very convincing way that conductor resistance was as much a factor in retardation as induction. He was the son of a famous artist, Cornelius Varley, and was one of a famous family of electricians. C. B.

IT is with much regret that we have to record the death of M. JULES CARPENTIER on June 29. M. Carpentier was born in 1851, and received his education at the Ecole Polytechnique. In 1876 he entered the service of the Paris-Lyons-Marseilles railway as assistant constructional engineer, and would probably have developed his genius for machine construction in the service of the railway had not the death of Ruhmkorff directed his attention to the design of electrical apparatus. He took over Ruhmkorff's workshops, reorganised them, and commenced to manufacture standard electrical apparatus suitable for the measurement of the heavy currents necessary for the application of electricity to industry. Amperemeters, voltmeters, electrodynamometers, and other apparatus associated with the names of d'Arsonval, Marcel Deprez, and Baudot were in a large measure developed and made practical instruments by the genius of Carpentier. His activities did not end with electrical instrument-making, for his name is also associated with three-colour photography, while during the war his workshops turned out a number of periscopes for use on submarines. M. Carpentier was elected a free member of the Paris Academy of Sciences in 1907, where he represented the mechanical arts and the manufacture of instruments of precision.

THE death occurred on August 13, at the age of sixty-five years, of SIR ALFRED W. W. DALE, late vice-chancellor of the University of Liverpool. Sir Alfred was educated at King Edward's School, Birmingham, and Trinity Hall, Cambridge. For twenty years he was lecturer, bursar, and tutor of his old college, during which time he established for himself a reputation as an able administrator of university affairs, as well as a classical scholar. In 1899 he was appointed principal of University College, Liverpool, and when Victoria University was dissolved in 1903, and its separate colleges assumed university rank, he became the first vice-chancellor of Liverpool University, retaining this post until 1919, when he was succeeded by Dr. J. G. Adami.

Notes.

THE local secretaries of the British Association for the Edinburgh meeting desire to contradict the statement which appears to be current in some quarters that the hotels and boarding-houses of Edinburgh are fully booked for the period of the meeting. There is plenty of accommodation vacant in certain hotels, in boarding-houses, and in apartments; and in one of the hostels—a modern hall of residence—fifty places are still available for the accommodation of members. The Secretary for Hotels and Lodgings, the University, Edinburgh, will be glad to answer inquiries. Members who write to hotels and boarding-houses direct should enclose a stamped addressed envelope for reply.

THE outbreak of smallpox in Nottingham is at present kept within bounds by the incessant work of the medical and civic authorities. The trouble is that Nottingham has been for some years a hunting-ground of "anti" people. Still, we may be fairly sure that Nottingham will not suffer the fate of Gloucester, where 279 unvaccinated children died of smallpox in 1895–96. But there is always this difficulty, that vaccination in early childhood, though it may fail to give complete protection against smallpox some years later, may so modify the attack that the case is mistaken for chicken-pox. This mistake must be reckoned as well-nigh inevitable, now that smallpox is so rare that many doctors have never seen a case of it. The annual report (1920) of the Scottish Board of Health contains a good summary of the Glasgow epidemic last year. It is the old story: that the general neglect of vaccination in childhood is bringing about a reversion to the original habits of the disease. Smallpox naturally prefers children under ten years of age: and now it gets them. Of course we all know that vaccination is not a perfect method; we all hope for a perfect method; we all would like to get rid of the calf, to be able to use a non-living vaccine, exactly standardised; a hypodermic dose, and no scratching of the skin. Some day, surely, this perfect method will be worked out. Meanwhile we all know what would happen if it were possible to take a school of 200 small children, to vaccinate 100, to leave 100 unvaccinated, and then to expose the whole school to smallpox. Even the anti-vaccinationists know what would happen. The present writer put this view of the disease to one of them, and he answered that God would interfere in favour of the unvaccinated children: a fool's answer. Two cases of smallpox have just occurred in Huddersfield (*Times*, August 11). Let us hope that vaccination of contacts, quarantine, and other sanitary measures will prevent the spread of infection. Probably we shall have other outbreaks of the disease this autumn and winter.

IT is the intention of the Rockefeller Foundation to publish from time to time a circular of information reviewing its activities, and the first number was issued on July 25. A million francs was voted towards the endowment of La Fondation Reine Elisabeth, a new institution for medical research established in connection with a hospital in the suburbs of Brussels, while three million dollars have also been allocated to the Brussels authorities for medical education. Reference is also made to the grants of five million dollars each to Canada and to University College and Hospital in 1919 for medical education. Support has been given to several medical schools in the United States, contributions have been made towards campaigns against malaria, yellow fever, hookworm disease, and tuberculosis, and emergency relief of a million dollars has been contributed to the fund for European children. In addition, the Medical School in Peking has been maintained and aid given to thirty-one hospitals in China with the object of increasing their efficiency.

IN the June issue of *Folk-lore* Mr. R. Grant Brown discusses the pre-Buddhist religion of the Burmese. It is not confined to the animistic beliefs which were possibly introduced with the so-called "corrupt" Mahayamist or northern form of Buddhism, which, to a far greater extent than the southern form which now prevails, incorporated the ancient beliefs and ceremonies of the people. The animism which now widely prevails is quite apart from Buddhism, and though Burmese Buddhism is in one sense only a veneer over the prevailing animism, it is not more superficial than the state of belief even in Western countries. It is frowned upon by the monks, yet not only do the votaries of the orthodox creed refrain from persecuting the beliefs and practices of the lower orders, but also both forms prevail even among the same individuals. A good example of this form of worship is that of the Nats, spirits of mountain, whirlpool, tree, earth or sky, rain or wind, and a hundred other things. Human sacrifice is still found in the Chindwin district, when a boy or a girl of a distant village is annually sacrificed and the blood sprinkled on the seed-rice. Cannibalism, in the sacramental form, appears in the case of a rebel leader who had been a monk and a reputed sorcerer; he was killed, his body dug up, and the flesh boiled down into a potent decoction. Mr. Brown's account of these and similar practices is interesting for comparison with customs of the same class prevalent in the lower cultures of some tribes in the Indian Peninsula.

THE Pennsylvania University Museum has recently acquired a copy of a rare book, "A Catalogue of Specimens of Tapa or Bark Cloth," illustrated with samples of the cloth collected by Capt. Cook during his three voyages. The book was published in London in 1787, and contains, besides the catalogue and specimens of tapa, "A Particular Account of the Manner of Manufacturing the same in the various Islands of the South Seas: partly extracted from Mr. Anderson and Reinhold Forster's Observations, and the verbal Account of some of the most Knowing of the Navigators: with some Anecdotes that happened to them among the Natives." The list describes thirty-nine specimens, whilst this copy contains forty-three, four samples having apparently been added since the book was originally published. The *Museum Journal* for March, 1921, reprints the catalogue, with useful notes and descriptions of the method of preparing tapa cloth.

"THE *Rôle* of Meteorology in Malaria" is the subject of a paper by Brevet Lt.-Col. C. A. Gill (*Indian Journ. Med. Research*, vol. viii., No. 4, 1921, p. 633). Col. Gill finds that whilst humidity exercises no direct effect on the malaria parasite in the mosquito, the survival of infected insects during and beyond the incubation period of the parasite in its insect-host is dependent upon the occurrence of certain favourable degrees of relative humidity over a wide range of temperature. On the other hand, the completion of the developmental stage of the parasite in the mosquito is determined by the association of relatively high temperature with relatively high humidity. The meteorological circumstances favourable to mosquito life and to the transmission of infection are thus not identical, and no relationship need, therefore, exist between the distribution of the carrier insect—the mosquito—in Nature and the distribution of endemic malaria.

DR. R. J. TILLYARD deals with the Neuropteroid insects of the Hot Springs region of New Zealand in relation to the problem of trout-food in vol. iii. of the *New Zealand Journal of Science and Technology* (Nos. 5 and 6, 1921). Observations made in various parts of the world, as well as in other regions of New Zealand, show that the larvæ of caddis-flies form one of the most important foods for the trout. In the district under consideration Dr. Tillyard states that the depredation caused by excess numbers of trout has enormously reduced the original fauna of these and other Neuropteroid insects which serve as food for this fish. In fact, the present position of the trout-fisheries in the Hot Springs region is such that there is not enough food for the trout present. It is clear that improvements can be effected along two distinct lines, viz. improvement of the food-supply and reduction in the number of trout. A series of recommendations is made by Dr. Tillyard in order to achieve this end.

THE annual report of the Gresham's School Natural History Society for 1920 is an interesting and valuable record of the work done by a school society which is active and keenly alive to the importance of regional survey work. There are records of plants new to the district round Holt, of the insects collected by various members, of astronomical phenomena observed at the school, and of the first appearance of migratory birds in the neighbourhood. The most interesting record among insects is that of the first fully winged specimen of the Hemipteron, *Nabis boöps*, ever taken in Britain, captured by G. E. Hutchinson at Tidworth Pennings. One of the members, C. E. G. Bailey, has perfected and patented a self-tuning wireless apparatus which should prove valuable in expediting the work of wireless operators in synchronising their apparatus to that of the transmitting section.

BULLETIN 702 of the United States Geological Survey contains information on the oil possibilities in and around Baxter Basin, Rock Springs Uplift, Wyoming, and is the work of A. R. Schultz. Little work has hitherto been carried out in this area, although geologically it has long been favoured as a likely field, but latterly active interest has been taken in its development, and consequently the presentation of this official report is of much importance. The Rock Springs Uplift consists of an enormous dome of Cretaceous and Tertiary strata rising in the middle of the horizontally bedded rocks of the well-known Green River Basin, the dome itself being much warped into minor folds; Baxter Basin is situate in the central part of this dome, and consists structurally of a broad eroded anticlinal involving the Mesaverde, Blair, Baxter, Frontier, and Aspen series (in descending order) of Upper Cretaceous age, with probable representatives of much older formations. Oil occurs at several horizons, but the Frontier series, the principal oil-bearing series in Wyoming, lies at a depth of some 5000 ft. below the surface, which is almost the limit here for drilling. In addition, there are the extensive deposits of oil shale, the Green River formation of Tertiary age, surrounding the central area of the Rock Springs dome, and development of these should prove successful. Recent drilling on the Baxter Basin anticline has been carried out with promising results, mainly by three companies, small quantities of oil and a flow of gas at several hundred pounds pressure being obtained. This is a field of which we shall undoubtedly hear more in the course of time, and the Geological Survey officers are to be congratulated on the large amount of valuable preliminary information here published as an aid to its development.

IN Bulletin 713 of the U.S. Geological Survey (1920) there is an illustration of a recumbent cedar in vigorous growth, a member of a grove of similar habit on a wind-swept slope in Idaho. Physiographers and students of forestry will like to compare it with the drawing of *Pinus montana* in its climbing attitude in Brunhies's "Le Parc National Suisse" (NATURE, vol. cvi., p. 466).

WE have recently received a copy of part 3, vol. xl., Mem. Geol. Surv. India, by E. H. Pascoe, dealing with the occurrences of petroleum in the Punjab and North-West Frontier Province, which, though somewhat belated owing to the war and other circumstances, makes a welcome appearance just when first-hand information concerning our Imperial oil resources is required. The main petroliferous region occupies a belt flanking the Himalayas and traceable westwards from Simla, though it is not clearly defined until the division of Rawal Pindi is reached; it extends for 140 miles across the Indus through Kohat and Bannu and southwards into Baluchistan. The altitude of this belt suggests relationship to two distinct systems of tectonic movement: that of the Himalayas to the east, with their north-west to south-east trend in this region, and that of the Afghanistan-Baluchistan system to the west, a somewhat complex series of tectonic elements with a general curving strike from north to west, here recognised as the Attock arc. The belt lies in the re-entrant between these two systems, and occupies the site of an ancient river valley (Indobrahm), much in the same way as the petroliferous belts of Burma and Assam are coincident with ancient river-courses. Geologically the belt is divisible into halves, a northern and a southern, separated by a broad synclinal area. The northern half embraces the occurrences of oil around Rawal Pindi, in the Kala Chitta Hills, at Khaur, and in the trans-Indus salt area; the southern includes those of the salt range with the seepages of the Khasor Hills. Structurally the oil and gas are associated with anticlines involving rocks of Nummulitic or Muree age, the trend of these anticlines conforming to the main tectonic features existent at the particular locality at which they occur. Although the occurrence of petroleum in this part of India has been known of for many years, exploration has not met with unqualified success save in the case of the Attock Oil Co., which has carried out developments at Khaur. The oil obtained at Khaur varies in specific gravity from 0·894 to 0·876 in the upper sands, and from 0·877 to 0·840 in deeper sands, and is generally darker in colour than Burmese oil. The author regards the origin of the oil in this region as doubtful, though it would seem to be indigenous to the Nummulitic beds, its occurrence in the overlying Muree beds being probably due to upward migration.

THE subject of climatic conditions on the principal air routes in the East Indian Archipelago has been recently dealt with by Dr. C. Braak, of Batavia. Dr. Braak is of opinion that from an international point of view the air route from Singapore to Port Darwin is the most important. Relative to the different conditions in the tropics and in temperate latitudes, he asserts that in the tropics higher temperature at the surface is responsible for lighter air for aeroplanes at the start, but the wind conditions are said to be strongly in favour of the tropical climate. Cyclones are rare in the Archipelago, their occurrence being limited to the month of April and to the late days of March and early days of May, whilst there is usually only one in each year. The variability of wind direction is relatively small, and the wind variations are principally reinforcements and weakenings of the monsoons. A feature favourable to aerial navigation is stated to be the well-marked and very regular daily variation in most of the meteorological factors, so that choice can be made of the time of day that affords the best flying conditions. Details are given of the surface winds, as well as of the air movement in the higher levels. Monthly rain measurements and the number of rainy days are tabulated for many places within the area. The distribution of rainfall over the day is shown, as are also frequency of thunder, relative cloudiness, and haziness. It is stated that when comparison is made with the climatic conditions in temperate latitudes the conditions in the Archipelago may be called rather favourable.

IN the Bulletin of the Central Meteorological Observatory of Japan (vol. iii., No. 3, Tokyo, 1921)

Sin-iti Kunitomi and Hikotarô Takô discuss the correlation between the fluctuation of solar activity, as shown by sun-spots and faculæ, and the terrestrial precipitation of rain, as measured at Tokyo and other stations in Japan and Japanese territory elsewhere. The Greenwich records were drawn on for the solar data, and the periodogram method was applied to these and to the rainfall statistics. The investigation suffers from the paucity of the latter material, which is limited to a period of three years; the authors state that only when the influence on the rainfall, of other than solar causes, was eliminated by the periodogram treatment was it possible to obtain any significant correlation coefficients at all. Even so, they suggest that the relation between the solar activity and the precipitation is likely to be somewhat indirect. To the reader acquainted with studies of this kind it will probably appear that the amount of material used was inadequate to allow of even the most tentative conclusions being based upon it. The authors recognise the necessity for further discussion, and promise a more elaborate study of the subject later.

THE August issue of the *Philosophical Magazine* contains the concluding portion of Dr. N. R. Campbell's paper on the disappearance of gas when an electric discharge is passed through more or less exhausted tubes, a subject he has investigated for the General Electric Co. His observations cast serious doubt on the results which have been obtained by many previous workers, according to whom Faraday's laws of electrolysis hold in gases. Dr. Campbell finds, on the contrary, that the current arriving at the electrodes is not related in any simple way to the ionisation and recombination—that is, to the chemical reaction—taking place in the gas. The current, for example, at the cathode is made up of positive ions arriving and electrons leaving, and while the latter process is closely connected with the former, the two processes are not likely to be connected with the rate of progress of the reaction in the gas in the same way.

AFTER an interval of seven years the Geological Society of London has been able to resume the issue of its annual index to "Geological Literature Added to the Geological Society's Library," which is so complete a work of reference, both to subjects and to the output of individual authors. The present part (5s.) brings the matter down to the close of 1913.

Our Astronomical Column.

THE AUGUST METEORIC DISPLAY.—Mr. W. F. Denning writes that on August 8 several fine meteors were observed by him at Bristol, and they belonged to the well-known shower of Perseids. On August 11, watching for two and a quarter hours before midnight, he counted 134 meteors, although the moon in her first quarter was shining brightly nearly all the time. The display was an exceptional one as regards both the number and the brightness of the meteors. Of the total number seen, 122 were Perseids and 12 belonged to the minor showers of the period. The radiant point of the Perseids was at $44^\circ+57^\circ$, but it was not so sharply defined as it sometimes is.

About 33 of the meteors seen were equal to, or brighter than, stars of the first magnitude, and they exhibited the swift motions and luminous streaks which are characteristic of the August meteor swarm. Clouds came over the sky at 11.50 G.M.T. and prevented observations in the morning hours, but there probably occurred a very rich exhibition of meteors at places where the stars were visible. On August 12 the firmament was partly cloudy at Bristol, but there was a considerable number of meteors to be observed, for in clear spaces they were frequently seen, though no continuous observations were made. At 2.30 a.m., G.M.T., four Perseids were seen in less than two minutes, but immediately afterwards clouds interfered.

Mr. C. P. Adamson, of Wimborne, Dorset, watched the sky during two and a quarter hours on the evening of August 11, and counted 131 meteors. His results, therefore, as regards the numerical strength of the shower are in close agreement with those obtained at Bristol. Mr. Adamson found the radiant point elongated, from $43^\circ+57^\circ$ to $49^\circ+58^\circ$. Of the total number of meteors seen he says there were 125 Perseids, and at least 50 per cent. were equal to, or brighter than, first-magnitude stars.

THE BRIGHT OBJECT NEAR THE SUN.—Three of the five observers of this object, referred to in last week's issue, p. 759, were Prof. Campbell and his wife, and Prof. H. N. Russell, who is staying at the Lick Observatory. The object was seen shortly before sunset; the fact that it partook of the diurnal motion indicated that it was a celestial body. Prof. Campbell observed it with binoculars, and noted that it still appeared stellar, which favoured its being a nova. If so, it is probably the most brilliant since that of Tycho Brahe. The approximate position is R.A. 9h. 22m., N. decl. 16°. The galactic latitude is about 40°. The object does not appear to have been seen since August 7. It may be recalled that the great 1882 comet and that of January, 1910, were seen close to the sun.

A report from Königstuhl Observatory, near Heidelberg, states that on the night of August 8–9 a number of luminous bands lay across a clear sky from W.N.W. to E.S.E.; they moved slowly towards N.N.E., growing paler as the dawn came. It was conjectured that it might be the tail of the light object seen at Lick Observatory on August 7, passing very near the earth. It will be recalled that a somewhat similar phenomenon was reported when the earth passed through the tail of the great comet of 1861 on June 30 of that year.

It seems possible, however, that the present streamers may have been auroral, as the cometary nature of the Lick Observatory object is still in doubt.

CONTINUATION OF THE EPHEMERIS OF EROS.—This planet was photographed at the Algiers Observatory in July, within 3′ of the predicted position. The following ephemeris, for Greenwich midnight, is by Mr. F. E. Seagrave, corrected approximately by observation:—

	R.A. h. m. s.	N. Decl. ° ′		R.A. h. m. s.	N. Decl. ° ′
Aug. 20	23 25 41	12 20	Sept. 9	22 52 56	13 57
24	23 20 18	12 52	13	22 45 22	13 57
28	23 14 13	13 18	17	22 37 54	13 49
Sept. 1	23 7 32	13 38	21	22 30 44	13 35
5	23 0 23	13 51	25	22 24 3	13 16

Values of log r, log Δ, August 20, 0·2249, 9·8676; September 25, 0·2026, 9·8064. The magnitude in mid-September will be 10·5. The planet will thus be easily accessible in ordinary telescopes. Accurate observations of position are desired

University Education in the United States.

THE Washington Bureau of Education has just issued Bulletin No. 87, dealing with certain statistics of State universities and colleges in the United States of America for the year ended June 30, 1919. This is an annual publication which was formerly prepared and published by the National Association of State Universities, and contains data relating to ninety-two public institutions of university rank. The total enrolment in these State institutions for the year 1917–18 was 110,900, as against 244,231 in the corresponding private institutions. In 1918–19 the lowest enrolment was 31 for the New Mexico School of Mines, and the highest 8857 for the University of Michigan. With regard to teaching staff, the numbers in the State institutions vary from 7 to 908, the latter being the number of teachers in the University of Minnesota in 1918–19. It is curious to find that the University of Michigan with its 8857 enrolments shows an average of 20 regular term students per teacher, while the University of Minnesota with an enrolment of 6095 has an average of only 7. What is perhaps more curious is the fact that the total working income of the former is 3,069,587 dollars, while that of the latter is 3,462,361 dollars.

The fact that the institutions to which the bulletin has reference are passing through a stage of financial stringency very similar to that which is being experienced by the British universities at the present time gives an added interest to the publication. In the American State universities, just as in this country, "the cost of salaries has not risen to the same extent as the cost of living," and, as the bulletin very pertinently says, "unless the people wish to see their higher institutions staffed with men of inferior ability, it will be necessary to pay salaries sufficiently large to attract teachers of merit and ability." University teachers in this country will recognise a familiar ring about this language! The bulletin contains a mass of statistics which have been compiled by the Bureau of Education in the hope that they will be "very useful in the promotion of State campaigns for the more adequate support of higher education." While one may express the hope that American State universities and colleges will receive such public support in the future as will be necessary for their development, it should be observed that already they receive in the aggregate almost 73 per cent. of their income from public funds. In four States, indeed, the percentage is more than 90. In this country, notwithstanding the recent additional grant of 500,000*l*. to the universities, State aid is greatly inferior to the State aid which is given to public institutions in America.

Of special interest is the question of students' fees in these universities and colleges. At the outset one must make a clear distinction between public and private universities or colleges in America. The number of students enrolled in the public higher institutions amounts to about 31 per cent. of the whole, while the remaining 69 per cent. are enrolled in private or non-State-aided institutions. As a rule, the former pay small fees. In the case of New York University the income from fees is as low as 3 per cent. of the total income. The average for the whole country in 1917–18 was 22 per cent. of the total income. In the private institutions the percentage for the same year varied between 17 (Connecticut) and 87 (Alabama), with an average of 54 per cent., the remaining income being derived mainly from "productive funds" or private benefactions. So far as the State institutions are concerned there is no indication that students' fees, though lower than those in this country, are to be increased. The campaign to increase the income is apparently to be directed to obtaining increased assistance from public or State funds. The plea for State aid is concisely expressed in the words:—"When the State appropriates money to education, it is making a wise investment which will yield manifold returns. Liberal support of higher education is good public economy and wise forethought for the future." One may be allowed to hope that the Government of this country will ponder over these words. Our home universities are sadly in need of further State aid.

Recent Work on Minerals and Rocks.

NOW that questions of crystal structure and of approximate isomorphism play so large a part in chemical and physical conceptions, the study of crystallography is no longer for specialists alone. Students of many branches of science will welcome the re-issue of J. B. Jordan's nets for making models of simple crystal-forms (T. Murby and Co., London, 3*s*.). The older names can be covered by labels bearing those suggested in this edition, though we should like to see "bipyramid" substituted for "pyramid" throughout, since no true pyramids, such as those occurring in tourmaline, are utilised. These models were familiar in the Royal School of Mines forty years ago, and should now serve many future generations of students whose outlook on crystals has widened with physical research. Their effective colours and their price certainly commend them.

A. D. Hall provides a very interesting memoir (Union of South Africa Geol. Survey, No. 15, 1920, 7*s*. 6*d*.) on "Corundum in the Northern and Eastern Transvaal," in which the modes of occurrence and of working are fully illustrated. The author, in a chapter on "The Problem of Genesis," very properly directs attention to the tardy recognition of corundum as a rock-forming mineral, and lays stress on the experimental work of Morozewicz in 1899. Corundum in the Transvaal arises from a granite magma supersaturated with alumina. Hall holds that this supersaturation arises, not through absorption of aluminous material from contact-rocks, but by removal of silica into those rocks along the zones of contact.

In "Phosphate in Canada" (Canada Depart. of Mines, No. 396, 1920) Hugh S. Spence describes and illustrates the well-known occurrences of apatite in Ontario and Quebec, and discusses works established in other parts of Canada where imported phosphatic materials are used. The apatite "is to be considered of igneous origin rather than to have been derived from the original limestones" through which the pegmatite masses have passed. The associated minerals, such as pyroxene, scapolite, and phlogopite, are described. At Huddersfield, Quebec, allanite occurs in crystals more than an inch in diameter, and fluorspar, which is here abundant in calcite, assumes a deeper violet colour in close proximity to it. An emanation-influence naturally suggests itself.

The minerals of saline lakes, notably epsomite, are dealt with by L. Reinecke in "Mineral Deposits between Lillooet and Prince George, British Columbia"

(Canada Geol. Survey, Mem. 118, 1920). R. Lockhart Jack, in "The Salt and Gypsum Resources of South Australia" (Geol. Surv. S. Australia, Bull. 8, 1921) interestingly connects the salt of the lagoons of the Yorke Peninsula, between Spencer Gulf and the Gulf of St. Vincent, with "cyclic" salt imported aerially during long ages from the sea. The supply thus given to the soil is drawn on by the lakes, with, of course, some addition from salt-dust now falling on their surfaces, and depends on conditions of dryness, whereby the local water-table does not rise dangerously high. The meteorological features of the region are well put forward. The deposits of gypsum are similarly attributed to cyclic matter, which has been redissolved and carried by the saline ground-waters (p. 90) into lake depressions. On the margins of these it evaporates and becomes blown up into dunes. There are also some occurrences of gypsum in a more normal and less interesting manner in Cainozoic rocks.

The graphite deposits of the world outside the United States are reviewed, with maps, in a valuable paper by A. H. Redfield ("Foreign Graphite in 1919," U.S. Geol. Surv., Min. Resources, 1919, part ii., No. 12, 1921). This pamphlet should stand beside our text-books of mineralogy, which constantly require the refreshing influence of general surveys of this nature. Though the commercial aspect is naturally paramount, the names of localities and the references to literature will be of service to the student.

The work of R. E. Liesegang has added considerably to the interest of zoned and banded deposits. P. A. Wagner (Trans. Geol. Soc. S. Africa, vol. xxiii., p. 118, 1921) describes the "Nature and Origin of the Crocodile River Iron Deposits" in the Rustenburg district of the Transvaal. He compares them with those of the Lake Superior region, and holds that the hæmatite and hydroxide masses are concentrations by downward percolation from beds of siderite and ferruginous chert. In some cases alteration in place has led to the formation in chert of magnetite, hæmatite, or brown hydroxide, alike pseudomorphous after rhombohedral siderite.

Olaf Holtedahl (*Amer. Journ. Sci.*, vol. cci., p. 195, 1921) reviews old and recent work on the zoned concretions of calcite in the magnesian limestone of Durham, pointing out the reasons that have led English geologists to regard them as mineral structures arising through secondary alteration. Their resemblance to some of the pre-Cambrian structures claimed by Walcott as algal (Camasia, Newlandia, Greysonia, etc.) inspires the author with caution in dealing with these older specimens.

Mineralogists cannot afford to overlook the paper by F. W. Clarke and W. C. Wheeler on "The Inorganic Constituents of Marine Invertebrates" (U.S. Geol. Surv., Prof. Paper 102, 1917) with its important series of analyses of the hard parts of a wide range of living creatures. The proportion of magnesium carbonate to calcium carbonate bears, of course, on the much-discussed origin of dolomite, and it is shown that organisms capable of depositing calcite may accumulate magnesium by isomorphous substitution, while this cannot take place when the hard parts are formed of aragonite. The utilisation of magnesium is very distinctly favoured by warm conditions, specimens from Arctic or Antarctic waters, or from very deep waters, showing relatively small proportions. Crinoids, for instance, from 47° N. lat. and a depth of 1000 metres may yield 9 per cent. of magnesium carbonate, while 12 per cent. commonly occurs at similar depths near the equator. A biological problem of much interest is here opened. No such authoritative and detailed analyses have hitherto been available. As was already known, alcyonaria generally are rich in magnesium carbonate. An equatorial specimen of *Phyllogorgia quercifolia* is here shown to contain 15·73 per cent. The influence of these facts on determinations of specific gravity in fossil forms should, of course, be noted.

The rhyolites of Lipari, including the familiar obsidian of the Rocche Rosse, have received complete and critical examination and analysis from H. S. Washington (*Amer. Journ. Sci.*, fourth series, vol. l., p. 446, 1920). It is shown that in the glassy varieties ferrous oxide predominates largely over ferric oxide, while this condition is reversed in crystalline types. It is suggested that the glassy state retains more nearly the constitution of the igneous magma, while oxidation occurs as the gases are permitted to escape.

W. R. Browne provides a new study of differentiation in an igneous mass, through the sinking of crystals and later extrusions, in his description of "The Igneous Rocks of Encounter Bay, South Australia" (Trans. Roy. Soc. S. Australia, vol. xliv., p. 1, 1920). In the same volume, p. 300, W. Howchin reviews coarse fragmental structures of various kinds in rocks, citing Australian examples, and he usefully directs attention to the influence of desiccation in breaking up a sediment in an early stage of its history. The drying mud of lakes is an example. Attention may be directed to the moderate price (10*s*. 6*d*.) of this volume and of some other illustrated publications from our federated Commonwealths, in the hope that the enterprise displayed may react on issues in the homeland.

G. A. J. C.

Plant Pests and their Control.

By DR. WILLIAM B. BRIERLEY.

THE "Report on the Occurrence of Insect and Fungus Pests on Plants in England and Wales for the Year 1919,"[1] which has just been issued by the Intelligence Department—Plant Pests Branch of the Ministry of Agriculture and Fisheries, marks a very definite step in the recognition in this country of the danger to our food crops from diseases caused by insects, fungi, bacteria, etc. This disease-survey work was originated by a sub-committee of the Technical Committee of the late Food Production Department, which was formed to advise the department on questions relating to plant disease and insect pests. A few honorary correspondents scattered throughout the country forwarded monthly statements relating to diseases and pests in their own particular areas, and at the close of the year these were summarised by the sub-committee, and a "Report on the Occurrence of Insect and Fungus Pests during 1917" was published. This was the first time that any successful attempt had been made to gather together and systematise data relating to the incidence and spread of plant disease in this country. With the experience gained the work was continued in a more efficient manner, and a report for 1918 issued. There has now appeared the present, and somewhat belated, report for 1919, and a comparison of these three publications

[1] Ministry of Agriculture and Fisheries. Intelligence Department: Plant Pests Branch. (Miscellaneous Publications, No. 33.) "Report on the Occurrence of Insect and Fungus Pests on Plants in England and Wales for the Year 1919." Pp. 68. (London: H.M. Stationery Office, 1921.) 1*s*. 6*d*. net.

shows a marked progress in width and inclusiveness of vision. A mass of valuable data has been accumulated, and the Ministry, by becoming acquainted with those areas where disease is most serious, is in a better position to advise and to urge measures of control. Further, the Ministry must lead the way, and by the recognition of those diseases most responsible for heavy losses, it will be enabled to suggest, or institute, policies which will lead to the prevention of the present appalling waste of foodstuffs.

The report for 1919 is divided into three sections, the first being a tabulated and summarised list of the correspondents' reports on insect pests received during the year. The second section is a complete and up-to-date hand-list of the authenticated fungus diseases in the country, and if expanded and elaborated would form a very useful reference book for plant-pathologists, filling a niche at present singularly empty. The third section is a summary of meteorological data with which the incidence and spread of disease might be correlated. The report is a notable achievement, and a fine example of the solid scientific work which, quietly and unassumingly, is being carried out by this branch of the Ministry of Agriculture. Much credit is due to Messrs. Fryer and Cotton, who, in the face of not a little discouragement and lack of aid, have carried this work through to such a pitch of efficiency and permanent value.

There are naturally many features at which one could cavil, but these are due primarily to the exigencies of the incomplete and voluntary system on which the field reporting necessarily is based, and upon the innate difficulties in the reporting itself. Thus whilst it is important to learn that a particular disease is present in certain localities on specific dates, the really important thing in this connection is to find out what, if any, relation exists between the several outbreaks, and what relation the outbreaks bear to climatic conditions and dispersive factors. The acquiring of such knowledge, however, is a considerable piece of research, needing the whole-time services of a large *personnel* of highly trained investigators, and these the country does not possess, nor will it until plant disease is regarded a little more seriously by the university and the farming mind. Again, to learn that "Mosaic Disease is present in tomatoes grown in the open," is interesting, but one would like to know exactly what percentage of the plants are killed or sterilised by this disease, or of those in bearing what percentage of a normal yield is obtained, and what is the financial loss incurred by the trade? The present lack of standardised criteria in loss estimation is very unsatisfactory. However, these are questions easy to ask, and almost, if not quite, impossible to answer, and only slightly detract from the value of this report as a foundation for epidemiological study in plant disease.

But the preparation of such a report as this has a far greater value than its local interest. Plant diseases are no respecters of diplomats or political boundaries. The disastrous spread into this country of American gooseberry mildew, or wart disease of potatoes; of citrus canker and chestnut bark disease into America; the wiping out of the coffee industry in Ceylon by the introduction of the coffee leaf disease into that island—the remembrance of these among many examples that could be quoted, should convince everyone of the critical importance of an accurate and systematic survey of plant diseases in order that undesirable aliens may be excluded, or if found to be present, crushed whilst still limited in distribution.

The control of plant disease in our crops is one of the most vital factors in agriculture to-day, and in the lean years to come, when every ounce of food will be an asset, the knowledge gathered together in such reports as this will be a very material aid in the struggle to provide the nation's sustenance.

Studies of Shore Fishes.[1]

NOT the least of the Danish marine expeditions in the *Thor,* under the skilful hands of Dr. Johs. Schmidt, was that devoted to the careful search of the Mediterranean and the sifting of the work of Grassi and Calandruccio in regard to the spawning of the eel and the murenoids.

In the course of this work many young shore-fishes were encountered, and M. Louis Fage has given an excellent report thereon. Some of them are common to British waters as well as to the Mediterranean, whilst others, such as Macrorhamphosus, Anthias, Callanthias, and Uranoscopus, are more characteristic of the southern waters. Though the shores of the Mediterranean are rich, they fall far short of the plenitude and variety of the shore-fishes of Japan. Of the twenty families encountered, thirteen have pelagic eggs and seven demersal. The striking changes between the adult outline and that of the young are well shown in such species as *Macrorhamphosus scolopax,* the gurnards, *Serranus cabrilla,* and *Anthias sacer.* The illustrations appear to have been made from preserved specimens, and in a characteristic form like the grey gurnard in its early stage the pectorals fall short of the actual proportions (*cf.* Prof. Prince's figure from life, Trans. Roy. Soc. Edin., vol. xxxv., pl. xvii., Fig. 5).

Perhaps the most interesting part of M. Fage's memoir is the introduction, in which he discusses the problems connected with the reproduction of the Teleosteans. Amongst other features, he believes with Giard that the embryology is condensed as we advance to the north, yet that the pelagic embryos are specially adapted to the colder waters. Thus, taking the genera Sebastes and Scorpæna, the latter having two subgenera, Helicolenus and Scorpæna, it is found that *Sebastes marinus* is rare south of the Faroes, and is viviparous. The widely distributed *Helicolenus dactylopteris,* Delar., reproduces in winter in northern waters, and the larvæ agree with those of other Scorpænidæ. On the other hand, *Scorpaena porcus* and *S. scropha* in the southern waters are developed in summer, and their early pelagic stages have enormous pectorals for sustaining them. The larval stages of some of the fishes from southern waters are prolonged, *e.g. Arnoglossus laterna,* Will., as shown by Dr. H. M. Kyle, undergoes metamorphosis in northern water when 16 mm. long, but in the Bay of Biscay when 26–30 mm. in length.

M. Fage attributes the wide distribution of the young forms of certain shore-frequenting species to the cyclonic currents of the Mediterranean; but he has to except the young of the genus Callionymus. A wider view of the subject, however, creates doubt as to the general applicability of such an explanation. In connection with the adaptations of the larvæ he forms two groups (after Dollo), viz. the *nectique* and the *plantique.* The slow forms, especially the benthal, develop organs for maintaining equilibrium in the plankton, such as long ventral or pectoral fins

[1] Report of the Danish Oceanographical Expeditions in the Mediterranean, 1908–10. "Shore Fishes." By Louis Fage, of the Natural History Museum, Paris. Pp. 154. (Copenhagen: And. Fred. Høst and Son, 1918.)

or elongated dorsal fins, but the author does not allude to the slow lumpsucker, which has none of these characteristics.

Lastly, M. Fage refers to positive and negative heliotropism in the larvæ, the former being illustrated by the capture of the young *Capros aper* much nearer the surface by day than by night, and the latter by the passage of *Paracentropristis hepatus* from considerable depths by day to a more superficial area by night. The study of this subject, however, is still in its infancy. Many other interesting features are instanced by the author, whose memoir forms an important contribution to the subject of the larval forms of shore-fishes.

W. C. M.

The Lac and Shellac Industry in India.[1]

By DR. A. D. IMMS.

AT the present time India holds what is virtually a monopoly of lac production, and no satisfactory substitute has yet appeared on the world's markets. This monopoly cannot, however, be regarded as a sinecure; other countries are likely to be found suitable for lac cultivation, and the present high value of lac and its importance to many Western industries render it urgent that the production of this substance should be encouraged along improved scientific and economic lines. The propagation of lac is still very carelessly carried out, and its methods of collection need much improvement. The crop varies from year to year, prices fluctuate seasonally, and there is much injurious market speculation. The bulk of the world's lac comes from Chota Nagpur, Orissa, the north-eastern half of the Central Provinces, some western districts of Bengal, and from part of the Mirzapur district of the United Provinces. Out of the ninety or more trees which have been recorded as hosts for the lac insect (*Tachardia lacca*), the most important include *Schleicheria trijuga, Butea frondosa, Zizyphus jujuba* and *xylopyrus*, together with species of Acacia, Ficus, etc. These plants contain much gummy or resinous matter or are rich in latex.

The problems concerning lac production are manifold, and may be roughly divided into (1) botanical, (2) entomological, (3) chemical, (4) cultural, and (5) technological. On the botanical side we need more especially to determine the optimum conditions which conduce to the food-plants yielding a heavy crop of lac. It also needs to be ascertained how far it is possible by cultural treatment to stimulate the plant's production of those substances which are utilised by the insect in lac secretion. On the entomological side the most important problem is to deal with the enormous number of parasitic and other insects which annually destroy a prodigious amount of lac, either directly or indirectly. It is extremely unlikely that any marked improvement in lac culture will result until this complex problem has been thoroughly gone into. On the chemical side we need to know what plant substances are essential as food or raw material for the lac insect. Once the biochemistry of this problem is understood, it will pave the way for a better understanding of the requirements of the insect and open up a whole field of research into the cultural conditions necessary.

Under the latter heading are many other problems. Pruning and pollarding are highly desirable, for the lac insect is dependent upon the existence of young shoots in the right physiological condition. The extent and frequency with which the trees can be safely infected to yield the optimum crop need to be ascertained. It is also necessary to acquire definite information whether the best results are likely to be obtained from the establishment of lac nurseries composed of young trees of convenient size under careful cultivation, or whether little benefit is likely to be derived, as compared with the present system of relying solely upon existing trees growing wild and distributed over wide areas. On the technological side much improvement is possible; we need to ascertain the best and most economic methods of dealing with lac in all stages of its treatment—from the condition when it is received as stick-lac up to the final products of shellac, lac-wax, and lac-dye. The present system is primitive and often uneconomic, and adulteration is frequent.

The problems are highly complex and involved, and this fact is fully appreciated by Messrs. Lindsay and Harlow in recommending that a central lac laboratory be established in India. Under the existing system most of what research has been done at all has been carried out partly by the Forestry Department at Dehra Dun and partly by the Agricultural Department at Pusa. Neither of the research institutes located in the above places has the necessary staff available for the work. The choice of a site for such a laboratory is likely to prove difficult, as there are many factors to be considered The *sine qua non* is that it must be located in an important area of lac production, where the problems can be studied on the spot. Such a laboratory would be devoted primarily to the study of the growing crop in relation to its environment. Its first aim presumably would be to obtain exact and trustworthy information bearing upon the many problems involved. At the present time we need new ideas and trustworthy knowledge. Much that is published is largely a repetition of what has appeared previously; the same statements, and often the same errors, have reappeared with perennial regularity, and little or no real progress has resulted. Messrs. Lindsay and Harlow's bulletin is a useful *résumé* of the present position of the problems concerned, and the suggestions which they bring forward will, it is to be hoped, receive the fullest consideration by those whose duty it is to develop and influence our means of utilising the natural resources of India.

[1] H. A. F. Lindsay and C. M. Harlow: "Report on Lac and Shellac." Indian Forest Records, vol. viii., part i., 1921. Pp. x+162+4 plates+10 charts+1 map.

Flight of Flying-fishes.

DR. E. H. HANKIN has made some interesting observations on the "flight" of flying-fishes (Proc. Zool. Soc. London, 1920, pp. 467–74, 2 figs.). He concludes that much depends on the atmospheric conditions. On a very still evening in the Arabian Sea he noticed that the length of a glide after leaving the water was only about a metre, and the fishes showed much lateral instability. During the same voyage, but in sunshine and with a light wind, the longer flights attained to between 200 and 400 metres in length. The pectoral fins are usually in the "flat" position, *i.e.* extended in the horizontal plane. Sometimes the wings are slightly inclined upwards, with the outer part of the fin at a higher level than its base. This is the usual position in slow-speed flight. In rare cases the fins are inclined very slightly downwards, and this "down" position is probably used for flight at highest speed. Now soaring vultures have their wings in the "up" position for slow-speed flight, and use the "flat" wing-disposition for flight at high speed.

A further resemblance between flying-fish and soaring vulture is indicated by the observation that the tips of the pectoral fins may be bent up, forming an angle of perhaps 45° with the rest of the fin, which is comparable to the bending up of the terminal quills of the vulture's wing during horizontal soaring flight.

Dr. Hankin confirms the conclusion that while there may be flapping of the pectoral fins at the start, there is none after the fish has got well under way. A speed of 10 metres per second was observed during eight seconds, and a maximum of 20 metres per second is probable. Taking advantage of species of Exocœtus with coloured pelvic fins, Dr. Hankin was able to discover how the displacement of these is used to check the velocity in both high-speed and low-speed flight. In a species with the pelvic fins small in size and placed far forwards, therefore unsuitable for checking speed or for steering in the vertical plane, the fishes at the end of their flight steer downwards by drawing the pectoral fins back through an angle of about 45°. They then plunge head foremost into the water without any visible attempt to check their speed.

It seems that flying-fishes sometimes make mistakes as to the suitability of the air for flight. They may emerge with low-speed disposition when high-speed disposition would have been appropriate; they may emerge tail "up" when they should have tried tail "down." Thus their "flights" are often involuntarily short.

University and Educational Intelligence.

LONDON.—The Ph.D. degree in the faculty of science has been conferred on the following:—Connell Boyle (Royal College of Science), for a thesis entitled "Studies in the Physiology of Fungi"; Sri Krishna (East London College), for a thesis entitled "The Condensation of Phenols with Acid Anhydrides, with Special Reference to Coumarin"; Isabel Soar (Birkbeck College), for a thesis entitled "The Structure and Function of the Endodermis in the Abietineæ"; Nellie Barbara Eales (University College, Reading), for a thesis entitled "Monograph on the General Morphology of *Aplysia punctata*"; Frederick H. Newman (Royal College of Science, and University College, Exeter), for a thesis entitled "The Absorption of Gases in the Electric Discharge Tube"; and George N. Pell (University College), for a thesis entitled "The Trajectory of Bombs Dropped from Aircraft."

THE Bureau of Education, Washington, has issued a pamphlet dealing with the opportunities for the study of medicine in the United States (Higher Educational Circular, No. 22). The system of education in the United States is first briefly surveyed, and details are given of the preliminary studies and examinations necessary in order to enter a medical school. The medical curriculum is then described, and a list of the medical schools is given, with notes on their numbers of students, graduates, and teachers, and the fees. Other sections of the pamphlet deal with the expenses incident to an education in an American medical school, social opportunities, and scholarships and loan funds. Of the 85 medical colleges in the country, about 60 are open to both sexes.

Calendar of Scientific Pioneers.

August 19, 1662. Blaise Pascal died.—A religious philosopher, mathematician, and physicist, the author of the "Provincial Letters" and the "Pensées," Pascal spent the earlier part of his life in scientific studies. He made the first calculating machine, measured heights by the barometer, and with Fermat founded the theory of probabilities.

August 19, 1822. Jean Baptiste Joseph Delambre died.—During the French Revolution Delambre with Méchain made the geodetic measurements which formed the base of the metric system. He succeeded Lalande at the Collège de France, and distinguished himself as one of the secretaries of the Paris Academy of Sciences. His great "History of Astronomy" was published during 1817–21.

August 19, 1856. Charles Frédéric Gerhardt died.—An Alsatian by birth, Gerhardt became an assistant to Liebig, held a chair at Montpellier, and during the years 1848–55 resided in Paris, where he published his "Traité de Chimie organique," which contains his important views on the structure and constitution of chemical compounds. He died at Strasbourg, where a monument is to be erected to him.

August 19, 1896. Josiah Dwight Whitney died.—Graduating at Yale in 1839, Whitney rose to a foremost position among American geologists. In 1865 he became professor of geology at Harvard.

August 23, 1782. Henri Louis Duhamel du Monceau died.—A botanist, physicist, and technologist, Duhamel du Monceau had an unrivalled knowledge of timber, and as Inspector-General of the French Navy contributed to the advancement of naval architecture.

August 23, 1806. Charles Auguste de Coulomb died.—A French military engineer, Coulomb made important researches on friction, invented the torsion balance, and discovered the laws of the attraction and repulsion of electrified bodies. He was an original member of the French Institute, and was employed by Napoleon as an Inspector of Public Instruction.

August 23, 1835. Leopoldo Nobili died.—Nobili, who was professor of physics in the Archducal Museum at Florence, is remembered for the introduction of the astatic galvanometer and the thermo-electric pile.

August 24, 1664. Maria Cunitz died.—A native of Germany, during the Thirty Years' War Maria Cunitz removed to Poland, where, with the assistance of her husband, she compiled her astronomical tables, "Urania propitia . . ." From her universal accomplishments she was called the "Silesian Pallas."

August 24, 1832. Nicolas Léonard Sadi Carnot died.

August 24, 1888. Rudolf Julius Emmanuel Clausius died.—Both famous physicists, Carnot and Clausius are among the founders of thermodynamics. The son of the "Organiser of Victory," Carnot was born in the Luxembourg in 1796, passed through the Ecole Polytechnique, and served in the Army. His essay of 1824, "Réflexions sur la Puissance motrice du Feu," called by Kelvin an "epoch-making gift to science," for many years remained unnoticed. Clausius was born in 1822, and as a *Privatdozent* at Berlin in 1850 re-stated Carnot's principle, enunciated the second law, and afterwards developed his conception of entropy. His "Die mechanisch Wärmetheorie" appeared in 1867. While Carnot's work was the outcome of his study of the steam engine, that of Clausius led to the application of scientific principles to its improvement. The kinetic theory of gases also owes much to the labours of Clausius, who for some years was professor of natural philosophy at Bonn, where Hertz was his successor. E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, August 1.—M. Georges Lemoine in the chair.—The President announced the death of M. Edmond Perrier.—A. **Lacroix**: The mineralogical composition of rockallite. Dr. Charcot has recently made a successful landing on the island of Rockall, examined its geological structure, and collected specimens of the rocks. The present paper contains an account of the mineralogical, chemical, and spectroscopic examination of some of these.—L. **Maquenne** and R. **Cerighelli**: The distribution of iron in plants. Figures are given of 100 determinations of iron in various organs of forty species of plants. The quantities found are very small, varying from 1 to 362 parts of iron per million of dry plant material. Young organs, buds, and leaves contain more iron than the older ones.—A. **de Gramont** and G. A. **Hemsalech**: The conditions of the emission of the spark lines by the electric arc. Conditions of experiment were devised so that the effects of cooling the metallic vapours or the electrodes, of heating the electrodes, and of varying the chemical nature of the medium in which the arc was struck could be studied. The results prove that spark lines are always emitted when the current of the electric arc is obliged to pass through media (vapours or gases) possessing a relatively low degree of ionisation—that is to say, offering a strong resistance to the passage of the current. This amounts to saying that the emission of spark lines is related to the existence of intense electric fields.—L. **Antoine**: Perfect ensembles discontinuous throughout.—J. **Kampé de Fériet**: Certain systems associated with equations of finite differences or with partial linear differential equations.—H. **Beghin**: The Anschütz and Sperry gyrostatic compasses.—M. **Charcot**: An expedition of the *Pourquoi-Pas* to Rockall. An account of the landing of two men on the island on June 19 and of three men on July 1 for the purpose of collecting specimens of rocks and algæ.—E. **Dubois**: The minimum potential of electric discharge in hydrogen at low pressures. A further study of the variations produced in the discharge potential by the occlusion of hydrogen by the platinum wire electrode. —H. **Pélabon**: The resistivity of selenium. The resistance of liquid selenium falls rapidly as the temperature rises, the logarithm of the resistance being a linear function of the temperature. While the resistance of liquid selenium is defined by the temperature, this is not the case with the solid grey selenium, the resistance of which depends upon its previous heat treatment.—M. **Sauvageot**: The retarded solution and premature precipitation of cementite in eutectic and hypereutectic carbon steels. —A. **Damiens**: The system bromine–tellurium. The nature of the lower bromide of tellurium. Since bromine has no solvent action on $TeBr_4$, the thermal study is reduced to that of the system $TeBr_4$–Te. No indication of the compound $TeBr_2$ was obtained from the metallographic or thermal analysis, but this substance was proved to be present by heating in a vacuum. This gave a non-volatile portion and two sublimates differing in colour and volatility. One of these was $TeBr_4$ and the other a mixture of tellurium and its tetrabromide in the proportions required to form $TeBr_2$. Hence the lower bromide would appear to exist in the gaseous state, but is unstable in the solid state, decomposing into tellurium and the tetrabromide on solidification.—P. **Woog**: The oiliness of fatty bodies. The property of oiliness or greasiness, valuable in lubricants, is not capable of exact definition. The molecular volumes of a considerable number of lubricating oils, fatty and mineral, have been determined by cryoscopic or boiling-point methods, and it is shown that in general the oiliness or greasiness of an oil diminishes as the molecular volume decreases.—V. **Auger**: The equilibria of tri-, tetra-, and penta-valent vanadium in concentrated sulphuric acid solution.—C. D. **Zenghelis**: The detection of nitrogen in organic compounds. The compound is heated with a reagent consisting of soda-lime (two parts) and copper powder (one part), and the ammonia evolved detected by the formaldehyde-silver nitrate reagent previously described by the author. Tests with a large number of different types of nitrogen compounds are given, the limits of delicacy ranging between 0·05 and 0·001 milligram of nitrogen.—E. **Rengade** and J. **Clostre**: The estimation of water in transformer oils. The oil is heated to 80° C. in a current of dry air, and the escaping vapours are cooled with solid carbon dioxide or liquid air.—E. E. **Blaise**: The preparation of the acyclic δ-diketones. Glutaric diethylamide is condensed with an alkyl magnesium bromide. The reaction does not proceed normally, much gas being evolved, but the δ-diketone is formed, with a yield of 25 to 30 per cent. Dipropionylpropane and dibutyrylpropane have been prepared by this method: their properties and reactions are described.—H. **Gault** and R. **Weick**: Additional properties of the keto-enolic double linkage. A study of the reactions of one of the three isomeric phenylpyruvic esters with ammonia and diethylamine.—R. **Fosse** and G. **Laude**: Syntheses of cyanic acid and urea by the oxidation of organic substances: amides, nitriles, and methylcarbylamine. —M. **Samec** and Mlle. Anka **Mayer**: The synthesis of amylopectin by the phosphoric etherification of the erythroamyloses.—J. **Savornin**: The middle atlas of Morocco.—Ph. **Wehrlé**: The notion of period in the study of the nuclei of pressure variations.—A. **Carpentier**: The presence of Cycadophytes in the Wealdian layer of Féron.—L. **Blaringhem**: Researches on the hybrids of flax (*Linum usitatissimum*).—A. **Guilliermond**: Cytological observations on the bud of *Elodea canadensis*.—G. **Bertrand** and Mme. M. **Rosenblatt**: The general presence of manganese in the vegetable kingdom. According to Maumené, certain plants are free from manganese. The authors' analyses show that none of the exceptional cases cited by Maumené can be retained: manganese is present in all plants without exception.—S. **Metalnikow** and H. **Gaschen**: Immunity and hypersensibility in the caterpillar.—R. **Sazerac** and C. **Levaditi**: The treatment of syphilis by bismuth. A detailed account of the treatment and results in five cases.

SYDNEY.

Linnean Society of New South Wales, June 29.—Mr. G. A. Waterhouse, president, in the chair.—G. F. **Hill**: Notes on some Diptera found in association with Termites. In opening up galleries of *Mastotermes darwiniensis* and *Calotermes irregularis,* the author frequently found larvæ and pupæ of Trypaneidæ and Syrphidæ; he describes one species belonging to each family, that in the Syrphidæ being new.—Vera **Irwin-Smith**: Studies in life-histories of Australian Diptera Brachycera. Part i.: Stratiomyiidæ. No. 2: Further experiments in the rearing of *Metoponia rubriceps*. Attempts to rear the larval *M. rubriceps* from the egg have met with considerable success, and it has been found possible to breed from flies reared from the larva in captivity. The cycle, from larva to larva of the next generation, has been obtained, but the bred larvæ all perished at an early stage, so that the cycle has not been quite completed, and the length of time passed in the larval state is still unknown.—Dr. R. J. **Tillyard**: Revision of the family Eustheniidæ (order Perlaria), with descriptions of new genera and species. The Eustheniidæ are described as a distinct family possessing only archaic family characters. To the three genera and four species which have been described the author adds two genera and seven species, all of which are described for the first time. The known distribution of the family is Tasmania, Victoria, New Zealand, mountains of East Australia, and southern Chile, and is regarded as an argument in favour of an Antarctic origin of the Perlaria.—Margaret H. **O'Dwyer**: Preliminary report on the nutritive value of certain Australian grasses. A number of grasses grown at the Botanic Gardens and at various State experiment farms have been analysed with the view of determining their value as foodstuffs. In order that the results might be of value for comparative purposes the material was obtained so far as possible at the following well-defined stages of growth:—(1) About half-way between the time when it begins to shoot and the flowering period, (2) early flowering period, and (3) when the seed is quite set. The paper comprises a preliminary discussion of the methods used and the results of the analyses.

CAPE TOWN

Royal Society of South Africa, June 15.—Dr. A. Young in the chair.—V. H. **Brink**: A preliminary genetic study on the osteology of the Griquas.—E. **Newbery**: Note on the life-period of the over-voltage compounds. A series of experiments has been carried out to determine the effect of changes in the speed of the commutator upon the measured over-voltage of various cathodes in dilute sulphuric acid. The commutator was rotated at speeds varying between 300 and 1500 revs. per minute, and an interesting set of curves was obtained by plotting the observed over-voltages against these speeds. The relative rates of decomposition or decay of the over-voltage compounds are shown by these curves. Those of zinc and chromium are so stable that no perceptible change of potential occurs within the time-limits of the experiments. The hydrides of silver, platinum, and graphite show signs of decay after one-twentieth of a second, those of copper and cadmium after one-thirtieth of a second, whilst those of lead and nickel appear to be decomposed with very great rapidity.

July 20.—Dr. J. D. F. Gilchrist, president, in the chair.—E. J. **Hamlin**: The effect of sunlight on secondary batteries.—Dr. J. D. F. **Gilchrist**: Note on the pectoral fin of Achirus (a species of sole).

Books Received.

Memoirs of the Geological Survey: England and Wales. The Geology of the South Wales Coalfield. Part xiii.: The Country around Pembroke and Tenby. By E. E. L. Dixon. Pp. vi+220+5 plates. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd.) 8*s*. net.

Greek Atrocities in Turkey. First Book, Publication No. 4. Pp. 153+5. (Constantinople: Ministry of Interior, Dept. of Refugees.)

Ministry of Finance, Egypt: Survey of Egypt. The Soils and Water Supply of the Maryut District, West of Alexandria. By Dr. W. F. Hume and F. Hughes. (S.D.P. No. 37.) Pp. v+52+xiii plates. (Cairo: Government Press.) P.T.10

Loughborough College, Leicestershire. Calendar: Session 1921–22. Pp. xviii+190. (Loughborough: The Echo Press.) 2*s*. 6*d*. net.

A Text-book of Physics. Edited by A. W. Duff. Fifth edition, revised. Pp. xiv+700. (London: J. and A. Churchill.) 16*s*. net.

Department of Mines and Explosives, Mysore State. Report of the Chief Inspector of Mines in Mysore for the Year 1919–20; with Statistics for the Calendar Year 1919. Pp. 34+45. (Oorgaum.) 2 rupees.

The Law of Births and Deaths: Being a Study of the Variation in the Degree of Animal Fertility under the Influence of the Environment. By Charles Edward Pell. Pp. 192. (London: T. Fisher Unwin, Ltd.) 12*s*. 6*d*. net.

Magnetizzazione della Elettricità: Rotazione Elettro-Magnetica del Sistema Planetario e Specialmente del Terreno e dei Vegetali Terrestri. By Niccolò Mancini. Pp. iv+91. (Firenze: B. Seeber.)

Die Ursachen der diluvialen Aufschotterung und Erosion. By W. Soergel. Pp. v + 74. (Berlin: Gebrüder Borntraeger.) 18 marks.

Department of Scientific and Industrial Research: Report of the Fuel Research Board for the Years 1920, 1921. First Section: Steaming in Vertical Gas Retorts. Pp. viii+54. (London: H.M.S.O.) 1*s*. 6*d*. net.

An Introduction to the Flora of Natal and Zululand. By Prof. J. W. Bews. Pp. vi+248. (Pietermaritzburg: City Printing Works; London: Wheldon and Wesley, Ltd.) 15*s*.

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