THURSDAY, AUGUST 19, 1909.

OILS, FATS, AND WAXES.

Chemical Technology and Analysis of Oils, Fats, and Waxes. By Dr. J. Lewkowitsch. Fourth edition, entirely re-written and enlarged. 3 vols. Vol. i., pp. xx+542; vol. ii., pp. xi+816; vol. iii., pp. viii +406. (London: Macmillan and Co., Ltd., 1909.) Price *2l.* 10*s.*

THE third edition of this work was reviewed in these columns about five years ago (vol. lxx., p. 502). It is therefore unnecessary again to describe the plan of the book in any detail. In the broad outlines it remains unaltered, though there are changes in the arrangement, and considerable additions.

Much has been done, and much written, in this branch of technology since 1904; wherefore the author has found it necessary to expand the work into three volumes. Broadly speaking, the first volume describes the general chemical constitution of oils, fats, and waxes, and the usual physical and chemical methods adopted in examining them; vol. ii. treats of the individual natural products; and the third volume is devoted to the various groups of manufactured articles, such as edible oils, oxidised oils, candles, soaps, and glycerin. Some new sections, dealing with emulsified oils, the fatty-acid industry, and wax technology, have been added to this part of the work; and more space than formerly has been allotted to the description of manufacturing operations.

Apparently no pains have been spared in making the book as complete and as modern as possible. So far as the reviewer can judge by testing the information here and there, no recent work of importance on the theoretical and scientific side has been overlooked. Thus Bömer's process for the identification of pure glycerides is summarised, and a description is given of the "direct" method for isolating and determining glycerol recently proposed by Shukoff and Schestakoff. Valenta's suggested method of quantitatively separating aromatic hydrocarbon oils from those of the aliphatic series by extraction with dimethylsulphate is dealt with at some length; and an account is also given of the criticisms of the process by subsequent workers.

On the technological side an interesting development is mentioned which may prove of some importance in the candle industry. A large quantity of liquid oleic acid occurs as a by-product, and one of the standing problems of the industry has been to find some mode of converting this liquid acid into its solid homologue, stearic acid, thereby rendering it available as a material for candle-making. Many suggestions have been made, and many patents obtained, with this object in view; but no great success has hitherto attended these efforts—at least, on a manufacturing scale. It seems, however, that an application of Sabatier and Senderens' classical researches upon the "reduction" of organic compounds by means of finely-divided nickel may mark a new stage in the matter. Several investigators have proposed such an application, and Dr. Lewkowitsch states that, by a systematic study of the Sabatier and Senderens reaction, he has recently succeeded in converting oleic acid into practically the full quantity of stearic acid theoretically obtainable from it. What, however, is not quite clear is whether the translation from laboratory experiments to factory practice has been successfully accomplished. Details are withheld.

The author gives a tabulation of oils, fats, and waxes based upon the magnitude of the iodine values. He looks upon this as the most convenient classification for practical purposes. Probably it is; but there are, as would be expected, some inconsistencies and overlapping of groups in this arrangement. Thus certain of the non-drying oils have a greater iodine value than some of the drying and semi-drying oils. But as every chemist dealing with diverse varieties of oils and fats probably constructs some such table for himself, it will be useful to have a fairly complete tabulation of critically-selected values for general reference, even though it is not an ideal basis of classification.

Turning for a moment to commercial matters, most people know that we import large quantities of butter into this country, but many may be surprised to learn that lard is imported to the value, roughly, of five millions annually, and another million pounds' worth, our author calculates, is made at home. The section of the book devoted to this important fat has been increased considerably. Some of the statements made in the earlier editions have had to be modified —notably as regards the range of iodine values—but this was only to be expected, in view of altered circumstances of production. The author discusses at some length the difficult problem of detecting small admixtures of beef-fat with lard. Tables are quoted showing the melting-points of the crystals which deposit from solutions in ether of lard and beef-fat, respectively. The beef-fat crystals have much the lower melting-point. It seems, however, to have escaped the author's notice that the crystals obtained from a mixture of beef-fat and lard have also a lower melting-point than those from lard alone. Used with discretion, such as the author wisely inculcates in other matters, the importance of this fact in solving the problem is obvious.

In dealing with the adulteration of butter the author stigmatises as futile the attempt to prove "that an admixture of beef-fat or lard has taken place if only low titration-numbers for the insoluble volatile acids are found." Undoubtedly such an attempt is futile. It is so obviously futile as to raise a shrewd suspicion that there has been a misunderstanding somewhere.

In some minor matters we do not always see eye to eye with the author. For example, he unduly minimises the value of the specific gravity indications in the examination of butter-fat. His objection is that the test "would hardly lead to the detection of smaller quantities of an adulterant than 30 per cent." In a sense, that is true; but it is also true, in a sense, of every other single criterion which could be applied.

These, however, are small points. Summing up one's impressions of the book as a whole, they are that it well maintains its place in the front rank of works devoted to the study of oils, fats, and waxes. To the chemical technologist it is practically indispensable.

C. SIMMONDS.

A CYTOLOGICAL TREATISE.

Plasma und Zelle. Erster Abtheilung. By Prof. Martin Heidenhain. Erste Lieferung, Die Grundlagen des mikroscopischen Anatomie, die Kerne, die Centren, und die Granulalehre. Pp. viii+506. (Jena: Gustav Fischer, 1907.) Price 20 marks.

THIS somewhat bulky volume is the first instalment of Prof. Martin Heidenhain's treatise on "Plasma und Zelle" which is to form a part of Bardeleben's great work on human anatomy.

The method which the author has adopted is perhaps not the ideal one, but it must be remembered that the science of cytology is young, and its vigorous development has manifested itself in the growth of an enormous amount of details which some day will become connected up so as to make a coherent organism, despite the fact that at the present time the different sections seem to be somewhat isolated. The features which in one group appear to be of fundamental importance may elude recognition in, and perhaps be really absent from, others; and thus that logical connection so dear to the minds of many is difficult, and at present often impossible, to trace. Probably for some time to come the trees will be more apparent than the wood. Prof. Heidenhain has chiefly worked on the cells of a few vertebrate animals, and it must be confessed that throughout the somewhat lengthy treatment of his subject this point of view is rather strongly reflected. There is hypothesis in plenty, together with much really acute analysis, but one cannot repress the feeling that the chastening influence of the protozoan nucleus is rather conspicuous by its absence.

The treatment is frankly morphological, and upon a somewhat narrow range of very detailed observation of comparatively few forms a theoretical superstructure of doubtful stability has been erected. Some cytologists, at any rate, will criticise one of the earlier pronouncements (p. 3) in the book, to the effect that discussion (Erörterung) of biochemical structure forms no part of the province of scientific morphology, and that the latter must take the former as granted. Surely the trend of modern morphology is in the direction of discontent with such a position. Some of us, at any rate, believe that form and structure are merely the expression of biochemical constitution, and it is just this latter problem that we want to attack.

Prof. Heidenhain postulates "units of living substance" as the essential elements of an organism. The cells are regarded as a special case of the aggregation of these living units. In this he is practically following those who regard the cell as by no means the real unit of the organism, and unquestionably this is a tenable position; but, nevertheless, the cell, despite its complex organisation, represents actually the lowest rank in the polity of the multicellular organism out of which the organism itself is built up; nor is the case really different in syncytial bodies. The quarrel with the cell from this point of view is perhaps partly due to the fact that we have not been clear as to what we mean by an organism. A human society is made up of the individuals which compose it; we are justified in regarding them as the ultimate constituents of such a social organism and we cannot usefully push our analysis further back, for they form the lowest units which propagate themselves and differentiate into the complex structure of which the society is composed. Of course, we are aware that each one can be resolved still further into tissues and cells, but these things do not come into the scheme of the social organism as such. The same holds good when we get still lower in the scale. The cells plainly continue to be the units of which the *corpus* is built up—until we get to the unicellular organisms. In the latter we find a more elaborate differentiation than is characteristic of the metazoan or metaphytan cell, but in essentials it seems to be the same. The protoplasm and the nucleus still are requisite to maintain it as a going concern, and reproduction by fission or otherwise is always connected with the distribution of a combination of both to each of the offspring. This is strikingly shown in some forms in which a nucleus as such is perhaps absent, and only the stuff of which the nucleus is made is present in a more or less distributed condition in the cell.

But although we may not agree with the author in his belittlement of the cell, many will assent to his conclusion that it has been made too prominent as the "be all and end all" of the living body. The organism is higher than its parts, and itself determines what form it shall take—or, to put it more plainly, the reactions that are due to the relations subsisting between one part of the organism and another, or between it and its environment, are of such a kind as to influence the fashion of development of the new cells and new tissues.

Prof. Heidenhain's position with regard to the cell is clearly stated on p. 81, where he says that

"it is not the cell which is the bearer of life, but life is inherent in every living particle, down to the smallest molecular group which can be called alive. The cell is rather only a special apparatus which itself is made up of living material."

The crux of the matter obviously lies in the meaning we attach to the word "living."

Many pages are devoted to cell organs, such as centrosomes, and to a very lengthy discussion of Altmann's so-called "granular theory." We confess that much of the space thus allocated seems to us to be hardly well utilised; and although it is not fair finally to criticise a work of which only the first part has appeared, it appears to us that a more real service to cytology would have been rendered if Prof. Heidenhain had focussed the information which is so rapidly accumulating as the result of the study of the lower forms of life upon the problems presented by the higher types.

But he has, at all events, laid those who are interested in cytological development under a debt of gratitude by the exhaustive treatment he has accorded to those topics which he decided to discuss.

MARINE PROPELLERS.

The Screw Propeller: and other Competing Instruments for Marine Propulsion. By A. E. Seaton. Pp. xii+255. (London: Charles Griffin and Co., Ltd., 1909.) Price 12*s*. 6*d*. net.

THE author of this book is well known, both as a practising marine engineer and as an author. His "Manual of Marine Engineering" has long served as a text-book, and has passed through many editions. It was natural, therefore, that the announcement of a work by Mr. Seaton dealing with marine propellers should awaken interest over a wide circle of readers, more especially as the problem of propeller design has not yet received a complete solution. As Mr. Seaton says, "even in modern times . . . . our best men do sometimes fail to achieve success," although there are now available the results of much experimental and theoretical investigation on the subject. After seventy years' continuous work it still remains true that when novel types of ships or unprecedented speeds have to be attempted, although use may have been made of all available data, and the best advice taken, full success is not always or at once achieved. On the contrary, considerable gains in efficiency are frequently attained by a process of "trial and error," out of which comes a final selection of the propeller forms and dimensions best suited to novel conditions.

Such a confession may be thought discreditable; indeed, it is sometimes so treated by critics who have not themselves had occasion to undertake responsibility for ship and propeller designs; but it represents the facts of the case, and the explanation is not far to seek. When a problem has been unsuccessfully attacked by men like Rankine and William Froude, amongst those who have finished their work, and by men like R. E. Froude, Cotterill, Greenhill, and D. W. Taylor, who are still alive and interested in finding solutions, it may be presumed that the problem involves considerable difficulties. When one considers the almost endless variety of the conditions involved in ship propulsion, the failure to reach a complete solution of the problem need not cause astonishment, and it is reasonable to anticipate that we shall have to be content for some time to come, if not permanently, with partial solutions chiefly based on experimental investigations, and on careful scientific analyses of the results.

Mr. Seaton definitely states in his preface that the

"object of the present work is to amplify and extend what [had been given] in skeleton or in rudimentary form" (in his "Manual of Marine Engineering") in the shape of rules for guidance in the practical work of designing propellers. These rules are said to have been "generally based on scientific reasons and always capable of giving results agreeable with the best and most successful practice": and it is claimed that by means of successive improvements "they have become generally applicable to the design of a screw for an Atlantic liner or a torpedo boat." It is added that "the more abstruse and highly mathematical investigations connected with the theory of the resistance of ships and propellers have been left to be studied in the text-books and . . . . valuable papers" of various authors.

More or less empirical rules such as Mr. Seaton proposes no doubt have a certain value as representing his own practice and deductions from his study of published results of steamship trials, but it cannot be admitted that such rules can be depended upon absolutely when new conditions have to be faced. If it were true that the best results could be ensured by the use of any known rules in the designs of screws over the wide range from "an Atlantic liner to a torpedo boat," difficulties such as have been mentioned would disappear, and the work of the naval architect would become easy of performance. The occurrence of these difficulties demonstrates the imperfection of existing rules.

Turning to the general scheme of the book, it may be said that the section dealing with the history of marine propellers is both interesting and valuable. Bourne's book, giving the early history of the screw propeller, is not now generally accessible, and Mr. Seaton's summary will be found useful for reference. Paddle wheels, screws, and hydraulic (or jet) propellers are treated separately, their principles of action are explained, rules being given for their practical design. One chapter is devoted to an explanation, in popular language, of the modern theory of the resistance of water to the motion of ships, but readers desiring full information on the subject will necessarily have to turn to other sources, as Mr. Seaton only attempts a brief sketch. Naturally, screw propellers claim most attention, their various forms, numbers and positions are described; and the effects of changes in numbers, shape, and proportions of blades are also discussed at some length. Much information has been collected and collated respecting experimental trials made with screw propellers, but it seems doubtful whether the large amount of space devoted to trials made by the Admiralty and other experimentalists in the early period of screw propulsion might not have been better utilised, seeing that these trials were made on ships the forms, proportions, and speeds of which in no way represent present practice, while many important conditions affecting results are not definitely known. An antiquarian interest attaches to them, and from their consideration certain useful deductions may be, and, indeed, have been, made; but radical differences exist between conditions prevailing thirty or forty years ago and those of the present day, and the devotion of much time to this subject, when better and later information is available, is not desirable. The chapters dealing with the geometry of the screw and materials used in the construction of the screw propeller are excellent.

The book is well produced and illustrated. It has an excellent index, and as a work of reference will be found of service to all interested in the propulsion of ships.

STUDIES ON IMMUNITY.

Studies on Immunity. By Prof. Robert Muir, in collaboration with Drs. Carl H. Browning, Alexander R. Ferguson, and William B. M. Martin. Pp. xi+216. (London: Henry Frowde, and Hodder and Stoughton, 1909.) Price 7s. 6d. net.

THIS book contains a record of original work on the theory of immunity carried out during the past six years by Prof. Muir, of Glasgow University, in collaboration with his colleagues, Dr. Browning, Dr. Ferguson, and Dr. Martin. Eleven original papers, all of which have already appeared in various scientific journals, are incorporated in the present volume, but, by judicious alterations and additions, the author has endeavoured to knit the subject-matter of these papers into one continuous whole, so that the volume serves as a connected account of the particular immunity processes (hæmolysis and opsonic action) with which the author deals.

A work which treats in strictly scientific fashion of questions so difficult and complicated as those of hæmolysis and opsonic action must of necessity appeal only to the expert, and it is unfortunate that Prof. Muir has not seen fit to bring the subject up to date by the inclusion of references to papers which have appeared since the publication of the authors' original researches. Had he done so, the book would have appealed far more forcibly to the present-day worker, who, one may presume, has been for some time familiar with these highly important researches of Prof. Muir and his collaborators.

The volume opens with an interesting chapter on the properties of hæmolytic sera generally, and the technique usually employed in the investigation of hæmolytic phenomena. There follow chapters on the mode of union of the immune body with the red corpuscle, and the relation of this union to complement action. With regard to this latter question, Prof. Muir finds himself in agreement with Bordet, whose view is that there is no direct union of immune body with complement, as Ehrlich supposed, but that the complement unites with the cell receptor, which has, so to speak, been sensitised by the immune body. "A complementophile group in the amboceptor is not proved, and the use of the term 'amboceptor' does not appear to be justified." Certain interesting filtration experiments performed by Prof. Muir and his colleagues showed very convincingly that at 37° C. a direct union of immune body with complement was highly improbable. The question of complementoids is discussed in great detail, and the author believes that Ehrlich's views with regard to these bodies have been completely confirmed.

Some interesting researches are described showing that complement may act as an agglutinin. Thus, if a certain amount of immune body (obtained by immunising an animal with the red cells of the ox) be added to ox corpuscles in the presence of ox complement, scarcely any lysis occurs, but marked agglutination of the red cells takes place. If guinea-pig's complement is employed, lysis, of course, occurs, and if the ox serum be now added, the stromata flocculate as before. Like complement, this agglutinating body in ox serum is thermolabile, and acts only in cooperation with immune body. Whether this agglutinating complement and the ordinary lytic complement are one and the same, further research must determine.

Anti-immune bodies and anti-complements are treated at great length, and a considerable amount of space is devoted to the question of the deviation of complement, a process which forms the basis of numerous diagnostic methods of great practical importance. The delicacy of this reaction is compared with that of the precipitin method as a test for the presence of protein of human origin.

The concluding chapters of the book deal with the authors' experiments on the opsonic action of normal and immune sera. In view of their finding that the opsonic action of a normal serum could be almost entirely removed by saturating it with sensitised red cells or other combinations which absorb complement, they came to the conclusion that the opsonins of normal serum belong to the group of complements. This view, which attributes to complement an entirely novel property of acting alone, and takes no account of the presence of normal amboceptors, has not met with general acceptance, and a considerable amount of evidence has accumulated in the last two years, showing that in normal serum, as well as in immune serum, amboceptors cooperate with complement to produce an opsonic effect. One cannot yet say, however, that the question whether the opsonic action of normal sera is strictly analogous to that of immune sera is definitely settled, and in the last chapter of the book Prof. Muir brings forward evidence that in some cases normal bactericidal action may differ from that which takes place through the medium of an artificial immune body. Normal bactericidal action may, in fact, follow from the direct union of complement with the bacterium, and not necessarily from an indirect union through the medium of a natural amboceptor. All workers interested in these questions will find Prof. Muir's book worthy of careful perusal.

THE SCIENCE OF EDUCATION.

Psychologie de l'Enfant et Pédagogie expérimentale. By Dr. Ed. Claparède. Second edition. Pp. viii+283. (Geneva: Librairie Kundig, 1909.) Price 3.50 francs.

THE second appearance of Dr. Claparède's book in a greatly enlarged form is an excellent indication of the interest which has been aroused by the effort of recent years to give a scientific basis to the practice of education. If further evidence were wanted, it will be found in the opening chapter, which gives a brief account of the development of the movement and of the literature of the subject. Child-study societies and child-study journals have an almost world-wide currency—from Japan in the Far East to California in the Far West. No doubt there is more zeal than science in much of the published work, but the critic is already at work, and we may hope that science will follow in his wake.

Dr. Claparède is a psychologist, and the interest of the book is mainly psychological. As a justification for the subtitle he makes certain pedagogic deductions, not, however, as tentative hypotheses upon which experimental inquiry may be founded, but rather as so many statements of fact. This seems unfortunate, and students of education who take up the book in the hope of deriving guidance and inspiration in their own class-room investigations will surely feel some disappointment. The dogmatic spirit in which the author treats certain fundamental issues is not reassuring. He finds, for example, that the prime motive power in the mental development of the young, is their inborn tendency to play and to imitate. Groos's interpretation of play is, in the main, accepted, and we are led into a strongly-worded plea for "attractiveness" as the sole principle in educational practice. The plea is backed up with the "best opinion," and ends thus:—

"It is true that certain scholastic successes may be obtained by the opposite method. But see later what the effect upon the victims is! Worked out at school, they are left without initiative, and the power of energetic action. They never become men because they have never been children."

This sweeping generalisation applies avowedly to the whole school system. Not a word of evidence is put forward in its support, though probably few of the readers of the book would regard it as a self-evident proposition. It is not a satisfactory method of laying the foundations of a science of education.

The author is more successful as an exponent of child-psychology pure and simple. He gives a brief summary of the various sources of our knowledge, and his chapter on mental development is a useful introduction to current views on the subject of play, imitation, and interest from the standpoint of biology. The student who is anxious to learn something of actual methods of research will find references to special monographs in the bibliographies appended to each chapter. It is only when he treats the subject of fatigue that the author himself gives detailed accounts of experimental methods the value of which readers can test for themselves. The curves which are given in the text of earlier chapters, showing the variations in suggestibility &c., at different ages, embody results of investigations the character and significance of which are not in any way discussed. Perhaps in a later edition the author may find it possible to strike out what is mere dogmatism, and enlarge upon those parts of his book which deal with scientific inquiry. The value of the book might in this way be greatly increased.

J. A. GREEN.

BOOKS OF REFERENCE IN ORGANIC CHEMISTRY.

(1) *Analyse und Konstitutionsermittelung organischer Verbindungen.* By Dr. Hans Meyer. Second enlarged edition. Pp. xxxii+1003. (Berlin: J. Springer, 1909.) Price 28 marks.

(2) *V. v. Richter's Chemie der Kohlenstoffverbindungen oder organische Chemie.* By Dr. R. Anschütz and Dr. G. Schroeter. Erster Band, Die Chemie der Fettkörper. Pp. xx+793. (Bonn: F. Cohen, 1909.) Price 18 marks.

(1) THE study of structure may be looked upon as the basis of all investigation in organic chemistry. It is the fundamental distinction between this and other branches of the science.

Whilst physical chemistry is chiefly concerned with the mechanism of reactions, inorganic chemistry with the conditions determining the formation of compounds, organic chemistry is mainly directed to synthetic processes, for which a knowledge of structure is essential. It is as an aid to this knowledge that Dr. Meyer's book has been written. That it has found favour with chemists and is regarded as a valuable addition to chemical literature is shown by the fact that within a few years of its first appearance the publication of a new and enlarged edition has been called for.

The volume before us has reached the respectable bulk of one thousand pages. The chief addendum is the second part, on the determination of the parent substance, containing chapters on oxidation, reduction, and alkaline fusion; many new methods have also been introduced, and older and less trustworthy ones discarded.

The book is too well known to need anything in the way of general description. It contains methods of elementary analysis, methods for determining molecular weights, for ascertaining qualitatively and quantitatively the presence of certain groups, and for breaking up the molecule into simpler fragments. One may look in vain for any serious omissions. On the other hand, the great variety of methods and the long lists of references are rather bewildering, and constitute, perhaps, the chief defect of the book. There has been, apparently, no attempt at critical examination. Every method and every modification of it seems to have found a place. The reader is left to make his own choice and to draw on his own experience.

We would take as an illustration the well-known method of Zeisel. The original and obsolete form of apparatus is described and pictured in detail, together with modifications by Benedikt and by the author (the latter being described as the simplest and most convenient), whilst the method of Perkin, generally adopted in this country, is only indicated by a reference along with five others.

We would not press this criticism too far. It is better to have too much information than too little, and if the reader has not the luck to discover at once the most suitable process, he will hit upon it in the end if he only perseveres.

It is needless to point out that the compilation of so much detail must have entailed immense labour, and has been carried out with painstaking German thoroughness. The book is well printed and illustrated, and should serve as a standard work of reference in the library of an organic laboratory.

(2) Twenty-five years ago Richter's "Organic Chemistry" appeared as a small companion volume to the one on inorganic chemistry. Since then each succeeding edition has steadily increased in bulk. A few years ago it was issued in two parts, and now it has been found necessary to enlarge the *format.* Nothing could illustrate more forcibly the growth of this branch of chemistry.

Whatever may have been the original purpose of the book, it has long ceased to be a text-book for students. One shudders at the thought of a student attempting to commit to memory such a mass of detailed information as is compressed into this volume It has developed into a portable book of reference, and as such is eminently useful and trustworthy for filling up gaps in one's knowledge as occasion requires.

Whilst deprecating the use of books of this type as class text-books, we do not share the feeling expressed by some that the bulk of new facts accumulated year by year in organic chemistry have little or no value, or that the motives which lead to their production are unworthy. The worst that can be said of multiplying compounds is that, without adding anything to the complexity of the subject, they fill in, as it were, the missing blocks in the picture puzzle, and merely complete what was anticipated; and as to the motives of those who produce them it may be pointed out that much of the research work of the compound-making type is done by young chemists as an exercise in that kind of skilful manipulation which counts for so much in every branch of chemical investigation, and for which organic chemistry seems so exceptionally well fitted. J. B. C.

THREE FISH-FAUNAS.

(1) *Catalogue of the Fresh-water Fishes of Africa in the British Museum (Natural History).* Vol. i. By G. A. Boulenger. Pp. xi+373; illustrated. (London: Printed by Order of the Trustees; sold by Longmans, Green and Co., and others, 1909.) Price 32*s.* 6*d.*

(2) *The Fishes of Illinois.* By S. A. Forbes and R. E. Richardson, Nat. Hist. Survey of Illinois. Vol. iii., Ichthyology. Pp. cxxxi+387; plates, maps to accompany above; pp. 103. (Illinois, n.d.)

(3) *Andrew Garrett's Fische der Südsee.* Part viii. By A. C. L. Günther, Hamburg, Journ. Museum Godeffroy, vol. xvi. Pp. iv+261–388; plates, 141–160. (Hamburg: L. Friederichsen and Co., 1909.) Price 60 marks.

(1) THE zoological survey of the Nile, undertaken by the Egyptian Government during the administration of Lord Cromer, and the explorations of the great Central African lakes, initiated in that country, together with those of the Congo, carried out by the Belgian authorities, have resulted in an enormous expansion of the collection of African freshwater fishes preserved in the Natural History branch of the British Museum. That collection, moreover, as we are informed in the introduction to the first of the three works forming the subject of the present notice, contains a very large proportion of the type-specimens of the many new species which have been described as the result of the aforesaid explorations. It was, therefore, from all points of view highly desirable that a descriptive catalogue of this vast collection should be published, as such a work will serve as a basis for the discussion of the many points relating to the distribution and origin of the African fish-fauna, and likewise as a book of reference for workers in Africa itself, from which it can readily be ascertained whether specimens belong to already described species.

Mr. Boulenger, to instance only his volume on those of the Congo, published by the Government of the Congo Free State, has already devoted much study to African fresh-water fishes, and for this reason, coupled with his official position at the Museum, he was obviously the man to undertake the laborious task of writing this catalogue, which, it is considered probable, will run to three volumes.

The present volume, at all events to others than ichthyological specialists, will probably prove the most interesting of the three, as it includes some of the most distinctive and aberrant types of the African fish-fauna. To many naturalists it will be of special interest to learn that a shark (*Carcharias zambesiensis*) inhabits the Zambesi at a distance of 120 miles from its mouth, and also that a saw-fish ascends this and probably other African rivers to a considerable distance. Of the characteristic and peculiar Ethiopian types, two of the most remarkable are the bichirs (Polypterus) and Calamoichthys, the sole survivors of the fringe-finned ganoids, and the mud-fish (Protopterus). No fewer than ten species of bichir are now recognised, although the allied genus is still represented by a single known member; and there are two kinds of mud-fish.

Next in point of interest to these ancient types are the remarkable fishes forming the exclusively Ethiopian family Mormyridæ, many of the members of which display such extraordinary vagaries in the matter of beak-development—a development which has suggested for the group the not inappropriate name of elephant-fishes. Of these strange fishes eleven generic types are now admitted, some of which, such as Mormyrops (with thirteen), include a large number of species. It may be hoped that before long the author will take an opportunity of giving us his views as to the origin of this family, which, if determinable, will add considerably to our knowledge of th origin and relationships of the African fauna generally.

The other important family treated in this volume is the Characinidæ, which has a distribution similar to that of the Lepidosirenidæ, being common to Africa and Central and South America. The number of African genera admitted in the volume before us is twenty. The characinids, like the lepidosirenids, have been frequently quoted as affording evidence in favour of a land connection between Africa and America, but before it can be decided whether they are of any value in lending support to that theory, it is essential that their past history should be known.

Although we have not much to say in the way of criticism, it may be mentioned that *Elops saurus* (p. 25) has recently been shown by Mr. C. T. Regan to occur only on the American side of the Atlantic, and that there are now three African species of the genus, viz. *senegalensis, machnata*, and *lacerta*, the last of which is alone admitted in Mr. Boulenger's volume as a valid species. Then, again, family rank might well be granted to the genus Chanos. On the other hand, it is satisfactory to find that the author has recognised the correctness of Dr. Gill's removal of the Kneriidæ from among the Haplomi, and their transference to the neighbourhood of the Cromeriidæ. Finally, it may be pointed out that in the definition of the Cladistia the item "nostrils on upper surface of snout" is true of all the fringe-finned group, while in the definition of the Teleostei the statement that the supports of paired fins are dermal bones, and not endoskeletal elements, surely seems to stand in need of revision.

The volume is illustrated with a number of text-figures, for the most part of excellent execution, although some of these—apparently on account of the figures having been photographed from lithographs—are not printed so clearly as is desirable.

Mr. Boulenger and the trustees are to be congratulated on the issue of this valuable volume.

(2) Turning to the fishes of Illinois, it has first to be mentioned that the account of these by Messrs. Forbes and Richardson occupies a volume of cxxxi+387 pages of text, this being accompanied by an atlas showing the distribution of each species in the State. We learn from the introduction that the collections and field observations upon which this elaborate monograph are based were commenced so long ago as 1876, and continued, at somewhat irregular intervals, down to 1903. The establishment of a biological station in 1894 on the Illinois River at Havana first rendered it practicable to introduce exact methods of study and observation, such as had previously been impossible, and at the same time enabled the field-work to be conducted with greater regularity and continuity. The quantitative method of investigation, which yielded such good results in the case of the plankton, proved equally successful when applied to ichthyology.

In addition to numerous uncoloured illustrations in the form of both plates and text-figures, the volume contains a large number of coloured plates of Illinois fishes, which are admirable examples of modern colour-printing, and present life-like portraits of the species they portray. The monograph may, indeed, be regarded as a first-rate specimen of the thoroughness and completeness with which biological work is nowadays carried on in the United States, and of the excellent style in which the results are presented to the public.

The volume commences with an elaborate account of the topography and hydrography of Illinois, which is divided into a north-western unglaciated area, the areas of the Iowan and Illinoisian drift, the area of the Wisconsin drift, and the unglaciated southern area. This is followed by an equally full account of the river-systems of the State, after which we are furnished with notes on the fisheries of Illinois. All this occupies what may be termed the introductory portion of the volume, paged in Roman numerals, while the remainder is devoted to systematic work.

A total of 150 different species of fishes are recognised in Illinois. In the absence of geographical barriers to their dispersal, the causes influencing their distribution appear to be climatic, geological, and ecological. Geological limitations are indicated in the southern portion of the State by the fact that the area covered by the Illinoisian lower glaciation is inhabited by a certain number of species to the exclusion of others. An interesting fact in distribution is afforded by the existence "of a marked difference in preference of situation between nearly related species inhabiting the same area, the effect of which is to break the force of a competition between these species such as would prevail if they were similarly distributed ecologically as well as geographically. Closely related species are, as a consequence, often found much less frequently associated in their common territory than either is with widely unlike species of the same geographical range."

The Illinois fishes include the remarkable spoon-beaked sturgeon (Polyodon), locally known as paddle-fish, and now valued both for its flesh and as a source of caviare; and likewise true sturgeons, referable to the typical genus, and to the two exclusively American genera Scaphirhynchus and Parascaphirhynchus. The most interesting of these is the white sturgeon (*P. albus*), which appears to be a very rare species, represented only by about one specimen out of every three hundred examples of the common shovel-nosed *S. platyrhynchus*. Gar-pike and bow-fins form other exclusively American types among the Illinois fauna, and a large number of the genera of "white fish" are likewise solely American. The European perch is, however, represented by a nearly related species, and the same is the case with the bream; but one of the pikes of Illinois is inseparable from the well-known British fish. The authors of this monograph are to be congratulated on having made such an important contribution to the geographical study of fishes.

(3) Congratulations are likewise due to Dr. Günther on the completion of his famous work on the fishes of the South Seas collected for the founders of the Godeffroy Museum at Hamburg. This museum, we may remind our readers, was established by the Messrs. Godeffroy, the well-known Hamburg merchants, for the reception of the natural specimens collected by the officers of their vessels, and Dr. Günther accepted the task of describing the fishes, on the condition, we believe, that a selection of specimens, including all types, should be given to the British Museum. The portions of the work previously published were issued between 1873 and 1881, but for financial reasons the publication came to an end in the latter year. Now, through the generosity of Dr. W. Martin von Godeffroy, the means of completing the work have been provided, and Dr. Günther has, fortunately, been enabled to bring his long-delayed task to a successful conclusion. It should be added that a number of coloured illustrations of the Godeffroy fish collection were prepared by Andrew Garrett, and from these some of the beautifully coloured plates accompanying the present volume have been reproduced.

Since the issue of the preceding part of the work great advances have been made in our knowledge of the fishes of the South Seas, more especially as regards those of the Sandwich and certain other islands; and to correlate this new work with the material in hand required a large amount of investigation. Fortunately, this work could be most effectively done at the British Museum, where a large series of the Godeffroy fishes are preserved, and where also large collections of fishes from the Indian Ocean are available for comparison with those from the South Seas. The result of these investigations and comparisons has been to produce order and certainty where uncertainty and chaos—as regards the identification of species and the determination of their synonymy—previously prevailed to no inconsiderable extent.

Littoral forms of fish-life occupy a considerable portion of the part now before us, although a section is devoted to flying-fish and other pelagic types; but the deep-sea fishes do not come within the purview of the work. Coral-fishes, or coral-wrasses, of the family Labridæ, are treated in the commencement of the present part, and the brilliant hues and remarkable colour-patterns of these gorgeous fishes are most admirably rendered in the accompanying plates. Our sole regret is that the author appears to have made no attempt to explain the mutual relationships and special purpose of these varied markings. Ichthyologists will greatly appreciate the author's careful revision of the large number of species of flying fishes inhabiting the South Seas; but students of the habits of animals will perhaps regret that Dr. Günther has maintained a cautious reserve with regard to the manner in which these fishes perform their aërial flight. Both the "aëroplane" and the "vibration" theories are mentioned, with references, but the author does not give even a suggestion as to which he considers to be the more probable explanation.

With the bare mention that no new species are described, we repeat our congratulations to Dr. Günther on the completion of his long-deferred task.

R. L.

OUR BOOK SHELF.

Further Advances in Physiology. Edited by Leonard Hill, F.R.S. Pp. vii+440. (London: E. Arnold, 1909.) Price 15*s*. net.

THIS is the second volume of original articles issued under the editorship of Mr. Leonard Hill. The first appeared about three years ago, and was reviewed in NATURE, May 3, 1906. That the publishers have seen fit to issue a second volume is an indication that the first was a success. The present volume treats of a number of interesting and important questions which have recently been subjects of research among physiologists, and the senior student is thus provided with a summary of the latest views which otherwise it would have been impossible for him to have obtained without much labour and exploration in many journals. The idea of the book is thus excellent; one's only fear is that in the presentation of a good deal of controversial matter even the best of students may sometimes lose himself and wish there was more agreement among physiological workers. In some of the articles more attention is paid to points of difference than to points of agreement, and general conclusions to help the reader in the maze are not always forthcoming. On the other hand, from the point of view of the researcher, the descriptions given of recent work are too fragmentary in some cases to be of any real help, though perhaps this may be wise, for anything which tempts the original worker to neglect reading the actual writings of his predecessors on the same road is to be deprecated.

The articles contained in the book are the following:—Prof. B. Moore opens with a consideraton of the equilibrium of colloid and crystalloid in living cells; Mr. M. Flack comes next with an article on the heart, in which, *inter alia*, he discusses the *pros* and *cons*. of the myogenic and neurogenic theories; Dr. T. Lewis deals with pulse records in relation to the events of the human cardiac cycle; the editor advances his heterodox views on the part played by blood-pressure on such phenomena as lymph production and secretion; Dr. A. Keith contributes an anatomico-physiological article on the mechanism of respiration; and Dr. M. S. Pembrey an extremely useful essay on the physiology of muscular work; the problems of growth and regeneration of nerve, and the nature of the nerve impulse, are then considered by Dr. N. Alcock; Dr. J. S. Bolton treats of cortical localisation, and Marie's views on Broca's aphasia are described; and the volume concludes with an article by Mr. M. Greenwood on visual adaptation and colour vision.

The mere enumeration of the subjects treated indicates the wide-reaching interest of the book, and the names of the authors are a sufficient guarantee that the work is well done.

Weltsprache und Wissenschaft. Gedanken über die Einführung der internationalen Hilfsprache in die Wissenschaft. By L. Couturat, O. Jespersen, R. Lorenz, W. Ostwald, L. Pfaundler. Pp. iv+83. (Jena: Gustav Fischer, 1909.) Price 1 mark.

THAT an international language for scientific communication is desirable no one will question; that an artificial language will ever be generally adopted for such a purpose is more than doubtful. If success in this direction is to be attained, it will probably be on the lines indicated in the present pamphlet, which is a kind of unofficial manifesto of the "Délégation pour l'adoption d'une langue auxiliaire internationale" appointed in 1900. A commission including scientific and linguistic experts of different nationalities is more likely to devise an acceptable language than any individual, who of necessity suffers from the prejudice of his mother-tongue and a comparatively limited knowledge of the requirements of the new medium. After seven years' deliberation, the international delegation has adopted most of the principles of Esperanto, but with great modifications in detail.

For Europeans and Americans the fundamental requisites of a common artificial language are:—(1) a simple phonology and alphabet, only such sounds being admitted as are in actual use amongst all the principal European peoples (exclusion of English *w* and *th*, German modified vowels, French nasals); (2) a vocabulary composed, as far as may be, of words comprehensible at sight to cultivated Europeans; (3) as little grammar as possible. These principles are generally followed in the new lauguage "Ilo," the Slavonic peculiarities of Esperanto (*e.g.* the circumflexed consonants and absurd terminal j's) being carefully avoided. The vocabulary has a distinctly Romanic appearance, and grammar is reduced to small proportions, which might with advantage be smaller still. Word-formation from stems by means of prefixes and suffixes is systematic, but needlessly complicated. Why should we, for example, have the prefix *bo-* to indicate relationship by marriage? "Father-in-law"=*bopatro* is not a necessary word; "wife's father" or "husband's father" is equally simple and more definite. Again, to use *-isto* for "professional" and *-ero* for "amateur" is making a rather superfluous distinction. It may be convenient occasionally to distinguish between *fotografisto* and *fotografero*, but in the case of, say, *dentisto* and *dentero* the necessity is not so obvious.

Notwithstanding its shortcomings, "Ilo" is a great advance on its predecessors, and men of science who are interested in the general scheme may be cordially invited to join the "Uniono di l'amiki di la linguo internaciona." But for the general adoption of the language much enthusiasm will be needed, and it is rather disquieting to read in a specimen sentence:—"Omna entuziasmo posedas per su la tendenco, ne klarigar, sed trublar l'okulo di l'intelekto."

Einführung in die Lehre vom Bau und den Verrichtungen des Nervensystems. By Prof. Ludwig Edinger. Pp. iii+190. (Leipzig: F. C. W. Vogel, 1909.) Price 6 marks.

THIS is an excellent work consisting of fifteen lectures on the various parts of the central nervous system. Dr. Edinger has a very pleasant way of introducing information concerning the functions of the nervous structures as he describes them, a feature which makes his works much more readable than those which give merely geographical descriptions of the parts under consideration. Another feature of the present work is that it keeps the reader constantly informed respecting the comparative anatomy and evolutionary antiquity of the particular structure he is studying.

The book consists of 190 pages, but there are probably less than 100 pages of letterpress owing to the generous way in which it is illustrated. There are no fewer than 161 diagrams, in addition to a plate showing the development of the Neencephalon over the Palæencephalon. The diagrams are so clear and helpful to the student that a mere smattering of knowledge of the German language is probably all that is necessary for the book to be a useful addition to his library.

The first chapter, on methods of investigation of the nervous system, is largely historical; the second is devoted to the study of the histological elements; while the third is a charming combination and correlation of the histology, physiology, embryology and comparative anatomy of the nervous system as a whole. The author then presents a general survey of the brain and spinal cord, and subsequently discusses the various tracts of the spinal cord and traces them from their origin to their termination. Then follow chapters on the pons, cerebellum, mesencephalon, basal ganglia and connections of the optic nerve. The last four chapters are devoted to the various portions of the cerebrum, the corpus striatum, connections of the olfactory nerve, the internal capsule, &c.

On p. 61 there are two diagrams of the root distribution of cutaneous sensation (front and back views) which, so far as our memory serves us, are not in accordance with the findings of Head, Starr or Thorburn, and we are inclined to think that Edinger's diagrams are incorrect.

The addition of an index to the book would greatly enhance its value.

Annuaire astronomique de l'Observatoire royal de Belgique, 1909. Published under the direction of G. Lecointe. Pp. vii+347+258. (Brussels: Hayez.)

OF the numerous publications of the Brussels Observatory, none is, perhaps, more generally useful than this "Annuaire," and we know of no other annual which excels it in general usefulness. All the usual tables, ephemerides, &c., relating to the sun, moon, planets, comets, and stars are contained in the first part, which is followed by explanations as to how to use the tables, and a long list of the names and positions of the principal observatories of the world. A very useful and explicit statement of the legal time used in various countries is clearly illustrated by a folding map, particoloured to show the countries which have so far adopted "universal" time and those which have not; the date line is shown in detail too.

Other parts of the "Annuaire" deal with surveying problems—there are some useful formulæ and forms for amateur surveyors—the form of the earth and the more recent work in astronomy. W. E. R.

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.*]

Mining Administration in India.

IN view of the recent attacks made in the London *Mining Journal* on Mining Administration in India, and also, both directly and indirectly, on the director of the Geological Survey, we have deemed it advisable to send you the following extracts, one of which is taken from the *Mining Journal* of June 26, p. 801, and the other from the published evidence given by Sir Thomas Holland before the Royal Commission upon Decentralisation, and published in Blue-book Cd. 4369 (vol. x. of Minutes of Evidence, p. 47):—

From the *Mining Journal* of June 26, p. 801, leading article, headed "Mining Administration in British India."	Evidence of Sir Thomas Holland, director, Geological Survey of India, published in Blue-book Cd. 4369, being vol. x. of the Minutes of Evidence taken before the Royal Commission upon Decentralisation in India, p. 47:—
"We cannot close our observations on the evidence tendered to the Commission without noting the light thrown by the report on the sincerity of Sir Thomas Holland's attempt to suggest that we had imputed corruption to Government officials in India. As an argument against the establishment of a separate Provincial Survey, the director of the Geological Survey said:—	Question No. 43455: "Is not an officer who has to deal with mining concessions in any part of the world subject to great temptation?"
"'If I transferred an officer, say, to Burma, or any province beyond my control, and he was the officer who governed the granting of mining concessions, I have not the slightest doubt that within a year, if he had only ordinary intelligence, he would discover that his salary *would*[1] be only a fraction of his income.' We do not remember even to have seen the chief of what is professedly a scientific body so frankly confess his distrust of his colleagues' honesty and professional pride."	"Yes; if I transferred an officer, say to Burma, or to any province beyond my control, and he was the officer who governed the granting of mining concessions, I have not the slightest doubt that within a year, if he had ordinary intelligence, he would discover that his salary *need*[1] be only a fraction of his income."

By changing one word in quoting the Blue-book, the *Mining Journal* has altered the whole meaning of the remarks made by the director. In view of the comments made, it is for the *Mining Journal* to prove that this misquotation is accidental. Having regard to the claim of the *Mining Journal* that it "circulates all over the world," the writer of the article must know that it will be read by many to whom the Blue-books are not accessible, for no assistance has been given by a reference to the particular volume in which the director's evidence is recorded. As the inaccurate quotation has already received a start of some weeks before reaching us in India, we shall be glad if, by publishing this letter, you will assist in preventing any further dissemination of a grossly unjust insinuation.

With this sample before them, we can safely leave your readers to estimate the value of the attacks on the Indian administration recently made in the *Mining Journal.*

Needless to add, the relation between us and Sir Thomas Holland is one of perfect and mutual confidence.

We have been unable to communicate with three of our

[1] The italics are ours.

colleagues, who are at present absent in the field, but we are convinced that if they had the opportunity they would join with us in appending their signatures to this letter.

T. H. D. La Touche, H. H. Hayden (Superintendents, Geological Survey of India).

P. N. Datta, E. Vredenburg, L. L. Fermor, G. E. Pilgrim, G. H. Tipper, H. Walker, K. A. K. Hallowes, G. de P. Cotter, J. J. A. Page, H. C. Jones, A. M. Heron, M. Stuart, N. D. Daru (Assistant Superintendents, Geological Survey of India).

W. A. K. Christie (Chemist, Geological Survey of India).

Geological Survey of India, Calcutta.

An Optical Phenomenon.

In reference to the query of "V. P." in Nature of June 3 (p. 398), under the above title, I describe a simple experiment which will, in all probability, lead to an easy explanation.

Allow sunlight to fall upon a vessel filled with water to a depth of a few inches. If the bottom be white, so much the better. A bath-tub is excellent. Now draw a finger through the water so as to produce a wake, in which are to be seen the familiar "dimples" characteristic of vortex motion. Then, on the bottom will be observed, corresponding to each dimple, a black shadow with a brilliant edge, just the same sort of appearance, in fact, as that described by your correspondent. The same, by the way, may be observed in shallow brooks.

The explanation in this case is not difficult. A very small central portion forms a concave lens, the enfeebled illumination of which on the bottom is negligible. The portion surrounding this and extending as far as the plane water-surface acts somewhat after the manner of a convex lens, concentrating the light passing through it into a more or less sharply defined ring, a "focal ring," so to speak, as contrasted with a "focal point." The diameter of this ring would approximate that of the whole dimple. By far the greater part of the light falling upon the area of the dimple is collected here, and, consequently, the field within appears black aided by contrast. It is easy to see that an essential is the relative smallness of the concave part of the dimple, as is borne out by failure to obtain the phenomenon on a large scale by stirring water in a beaker.

Now, following up this experiment and considering window-panes, one would expect to find there flaws of a dimpled nature, or else of a corresponding heterogeneity of refractive index. The former I have found to be the case, especially surrounding air-bubbles, as is easily to be detected by the touch in many cases. The formation of these flaws could be accounted for by the contraction of the air during cooling in process of manufacture. Moreover, in this instance, the bubble itself, forming the concave lens, need not always be small, since it is usually of a focal length far shorter than that of the surrounding portions of the pane.

Flaws of this type are rarer than those of an opposite or protruding type, which, of course, produce patterns with a white centre. L. G. Hoxton.

University of Virginia, July 26.

A Question of Percentages

In reply to the letter on the "Calculation of Percentages" in Nature of August 5, may I venture the opinion that the only common-sense method of finding the percentage of marks gained by a student in a series of examinations is to add together all the marks obtained by the student, and find what percentage this total is of the maximum possible?

By this method the more difficult papers, which have a greater number of marks allotted to them, retain an important proportion in the result, whereas the elementary papers, which are worth only a few marks, have only a small influence on the final percentage.

If one were to calculate the percentage for each paper, and then average these percentages, this would manifestly be the same as giving the same number (*i.e.* 100) of marks for each paper. This would necessitate equal difficulty in each paper set. Lewis Whalley.

39 Clarendon Street, Keighley, Yorks, August 13.

In Nature of August 5 Mr. Cunningham appeals to mathematical readers for information on the question of averaging three results, viz. :—

$$37/50+50/50+71/100,$$

either giving

$$(37+50+71)/200=79/100$$

or

$$(2\times37+2\times50+71)/300=81\tfrac{2}{3}/100.$$

Though I am not a mathematician, but a chemist, I trust I can give the required answer.

The way of averaging depends on the weight of the single results. By the latter way of calculating, the third result affects the average with twice the weight of the former way. Equal weights for each result require equal denominators. Taking for a very simple instance the problem of averaging between 20/100 and 40/100, which is obviously 30/100, the first way of averaging, as proposed by Mr. Cunningham, would permit a calculation like this (20/100 being=2/10=1/5, &c.) :—

$$2/10+40/100=42/110 \text{ or } 1/5+40/100=41/105,$$

or (40/100 being=400/1000=4000/10,000)

$$1/5+400/1000=401/1005 \text{ or } 1/5+4000/10{,}000=4001/10{,}005.$$

These results, I believe, will explain better than many words the essential point of this question.

Breslau, Parkstr. 13. R. Abegg.

Kohlrausch's "Physical Measurements."

Replying to the letter of Mr. Nelson in Nature of August 12, the value given for the k in question in the ninth German edition of "Kohlrausch's Lehrbuch der praktischen Physik" (1901) is 0·457. But it must be borne in mind that this value is deduced on the assumption that the specific gravity of the brass weights is 8·4, and seeing that the specific gravity of various samples of "brass" varies not inconsiderably, it is immaterial whether one uses 0·457 or 0·458 for the correction factor. The rounded value, 0·46, is near enough for most purposes, and that is the one given in the tables of Landolt-Birnstein. For accurate work the specific gravity of the weights must be determined in any case, and the value of k calculated for these particular weights.

G. Rudorf.

"Ivor," Cranley Gardens, Muswell Hill, London, N., August 12.

A Kinematical Illusion.

The following experiment is easily tried, and throws, I think, some light on a certain type of illusions.

A small cogwheel from an old American clock is the only apparatus required. Holding the axle in the finger and thumb of the right hand, give it a twirling motion, say counter-clockwise. Let the teeth of the wheel click gently against a small card, or the finger-nail of the left hand. On looking at the wheel the spokes appear to revolve counter-clockwise (as they do) and the teeth to revolve in the reverse direction. C. S. Jackson.

25 Nightingale Place, Woolwich.

RÖNTGEN RAYS IN THE DIAGNOSIS OF DISEASE.

GREAT development has taken place in the last few years in the application of Röntgen rays to the diagnosis of disease. At first it was only possible to show the shadows cast by bones and by dense foreign bodies, usually metallic bodies. With improvement in apparatus and in method, the art of radiography has advanced in such a way that it is now possible to show, not only the outlines of the bones, but minute details of their structure, and, more than this, a considerable amount of detail can now be shown in the soft parts of the limbs. While at first surgeons alone found X-ray diagnosis useful, as in the diagnosis of fractures, dislocations, and foreign bodies, the physicians have gradually been able to take advantage of the useful properties of the Röntgen rays, and, indeed, the physicians commenced the use of this method of diagnosis very early, since it was found that the heart and aorta cast a fairly distinct shadow. Before long it was shown that certain diseases of the lungs were also recognisable, and still later some of the other organs, notably the kidneys and the liver, were added to the list of organs which were accessible to Röntgen-ray diagnosis. At the present time, not only these various organs, but the entire length of the alimentary canal can be revealed and explored. Opacity to Röntgen rays is almost entirely a function of density. Of the substances which enter into the construction of the human frame, the least dense is air. The healthy lungs have their spongy tissue filled with air, and they are, therefore, the most transradiant organs of the body. The lungs are contained in the thin-walled chest, so that there is very little substance to interfere with their transradiancy. In examining the chest upon the fluorescent screen, it is seen that the act of deep inspiration increases the transradiancy of the lungs, the shadows cast by the ribs being shown up in greater contrast than during expiration. This is exactly what would be expected, since the spongy tissue of the lungs becomes blown up and filled with air during the act of inspiration. The heart and aorta are far denser organs, and they are shown up in strong relief against the background of the air-containing lungs. It is, therefore, quite easy to estimate the size, shape, and position of the heart and aorta.

It must be remembered that the shadow cast upon the fluorescent screen (or obtained by photography upon a photographic plate) is greater than the actual size of the organ. For some purposes it is important to obtain an accurate measure of the true size of the heart. In this case the X-ray tube—which nowadays is always enclosed in an opaque box or shield—is so arranged that there is only a small opening through which the X-rays can emerge and penetrate the patient's body. The apparatus is arranged so that the X-ray tube can be moved to any position in its own plane. If the tube be moved around the margins of the heart, and these margins be marked out upon the glass which covers the front of the fluorescent screen, an outline of the heart is obtained upon the glass, and represents the true projection of the heart in the plane of the fluorescent screen, and for practical purposes this may usually be regarded as representing the true size of the heart. The pulsations of the heart and of the aorta can be studied minutely upon the fluorescent screen.

Coming now to the lungs, it will be clear that any tumour or condensed area in the lungs will be shown up in relief against the air-containing healthy lung tissue. In this way the consolidation due to phthisis is shown even in the earliest stages of the disease. For instance, there may be slight diminution of transradiancy near the apex of one lung. On deep inspiration the whole of the lung becomes more transradiant, showing up the impaired apex in stronger contrast. There are other signs observable on the fluorescent screen in phthisis; thus the range of movement of the diaphragm is much restricted. In more advanced phthisis the congested areas are shown as dark shadows, and in very advanced disease where there are cavities in the lung these cavities are frequently visible as lighter areas with irregular outlines surrounded by a darker area of congested lung. Other diseases of the chest, tumours in the glands, cysts, &c., are shown against the light background of the healthy lungs.

When there is fluid accumulated in the pleural cavity, *i.e.* between the chest wall and the lungs, it is necessary to examine the patient in the upright position in order to obtain the effect of gravity in causing the fluid to take up a position at the base of the chest. Fluid in the chest is very opaque when compared with the transradiancy of the lungs. When fluid begins to collect in the chest it is found at the most dependent part of the chest, where the diaphragm is attached to the chest wall. As the fluid accumulates, the opaque area increases upwards, its upper limit forming a curved line concave upward, the direction of which is from the middle line of the body upward and outward. The greater the quantity of fluid, the higher and the steeper does the position of this line become, but with increasing accumulation of fluid the lung itself, which is floated up upon the fluid, becomes more and more compressed, and, therefore, less and less transradiant, so that the line which separates the liquid from the lung becomes more and more ill-defined, and finally disappears altogether, the whole of this half of the chest becoming uniformly opaque, since the lung itself has become so greatly compressed that it no longer contains any appreciable quantity of air. As the fluid accumulates, it is observed that the heart becomes displaced further and further to the opposite side of the chest.

The foregoing description refers to cases in which there is an accumulation of liquid only, but in other cases (known as hydropneumothorax) not only is there a collection of liquid in the pleural cavity, but there is also free air in this cavity. In this case the appearances are fundamentally altered, for there is now a sharply-defined horizontal line of demarcation between the liquid and the air. The lung itself is collapsed, and usually occupies a small space close against the middle line of the body. The heart is displaced to the opposite side of the chest. We have here the physical conditions of a liquid contained in a vessel and placed in air. On tilting the patient, the liquid is at once seen to flow in a direction which enables its upper surface again to become horizontal. If the movements of the patient are fairly rapid, waves are produced in the liquid, and this is still better seen if the patient shake himself or be shaken. It frequently happens that the heart beats against the liquid and sends a regular series of waves along the surface of the liquid. Hitherto, in forming their opinion as to the nature of diseases of the chest, physicians have been dependent upon the information derived from the application of percussion and auscultation, and although very accurate information can in many cases be obtained by these methods, a Röntgen-ray examination is still of great importance in confirming the conclusions obtained from the other clinical methods of examination, and in supplementing information thus obtained. Thus in phthisis the degree and extent of the affected lung is shown with far greater accuracy by the Röntgen-ray method than by the methods of percussion and auscultation, and in many cases pulmonary lesions which are quite unrecognisable by percussion and auscultation may be clearly shown upon the fluorescent screen. In other cases the Röntgen-ray examination leads to a diagnosis entirely different from that obtained by percussion and auscultation.

In the examination of the abdomen, the conditions are very different from those which prevail in the case of the chest. There is usually no air in the abdominal cavity except such as may be contained in the stomach or in the large intestine. Consequently, the only structures which stand out in strong relief are the bones, viz. those of the vertebral column, the hip bones, and the lower ribs. There is a way, however, in which the conditions in the abdomen may be made more to resemble those found in the chest. Air may be forced into the large intestine, and its passage along the course of the intestine followed on the fluorescent screen. The air forms a very definite band of relatively high transradiancy. The size, shape, and position of all parts of the large intestine can usually be traced out by this means. The presence of air has a further advantage in that the solid organs of the abdomen stand out in sharp relief against the light background formed by the air-containing large intestine. Thus the lower edge of the liver is shown up as a well-defined margin; the upper margin of the liver is always obvious, as its domed surface lies in contact with the diaphragm on the right side, and has the base of the right lung immediately above it. On viewing the patient's back (especially if he lie prone on a couch with a loosely filled air-pillow under the abdomen, the X-ray tube being contained in a box under the couch), the shadows of the kidneys are shown one on each side of the vertebral column, and their movements up and down with respiration are easily observed. Should either kidney contain a calculus (stone), this is shown on the fluorescent screen, and it is seen to move with the kidney on respiration.

In a large proportion of cases in which there are symptoms suggesting the presence of a calculus, the Röntgen-ray examination shows that no calculus is, in fact, present. On the other hand, cases are by no means uncommon in which one or more calculi are found by the Röntgen-ray examination, when the clinical examination had led to an entirely different diagnosis. In these cases the calculi may be removed by the surgeon, and the patient cured.

There is another, an indirect, method of studying the digestive canal. For this method we are indebted to Prof. Rieder, of Munich, who discovered that large doses of bismuth salts may be given to patients without fear of ill effects. The salt used by Rieder in the first instance was the sub-nitrate. Unfortunately, several cases occurred in America in which the administration of large doses of sub-nitrate of bismuth was followed by fatal results, and we now know that this result was due to the formation of nitrous acid in the stomach, probably through the action of bacteria. The carbonate of bismuth is now commonly used, and it is a perfectly inert and harmless substance. Two ounces is the dose usually employed, though three or four ounces may be given at a time. It is important to use a pure preparation, for the presence of arsenic or selenium as an impurity becomes an important source of danger where large doses are used.

By placing the patient upright in front of the X-ray tube, and trans-illuminating him in an oblique direction, the course of the food-pipe is revealed, occupying a clear space in front of the vertebral column. If the patient be now given an emulsion containing about two ounces of carbonate of bismuth to drink, the course of this drink from the mouth to the stomach can be observed upon the fluorescent screen, as the bismuth-containing fluid throws a very opaque shadow. Any obstruction in the food-pipe, or any deviation in its course, at once becomes apparent. The bismuth having passed through the food-pipe, it is now seen in the stomach occupying the most dependent part of that organ. The opening in front of the X-ray tube-box is now closed down to a small size, and this part of the stomach is examined in detail. The regular contractions by means of which the contents of the stomach are expelled into the small intestine may now be observed, and any irregularity in the shape of the stomach or obstruction at its orifice is clearly shown.

Some hours later the course of the bismuth meal may be clearly traced in its path through the large intestine, and here again the exact size, shape, and position of all parts of the large intestine is shown in strong relief through the opaque mass of bismuth with which the fæcal masses are mixed. These bismuth meals thus constitute a most valuable diagnostic method, and pathological conditions, the recognition of which is of extreme importance, are frequently shown in a manner more certain than is to be obtained by any other means of diagnosis.

One of the newest books dealing with the Röntgen-ray method of diagnosis as applied to diseases of the chest is that of Dr. Hans Arnsperger.[1] Improved apparatus and improved methods have led to so rapid an advance in this branch of study that few physicians have been able to keep pace with it. The literature is already large, and is rapidly extending. Dr. Arnsperger has given a full review of the literature, and has made a full and laborious exposition of the subject. He has lost no opportunity of discussing the application of the Röntgen-ray method to the elucidation of contentious problems in physiology and pathology. It is true some of the physiological views expressed by those who have studied the Röntgen-ray appearances do not tally with the results of physiological experiment; still, many important practical questions are discussed in a useful manner.

Dr. Arnsperger is careful to lay emphasis on the importance of using the Röntgen-ray method in conjunction with other clinical methods of diagnosis, for it is rarely safe to rely on a Röntgen-ray examination unassisted by a knowledge of the clinical history of the case. It is true that in a case of phthisis (for instance) the extent and distribution of the disease may be shown with great accuracy on the fluorescent screen or on a photographic plate, but in other cases the Röntgen-ray picture is capable of various interpretations, and the most useful information will be derived from the Röntgen-ray examination if the clinical aspects of the case are fully known. Dr. Arnsperger points out the advantages of the fluorescent-screen examination as compared with the examination of skiagrams. Screen examinations enable observations to be made of the living processes in the body, the movements of respiration, the beating of the heart, the pulsation in the aorta, the peristaltic contractions of the stomach, and so on. Skiagrams are chiefly useful in enabling permanent records to be obtained of the appearances described. In some cases, however, the skiagram shows more detail than is to be seen on the more coarse-grained fluorescent screen, and this applies particularly to the quiescent parts of the body, notably the bones and joints. Dr. Arnsperger's book contains twenty-seven plates, upon which fifty-two photographs are reproduced by the half-tone process. It is unfortunate that no known process of reproducing photographs in print represents successfully all the detail which the original negatives show.

A. C. J.

THE CYANAMIDE INDUSTRY OF FRANCE.[2]

IN 1895 Frank and Caro laid the foundations of an important industry by discovering that barium or calcium carbide absorbs nitrogen at a temperature of 800°, and is converted into a cyanamide. They expressed the change by the following equation:—

$$CaC_2 + 2N_2 = CaCN_2 + C.$$

The cyanamide thus produced is a useful nitrogenous manure of the same class as ammonium sulphate, but has the further advantage of adding a calcium compound to the soil.

[1] "Die Röntgenuntersuchung der Brustorgane und ihre Ergebnisse für Physiologie und Pathologie." By Dr. Hans Arnsperger. Pp. 263+27 plates. (Leipzig: F. C. W. Vogel, 1909.) Price 12 marks.

[2] A paper by M. Pluvinage in the Bulletin de la Société d'Encouragement pour l'Industrie Nationale, No. 3, vol. iii.

Cyanamide is made in France at the village of Notre Dame de Briançon, near to Montiers (Savoie). Abundant water-power is available, and is, of course, an essential condition for the success of the industry. At the power station there are now three turbines of 2200 h.p., but provision is made for more when necessary; these produce a three-phase current of 15,000 volts, which is conducted a distance of 11 km. to the factory. There it is transformed; part is used for making calcium carbide, and part for making cyanamide. The calcium carbide obtained has a purity of 80·5 per cent., estimated with sufficient accuracy by measuring the volume of gas evolved on treatment with water. Nitrogen is prepared by Linde's method. Liquid air is fractionated, and the vapours made to pass through a column, where they meet with liquid air, and then, higher up, with liquid nitrogen; in these circumstances, the percentage of oxygen in the issuing vapours is reduced to 7, and then finally to zero.

The calcium carbide is broken up and placed in an electric furnace, about 300 kilos. forming the charge. It is raised to a high temperature in presence of a stream of nitrogen; the operation may last from eighteen to fifty-six hours. The resulting hard mass is then reduced to a fine powder. The daily production is at present 10 tons, but this output could readily be doubled. It is estimated that 2 tons of carbide can be produced per kilowatt per year, and that 2 tons of carbide combine with 500 kilos. of nitrogen. Two grades of cyanamide are sold—one containing 15 per cent. of nitrogen, *i.e.* the quantity present in nitrate of soda, the other containing 20 per cent., the quantity present in sulphate of ammonia. The latter grade also contains 20 per cent. of lime, 7 to 8 per cent. of silica, oxides of iron and aluminium, and 14 per cent. of free carbon, to which the dark colour is due.

When added to the soil, it is rapidly decomposed by bacteria to form calcium carbonate and ammonia thus:—

$$CaCN_2+3H_2O=CaCO_3+2NH_3.$$

The ammonia is then nitrified and taken up by plants.

Direct field trials to ascertain its manurial value were first made in 1901 by Gerlach and Wagner, and have since been repeated in other countries. All experiments prove its value, and show that it is comparable in its effects with sulphate of ammonia. It should be applied before sowing, and may be mixed with basic slag or potassic manures, but not with superphosphates. The dressing recommended is 150 kilos. to 250 kilos. per hectare, or $2\frac{3}{4}$ cwts. to $4\frac{1}{2}$ cwts. per acre, the smaller dressing for cereals, the higher for potatoes and beets. In England it would not be customary to use for these crops more than half the above quantities of "artificial" nitrogenous manures.

THE "PREHISTORIC HORSE" OF BISHOP'S STORTFORD.

A COMPLETE skeleton of a horse was recently found during excavations at Bishop's Stortford. As this skeleton lay in an extended position some six feet below the surface in a deposit which had apparently never previously been disturbed by man, it is conceivable that it belongs to a wild variety which inhabited England in prehistoric times. The Rev. Dr. Irving first thought the skeleton might belong to Hipparion (*Standard,* May 24), but he eventually came to the conclusion that it is the remains of a horse of the Neolithic or Bronze age.

Unfortunately, it seems to be impossible to determine the age of the deposit in which the skeleton was found. The examination of the skull, teeth and limbs indicates that the Bishop's Stortford horse differs from all the known wild horses of the Pleistocene period—from, *e.g.*, the small, stout horse of the "elephant" bed at Brighton; the small, slender-limbed horse of the Oreston Cavern, believed by Owen to be an ass or a zebra; the Prejvalsky-like diluvial horse of Remagen; and the coarse-limbed horse of Westeregeln. On the other hand, the horse described by Dr. Irving and figured in the *Illustrated London News* (June 5) closely resembles a variety from Walthamstow believed to be of Neolithic or Bronze age. This Walthamstow horse was probably a blend of a "forest" and a "steppe" variety in which the broad-browed forest ancestors were dominant. The limb bones indicate that the Bishop's Stortford horse measured from 14 to 14·2 hands (56 to 58 inches) at the withers—several inches more than the Walthamstow horses represented in the British Museum.

It is generally assumed that the horse did not live under domestication in Britain until the end of the Bronze or the beginning of the Iron age, and that the native British horses up to the coming of Cæsar were too small to carry men. The Bishop's Stortford horse was, however, as large and powerful as the Galloways used in border raids. Should the Bishop's Stortford horse be proved to be of Neolithic or Bronze age, we may have to modify our views as to the size of the horses in the possession of the ancient Britons. For an opportunity of examining the skull and limb bones of the Bishop's Stortford horse, I am indebted to the Rev. Dr. Irving.

J. C. EWART.

METEOROLOGICAL STUDIES AT THE BLUE HILL OBSERVATORY.[1]

(1) THIS is an account of the methods employed and the results obtained at St. Louis. Seventy-seven ascensions were made, and in most cases good traces were obtained. The funds were supplied partly by grants from the Exposition Company and from the Hodgkins fund of the Smithsonian Institution, and the remainder by Prof. Rotch.

A very large proportion of the balloons were found, a proportion looked upon with envy by those engaged in similar work in England, and this occurred notwithstanding the fact that they were mostly sent up in the evening to escape the chance of solar radiation.

A full description of the method of working and of calibrating the instruments is given, and every care seems to have been taken to secure accuracy in the results; but it is incorrect to say that the only method of making the registration yet devised is that of writing on a smoked metal surface. The plan of scratching on an electro-plated but unpolished silver surface has answered excellently in England, and Mr. Field's plan of using glass silvered lightly by the ordinary solution seems to be quite satisfactory.

The results from each ascent are published in full, and it appears that about half the ascents afforded records up to 10 kilometres in height. The general conclusion is in striking agreement with that obtained

[1] (1) "Exploration of the Air with Ballons-sondes at St. Louis and with Kites at Blue Hill." By H. Helm Clayton and S. P. Fergusson. Pp. 92; 11 plates. (Cambridge, Mass.: The Observatory, 1909.)
"Annals of the Astronomical Observatory of Harvard College." Vol. lxviii., part i., Observations and Investigations made at the Blue Hill Meteorological Observatory, Massachusetts, U.S.A., under the direction of A. Lawrence Rotch.
(2) "Annals of the Astronomical Observatory of Harvard College." Vol. lviii., part iii., Observations and Investigations made at Blue Hill Meteorological Observatory, Massachusetts, U.S.A., in the year 1905, under the direction of A. Lawrence Rotch. Pp. 147-228; 2 plates. (Cambridge, Mass.: The Observatory, 1908.)

on the Continent and in England, excepting that the minimum temperatures are somewhat lower there than on this side of the Atlantic. This is probably on account of the lower latitude. The gradients for the various seasons are given, but the distribution of the ascents is not wide enough to make these figures of much value. Thus the value of the upper part of the gradient for the spring is obtained from ascents on sixteen consecutive days in the spring of 1906, and we have no ground for assuming that these sixteen days represent the average spring conditions.

There is also a discussion of the results obtained from the kite ascents at Blue Hill. The values of the pressure, of the departures from the normal of the temperature, of the humidity, and of the direction and strength of the wind at different heights are plotted for the various segments of cyclones and anticyclones, and the curves and tables are well worth careful study.

(2) In addition to the ordinary observations and to those made by means of kites during the year, there is a general summary for the period 1901–5, and a table of mean temperature for the twenty years 1886–1905. Although the great difference of climate on the eastern and western sides of the Atlantic is well known, one cannot help feeling surprise on being reminded by a publication of this sort how great the difference is. Thus at Blue Hill, in latitude 42° 12′ 44″ N., a latitude further south than any part of France, and, be it remarked, closer to the Gulf Stream than many parts of England are to the Atlantic, we find that, on the average, the ponds are covered with ice from the end of November to the end of March, while in England, 10° further north, few people under twenty-five years are able to skate, owing to the almost total absence of opportunity during recent years. The difference is, of course, due to the prevailing westerly winds, which bring the temperature of the Atlantic to western Europe and the continental temperature of North America to the Atlantic coast of Canada and the United States.

There is also a very interesting account of the meteorology of total solar eclipses by Mr. H. Helm Clayton. In the brief space of a review it is not possible to refer to this in detail, but the tables give a collection of the changes that have been observed on various occasions. The temperature effect is perfectly plain, and is shown to vary with the intensity of the natural solar radiation at the time and place. It is pointed out how difficult it is with the other elements to separate the changes due to the eclipse from the casual and diurnal changes that are going on at the same time, but it appears to be proved that the barometer and hygrometer are influenced.

The shadow bands of the eclipse are discussed by Prof. Rotch, who comes to the conclusion that they are produced by rays from the narrow crescent of light passing through strata of different refractive index, the motion being due to the wind.

AUGUST METEORIC SHOWER.

On August 10 the sky was watched for 1¾ hours, but only 19 meteors were noticed, of which 12 were Perseids. The shower seemed disappointingly feeble.

On August 11 it became evident that the display had greatly intensified. In 2¾ hours before midnight 73 meteors were counted, and they were nearly all Perseids from 46° + 58°. Very few large ones were seen; in fact, the meteors were generally small, and the display could not be regarded as a very conspicuous one. The sky became rather foggy towards midnight, and many small meteors must have been hidden. The vapour increased, and next morning after sunrise there was a thick autumn-like fog, which was not dispersed until the sun had risen high.

On August 12 the atmosphere was beautifully clear when night came in, but meteors appeared to be scarcely so numerous as on preceding night. They were, however, of astonishing brilliancy, and made the shower a very attractive and notable one. In all 65 meteors were counted between 9h. and 12h. 52m., but clouds partially veiled the sky after 11h. and obscured many which would otherwise have been seen. Relatively to the total number counted, I have never, within a long experience, remarked such an abundance of fine, flashing meteors. Their long, graceful flights and highly luminous trails added to the interesting and striking nature of the spectacle. A fireball at 9.42 gave a lightning-like flash, and must have presented its best effect to observers at London and in the eastern counties. The following were the recorded paths of a few of the most brilliant objects :—

Aug. 12 h. m.	Mag.	Apparent path ° ° ° °
9 42	3 × ♀	5 +27 to 357 +15
9 42	♃	330 +19 ,, 320½ + 4
9 51	>1	7 +53 ,, 343 +40½
10 4	♃	302½ +37 ,, 291 +22
10 4	1	302 + 8 ,, 292 − 8
10 4	♃	265 + 1 ,, 259 −15
10 18	♃	352½ +24 ,, 340 + 3½
10 14	1	17 +37 ,, 12½ +30
10 19	♃	349 +51 ,, 318½ +34
10 37	>1	342½ +25 ,, 326½ + 6
10 43	>1	358 +62 ,, 332 +51
10 46	♃	349 +31 ,, 331 + 9
10 49	>1	18 +20 ,, 12 + 1

These were all Perseids, and duplicate observations would be valuable as furnishing data for the computation of the real paths. The very clear summer weather has recently offered an almost unique opportunity for studying the progress of the shower during its approach to the maximum.

The finest meteor which appeared during the display was recorded on August 12 at 9h. 42m. It lit up the sky like a flash of lightning, and left a streak which remained visible for several minutes. The fireball was observed at Bristol by the writer, and also by the following :—Observers at Greenwich; Dr. W. J. S. Lockyer, London; Howard E. Goodson, S. Kensington; H. Wilkie, Bognor; R. Langton Cole, Havant; J. S. Sowerby, Tatsfield, Surrey; T. K. Jenkins, Blama; George Powell, Aberdare. The meteor was a magnificent specimen of the Perseids, and was quite noteworthy, even during a shower which consisted of unusually brilliant members. Its radiant point was at about 47° + 58°, and it passed over the earth from above a point ten miles W. of Ipswich to a point about 15 miles E. of Croydon. Its height was from 87 to 53 miles, length of path 68 miles, and velocity about 35 miles per second. The observations from Hayling Island, Bristol, and S. Kensington are in excellent agreement. The streak was generated in the latter portion of the flight. As viewed from Bristol, the nucleus brightened several times, and just where the outbursts had occurred the streak exhibited sections which were intensely luminous. From Hayling Island this streak lay 4 degrees under α and δ Cassiopeia, and during the short interval it remained in sight it assumed a serpentine form and drifted two or three degrees to the westwards.

The following are particulars of four brilliant meteors recently seen and estimated = ♃ :—

Date	Aug. 8	Aug. 10	Aug. 11	Aug. 12
G.M.T.	10.8	11.15	9.57	10.19
Height at first	94 m.	87 m.	103 m.	78 m.
,, end	65 ,,	52 ,,	48 ,,	52 ,,
Length of path	58 ,,	62 ,,	110 ,,	52 ,,
Velocity per sec.	48 ,,	40 ,,	—	30 ,,
Radiant	41+57	43+56	43+58	47+58

On August 13 the watch was continued, but the Perseid shower had greatly declined. About 25 meteors were recorded in about 2 hours before 11h. 45m. (when clouds came over), and of these 11 only were Perseids.

On August 14, observing for a similar interval, 19 meteors were counted, including 7 Perseids. The principal minor shower seen at Bristol recently was at 302° + 22° in Vulpecula, and the same radiant was well marked in 1908, both in July and August.

W. F. Denning.

NOTES.

On Monday, August 16, an exhibition of manuscripts, portraits, medals, books, and natural history specimens illustrative of Darwin's life and work was opened to the public in the central hall of the Natural History branch of the British Museum. Although most of the special portion of the exhibits is displayed in one of the bays on the right side of the hall, a table-case, containing illustrations of the fertilisation of plants by insects and other animals, and a second devoted to insectivorous plants, have been placed in the middle of the hall. In addition to these, several of the permanent cases in the hall, such as those illustrating melanism, albinism, adaptation to natural surroundings, and the breeds of domesticated pigeons, are included in the exhibition. In order that the public may properly appreciate and understand the exhibition, an excellent little guide-book has been published, at the price of sixpence, in which, in addition to a brief but comprehensive biography of Darwin, and a photograph of the Darwin statue in the museum, will be found clear explanations of the leading features of the more important exhibits. These exhibits, apart from the two botanical cases, form a total of no fewer than 251, and certainly make a most instructive and interesting display. In the compilation of the guide-book it would have been better had the author avoided the use of words of the type of "exoskeleton," which are certainly not understood by the general public. As regards the specimens displayed, we must refer our readers to the guide, or, better still, to the exhibition itself.

The fourth International Congress of Aëronautics will be held at Nancy on September 18–24.

Mr. H. E. Harrison, principal of Faraday House, and a fellow of several scientific societies, died on August 12 at fifty years of age.

Captain H. E. Purey Cust, R.N., assistant hydrographer of the Navy, has been appointed hydrographer in succession to Rear-Admiral A. M. Field, F.R.S., whose term of office in that appointment has expired.

Reuter messages from Tokio report that a severe earthquake was felt at 3.30 p.m. on August 15 throughout Central Japan. Much damage was done to the important commercial city of Nagoya, which was practically destroyed by the earthquake that visited the district in 1891. Considerable damage is stated to have been done in part of the Shiga Prefecture.

We learn from the *Times* that on August 12 the Italian balloon *Albatross*, manned by Lieut. Mina and Signor Piacenza, and starting from Turin, reached the height of 38,715 feet, at which point one of the two aëronauts opened the valve. The highest altitude previously attained in a manned balloon was 35,500 feet, reached by Berson and Süring on July 31, 1901. The new record is equivalent to an altitude of 7·3 miles, and shows the great heights which can be attained when improved means of respiration are employed.

We record with regret the death, on August 14, of Mr. William F. Stanley at eighty-one years of age. Mr. Stanley was well known as a maker of scientific instruments; in 1856 he invented the first simple open stereoscope, and later he designed and manufactured scientific instruments for the use of various Government departments. He was the author of several text-books, and in 1895 he published "Notes on the Nebular Theory in Relation to Stellar, Solar, Planetary, Cometary, and Geological Phenomena," the book being reviewed in the issue of Nature for November 14, 1895 (vol. liii., p. 25). In addition to other beneficent acts, Mr. Stanley erected and equipped at Norwood the Stanley Technical Trade Schools, where boys are educated on thoroughly practical lines. The schools have been endowed adequately, and are for the future to be administered by the Charity Commissioners.

As has been already announced, the ninety-second annual meeting of the Société helvétique des Sciences naturelles will be held this year at Lausanne on September 5–8. The business of the meeting will be conducted in six sections, as follows:—section of physics and mathematics, president, Prof. H. Dufour; chemical section, president, Prof. H. Brunner; section of geology and geography, president, Prof. Lugeon; agronomic section, president, Prof. E. Chuard; botanical section, president, Prof. E. Wilczek; and the section of zoology and physiology, president, Prof. E. Bugnion. On September 6 two lectures will be delivered, one by Prof. S. Finsterwalder on aërodynamics in aviation, and the other by M. Auguste Forel on comparative psychology, determinism, and the theory of memory. Three lectures will be delivered on September 8 at Vevey, as follows:—M. Fritz Sarasin, on the history of the animal life of Ceylon; M. Raoul Gautier, on some recent important results furnished by astronomical photography; and M. Martin Rikli, on the natural history of Greenland. Full particulars of the meeting may be obtained from the general secretary, Prof. Paul L. Mercanton, the University, Lausanne.

To *Annotationes Zoologicae Japanenses*, vol. vii., part ii., Dr. N. Annandale, of the Indian Museum, communicates a paper on Japanese freshwater sponges, in which an apparently new species is described. Of the five known Japanese species, three are widely distributed and the other two peculiar to Japan.

The combined July and August issue of *Naturen* contains an important paper, by Messrs. Bjon Helland-Hansen and Fridtjof Nansen, on annual fluctuations in the mean temperature of the sea on the Scandinavian coast and their influence on the climate, agriculture, and fisheries of Norway. The paper is illustrated with a large number of temperature-charts.

In the August number of the *Irish Naturalist* Mr. C. B. Moffat suggests that one reason why certain species of birds construct covered nests is to enable them to rear a larger number of nestlings than would otherwise be possible. The author supports this theory by mentioning that out of the eight species of Irish birds which make domed nests, six lay larger clutches of eggs than birds which are content with open nests.

THE August number of *British Birds* contains reproductions from eight very remarkable photographs of a water-rail taken by Miss E. L. Turner. Some of these exhibit the bird in the act of removing its young from the nest; but whether this action represents a normal or an abnormal trait remains to be decided. To have obtained these beautiful photographs of such a shy and wary bird as the water-rail is a great triumph for the artist. We may also refer to a note by Mr. F. J. Stubbs, in which attention is directed to the fact that on certain Yorkshire grouse-moors there is no heather or heath, the place of which is taken by crowberry, and that on such grounds the birds, so far as can be ascertained, are free from disease.

WE have to welcome a new biological serial, the Transactions of the Royal Society of South Africa, of which we have received the first part of vol. i., comprising 319 pages of text and twenty-four plates. Among the more important articles, reference may be made to Mr. R. B. Newton's report on Cretaceous shells from Zululand. Many of these are identical with or nearly allied to South Indian Cretaceous forms, especially those from the Trichinopoli group; and it is specially interesting to note that some of these indicate a connection between the Cretaceous fauna of Trichinopoli and Angola. This suggests that the great tropical land-barrier shown in Neumayr's map of the Jurassic epoch had become partially broken up by Cretaceous times. Another important communication is the first part of Dr. L. Péringuey's descriptive catalogue of South African Coleoptera, dealing with the family Meloidæ.

OWING to a severe outbreak of a fungal disease in the mulberry nurseries near Srinagar, connected with the silk industry in Kashmir, Dr. E. J. Butler was deputed by the Indian Government to investigate the matter. The results of his investigation are published in the Memoirs of the Department of Agriculture in India (vol. ii., No. 8). The disease was traced to *Coryneum mori*, a fungus of the Melanconiales, previously recorded only from Japan. The fungus is a wound parasite which found its opportunity after a severe frost; it was also discovered on mulberry trees outside the nursery, and on a jungle tree, *Celtis caucasicum*. Reference is also made to three other fungi: *Septogloeum mori*, producing leaf-spot; *Phyllactinia corylea*, a mildew; and the bracket-fungus *Polyporus hispidus*—none of which, however, were doing much damage.

THE curious instances of polymorphism in the flower which occur in the orchid Cycnoches are described by Mr. R. A. Rolfe in the *Kew Bulletin* (No. 6), where he provides a revision of the genus. The production of flowers so different in appearance puzzled Lindley and other botanists until the solution was found in the dissimilarity between staminate and pistillate types. Nine species are recorded for which both types are known, and in six cases only the staminate flowers have been definitely identified. Two sections of the genus are recognised; in the Eucycnoches the difference lies chiefly in the column and attached sexual organs; in the Heteranthæ the distinction is more marked, as the staminate flowers are smaller, sometimes different in colour, and the lip is reduced to a small disc margined with clavate teeth.

INVESTIGATIONS on abstruse points in plant morphology have within recent years engaged the attention of several Austrian botanists. Two papers appear in the *Bulletin International* (1907), the official publication of the Académie des Sciences de l'Empereur François Joseph I., Prague. Miss M. Doubek contributes a discussion of the much-debated nature of the tendrils in the Cucurbitaceæ. An explanation is constructed on the hypothesis of adnation by different axes. The least complex examples—they cannot be described as simple—are furnished by Luffa and Cucurbita, but the author also offers solutions of the more difficult cases provided by Bryonia, Cyclanthera, and other genera. The second paper, communicated by Dr. B. Nemec, deals with regeneration in the unifoliate plant *Streptocarpus Wendlandii*. Some of his experiments were made with irregularly regular specimens bearing two well-developed cotyledons.

THE arrangement of the botanical garden of the Johns Hopkins University, which is described in the University Circular (No. 217), shows some novel features. The garden, which is being established primarily as an aid to botanical research and instruction, is divided into four sections. Two are planned for the cultivation of typical forms illustrating vegetative and reproductive organs. The third is devoted to plant relationship, as exemplified by species, genus, &c., extending to systems of classification for which Engler's system is selected for complete exposition. The fourth section contains two divisions, one for economic, the other for cultivated plants. The latter should be quite the most interesting feature in the garden. The three genera Dianthus, Rosa, and Chrysanthemum are chosen as types to indicate the origin and natural relationship of horticultural races. Cultivated roses are arranged under fifteen sections, and in addition eight groups of hybrids are illustrated.

A PAMPHLET published by the Hawaiian Sugar-planters' Association as Bulletin No. 9 of the division of pathology and physiology is devoted to an investigation by Messrs. L. Lewton-Brain and Noël Deerr of the bacterial flora of Hawaiian sugars. Sugar agar was the most satisfactory medium, as, for some reason undetermined, it was impossible to get a good gelatin preparation. Another difficulty was presented by what the authors term a "weed-bacillus" that produced its spores within twenty-four hours, and so escaped sterilisation. The practical object was to isolate and identify types of bacteria with the view of studying their action on moist sugars. Five different types were distinguished by the shape of the individuals or of the colonies formed in different media; their general action is to reduce the sucrose and form invert sugar, gum, or other products in sugars containing 1 per cent. or more of moisture.

THE Purdue University Agricultural Experiment Station has issued a pamphlet (Circular No. 15) on the growth of onions, an important crop in northern Indiana to which many hundreds of acres are annually devoted. The methods adopted on the large scale are described at length, and suggestions are offered for improvement; curing and marketing are also dealt with. Another pamphlet deals on similar lines with the Indiana cantaloup industry. In Bulletin No. 134 Messrs. Hunziker and Spitzer discuss methods for the estimation of fat in unsweetened evaporated milk. Since the introduction by the Act of Congress, 1906, of the new pure food standards requiring a definite minimum per cent. of fat and solids in evaporated milk, the product from numerous milk-condensing factories has been found below standard, rendering them liable to prosecution by Government and State authorities. It was known that no fat was removed by the firms in question, and the authors show that the fault lies in the method of analysis, the ordinary Babcock method failing to show all the fat in evaporated milk. A suitable method, giving correct results, is described.

THE introduction of labour-saving machinery on the farm has been one of the principal features of the modern revolution in agriculture, and has been rendered necessary by the difficulty of getting sufficient help. Few contrivances are more interesting than the milking machine. Rubber funnels are fitted on to the teats and connected by stout tubing to a milk-can; the pressure is diminished by a pump to about half an atmosphere when the milk begins to flow. A lengthy test has been made at the Wisconsin Agricultural Experiment Station, and is recorded in Bulletin No. 173. The machine worked more quickly and more cheaply than a man; it yielded a cleaner milk, which therefore kept better, and, finally, was shown to have no injurious effect on the udders or the general health of the animals. The machine, of course, requires proper attention and careful driving to get the best results, but proved decidedly economical in herds of thirty cows or more. There are already signs that the agricultural labourer of the next generation will be, in the main, an engineer.

WE have received from Mr. Stewart J. McCall, Director of Agriculture, Nyasaland, an interesting pamphlet on the growth of cotton in America. The four types dealt with are (1) Sea Island cotton, a small high-quality crop, forming less than 1 per cent. of the total American crop, but very important by reason of its quality; (2) upland cotton, short staple, the principal variety in commerce; (3) upland cotton, long staple, which has only been introduced within the last few years, and is almost exclusively confined to the rich bottom lands of the Mississippi; (4) Egyptian cotton, introduced to supply the manufacturers' demand for a lustrous cotton, well adapted for mercerisation. The pamphlet is written for the African cotton grower, and great stress is laid on the necessity for keeping out of Africa the cotton weevil, which has done incalculable harm in America, and made cotton cultivation impossible in some places. Mr. McCall suggests that all seed imported from America should pass through a Government Department for examination and treatment. The question of distributing insect and fungoid pests by artificial means has to be considered seriously. Unfortunately, our administrators are often insufficiently in touch with scientific problems to realise that a small pest which could at little expense be kept out of a country may do great damage once it is introduced.

THE mixed population of Manila, which includes almost all races of mankind in varying degrees of purity, has afforded to Mr. R. B. Bean an unrivalled opportunity of studying the different types of human ears, and formulating, for the first time, a morphological classification of the same. His results, which are published in the first number of vol. iv. of the *Philippine Journal of Science*, cannot fail to be of great interest to anthropologists. Names, such as Malay, Negroid, Cro-Magnon, Alpine, &c., are given to these various types of ears, which are characteristic of definite physical types of men, although it does not necessarily follow that they are also distinctive of all members of the races whose names they bear. The Alpine ear is, for example, the ear of the fat man. In the Philippines the author finds that ears not of European origin are morphologically older than those of European type, and from these data he draws certain conclusions as to the evolution of the modern Filipinos.

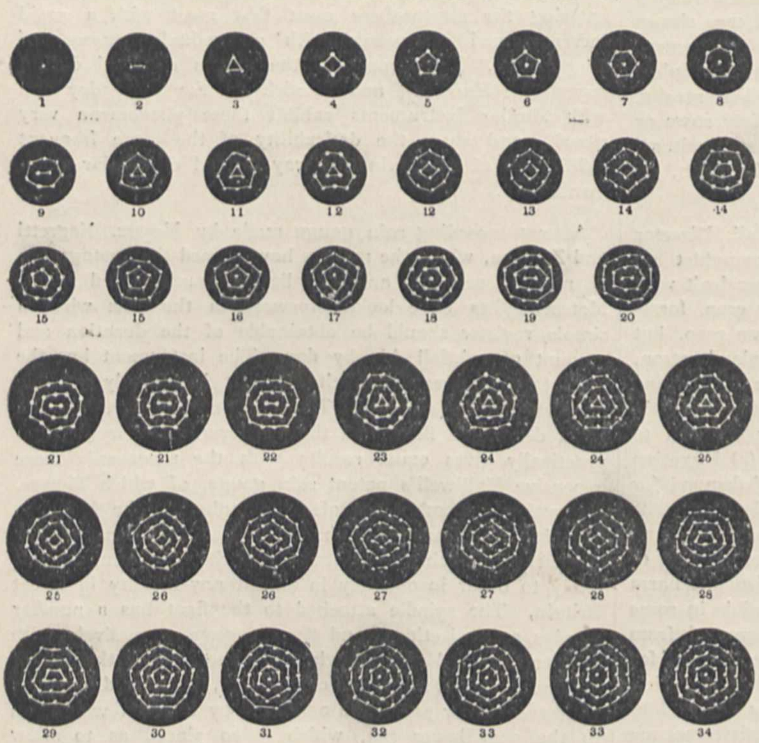
DR. F. ERK, director of the Bavarian Meteorological Service, has contributed to part i., vol. iii., of "Beiträge zur Physik der freien Atmosphäre" an interesting paper on the relations of the upper inversion of temperature to the areas of high and low atmospheric pressure. The author, who has the experience of a critical examination of daily weather conditions during the last twenty-five years, assumes, from the labours of recent investigators, that the relatively high temperatures of the region of the upper inversion (the "stratosphere") arise from the absorption of radiation, not from the surface of the earth, but from strata of some 4000 metres in height. He discusses at considerable length the effects of the descending air in the high-pressure areas of the upper regions and of the advance of the low-pressure systems towards the stratosphere, and shows how a registering balloon on entering the stratosphere must first meet with a rapid increase, and afterwards with a gradual decrease, of temperature. Photograms of the curves obtained during ascents at Hamburg and Munich on the same day and with similar instruments exhibit these phenomena very clearly, and show the desirability of the more frequent publication of results in this way instead of tabular statements only.

A NEW recording rain gauge made by Messrs. Negretti and Zambra, which the makers have named the hyetograph, is now procurable, and supplies a much-needed want. Meteorologists have looked forward to the time when a simple register should be obtainable of the duration and amount of rainfall day by day. The instrument has the advantage of great simplicity, and it is scarcely possible for it to get out of order. The only movable parts are the clock drum, the float, and the pen lever. The hyetograph practically gives equal results with the necessarily more expensive Halliwell's patent rain gauge, of which Messrs. Negretti and Zambra are also the makers. The funnel is 8 inches in diameter. The float has the capacity for measuring 4½ inches of rain, which is the maximum amount likely to occur in one day in almost any locality in Great Britain. The spindle attached to the float has a number of pins or projections, and these engage successively with a lever arranged so that when the pen reaches the top of the chart, wound round the clock drum, the lever disengages with the pin or projection and falls by its own weight on to the next lower pin, which is so placed as to allow the pen to fall to zero on the chart. The whole of the working parts are protected by a stout galvanised iron cover, and the water collected is removed by a hand-started syphon. The hyetograph complete, with 100 special charts, costs 6*l*. 15*s*.

THE "Report of a Magnetic Survey of South Africa," upon which Prof. J. C. Beattie, of Cape Town, and coadjutors have been engaged, with the aid of Royal Society and colonial grants, for a series of years, has now been published by the Royal Society at the price of 20*s*. net. It forms a quarto volume with numerous maps and plates, uniform with Rücker and Thorpe's Survey of the British Islands. Copies may be obtained from the Cambridge University Press Warehouse.

WE learn from the *Amateur Photographer* that Messrs. Aldis Bros., of Birmingham, have perfected a periscope lens which enables the observer to see completely round the horizon without movement of either himself or the lens. It consists of a ring of glass with an outer curved surface, while the inner surface, which is inclined and plane in one direction, serves to reflect the light that enters the system down the axis of the vertical tube that carries the lens at its upper part. A reflecting prism enables a horizontal eye-piece to be used. The lens has already been approved by the Admiralty for use in the conning towers of submarines. A photograph taken by it gives a well-defined annular picture of the view as seen in every direction around it.

WE have received a copy of a paper, by Mr. Louis Derr, on a photographic study of Mayer's floating magnets (Proceedings of the American Academy of Arts and Sciences, vol. xliv., No. 19, May). Although it is now recognised that inferences made in regard to the structure of matter from the exact behaviour of such floating systems must be received with caution, yet the groupings obtained are so suggestive that any fresh study of them is of interest. Mr. Derr has endeavoured to obtain a much more complete series, which he has photographed in order to show the progression from one form to another more clearly than can be done by tables. The magnets were clear ¼-inch steel balls, floated on freshly filtered mercury, as described by Prof. R. W. Wood, but initially magnetised by placing them one by one between the poles of an electromagnet. In the plate (part of which we reproduce) the balls as photographed have been connected together afterwards by lines, in order to bring out more obviously to the eye the formation in concentric groups. Many of the forms differ from those calculated by Sir J. J. Thomson; since the stability depends upon the exact law of force between the magnets—and in the experiments this is different from the law assumed in the calculations—the divergence is not to be wondered at.



Photographs of systems of floating magnets.

THE May number of the Bulletin of the Bureau of Standards contains a description of a new method of determining the focal length of a converging lens system, by Mr. Irwin G. Priest. The method depends on the measurement of the diameter of one of the circular rings of the Fabry-Perot interferometer when seen through the lens by reflected homogeneous light. If viewed without the intervention of the lens, the ring system is localised at infinity, and with the lens a real image will be formed in the focal plane of the lens. The outer edges of the rings are sharp, and admit of accurate measurement of diameters by means of a micrometer. From two measurements of the diameters of the same ring with different distances between the interference plates, the focal length of the lens can be found with an accuracy of about half per cent., and if with the interference plates a fixed distance apart the constant of the apparatus be determined once for all, a single measurement of the diameter of a ring is all that is necessary.

THE four numbers of the Journal of the Royal Society of Arts issued in July contain the Cantor lectures on the public supply of electric power delivered by Mr. G. L. Addenbrooke before the society in January and February last. After describing with great clearness the present position of affairs, the lecturer points out in what directions we may reasonably look for improvements in the future. Whatever the improvements in prime movers, he believes that electrical power will still be the most suitable for factories. This power will, when gas engines and producers have been rendered more suitable and trustworthy, be produced by internal-combustion engines of the four- or six-cylinder type. He considers that the time now required to obtain a provisional order in the case of a power scheme should be greatly reduced, and wishes to direct the attention of legislators to the importance of facilitating the supply of cheap electric power.

NONE of the formulæ in common use connecting the pressure and temperature of saturated steam can be regarded as satisfactory. Any empirical formula should cover the whole range, give a fair representation of those experimental results which probably approximate most closely to the true relation, and should be easy of calculation. Mr. S. Godbeer, in an article in *Engineering* for August 6, presents a new formula which should be useful. For various reasons, a table given by Holborn in 1908, ranging from 0° to 205° C., together with experiments by Cailletet covering a range up to the critical temperature, have been used as data. A few irregularities have been corrected, and the formula is as follows:—

$$\log p = \frac{1319\ (t+226)\ (t+2299)^2}{192028\ (t+808)\ (t+329)} - 30{\cdot}203,$$

where p is the pressure in millimetres of mercury and t is the temperature centigrade. If pressure and temperature curves be drawn for the experiments of Cailletet, Battelli, and Knipp, it becomes evident that there is a sudden disturbance in the general trend of the curve between 240° and 270° C., and the author suggests that further experiments in this region of temperature would be interesting.

METAL-CUTTING by means of oxygen is now finding a place among engineering operations, and several interesting applications are given in *Engineering* for August 6. The instrument used consists of an oxy-hydrogen, oxy-coal-gas, or oxy-acetylene mixed blowpipe, through which an additional stream of oxygen can be supplied at will by the operator. The object is to heat to incandescence the part on which the jet of oxygen is afterwards to play, and to keep it at that high temperature all the time the oxygen jet is operating. This method has been found to overcome entirely the older difficulties with regard to unsteady manipulation of the oxygen jet, as well as the trouble due to the presence of iron oxide. Plates and slabs of steel up to 12 inches in thickness can be cut by this method. The cut is very clean, and, in one example illustrated, where a slab of steel 8 inches thick was cut into pieces ⅜ inch in width, the width of the cut was only about ¼ inch, showing the intensely local nature of the operation. Another illustration shows an armour plate being cut circular by means of a special appliance carrying a blowpipe, the thickness of the plate in this example being 9 inches. The cut surfaces are left comparatively smooth, and the cut is square down from the face of the plate, although it is possible also to make bevel cuts. All grades of steel can be operated on.

MR. H. K. LEWIS, of Gower Street, London, has sent us a copy of a catalogue of the new books and new editions added to his medical and scientific circulating library during the second quarter of this year. The list will be sent post free to any address on application.

A SECOND edition of Prof. Marcel Moye's translation of Prof. Lowell's "Mars and its Canals" has been published at the office of the *Mercure de France*, Paris. The original volume has already been reviewed in these columns, and we are glad of this opportunity of congratulating Prof. Moye on the demand for a second edition of his translation of Prof. Lowell's interesting book. The price of the translation is five francs.

SIR WILLIAM RAMSAY'S volume of "Essays, Biographical and Chemical," which was reviewed in NATURE of July 29, has been translated into German by Prof. W. Ostwald, and published by the Leipzig Akademische Verlagsgesellschaft, under the title, "Vergangenes und Künftiges aus der Chemie." The German volume includes, in addition to the essays of the original work, an autobiographical sketch by Sir William Ramsay, occupying thirty-five pages.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF MARS.—Circular 110 from the Kiel Centralstelle announces that, at 2 p.m. on August 12, M. R. Jonckheere observed a brilliant spot detach itself from the polar snows of Mars and cover the Novissima Thyle, in longitude 320°.

In No. 4340 of the *Astronomische Nachrichten* M. Jarry Desloges records some observations of Mars made at the Massegros Observatory (Lozère) during June and July.

On June 20 and 23 a dark cutting was seen in the south polar snows, in longitude about 190°, and appeared to terminate in a rounded spot, which was of a darker shade. The crevasse observed by Prof. Lowell in longitude 350° was easily seen on July 4 with a 37 cm. refractor installed on the Revard plateau, and appeared to traverse the whole length of the visible part of the snow-cap. On the same day, at 4h. 15m. a.m., a broad, bright spot was seen on the dark edge of the snow in about longitude 30°.

RE-DISCOVERY OF PERRINE'S COMET.—A telegram from the Kiel Centralstelle announces that comet Perrine was discovered by Herr Kopff at 10h. 54m. (M.T. Königstuhl) on August 12. The position of the comet at that hour was R.A. = 0h. 17·1m., dec. = 35° 32′ N., and the magnitude was 15·0.

Of the three ephemerides given by Herr Ristenpart, the first (T = October 27·5) gives the nearest position to the above for August 12, the ephemeris place being

R.A. = 0h. 40·2m., dec. 36° 45·9′ (1910·0).

THE NUMBER OF THE STARS.—In the August number of the *Observatory* (No. 412, p. 323) Mr. Gavin Burns directs attention to the discrepancy between the Groningen and the Harvard estimates of the total number of stars, and suggests that Prof. Kapteyn's estimate is probably excessive. Tabulating the figures given by each of the two observatories, he shows that from the tenth magnitude downwards the Groningen numbers are greatly in excess of those given by Prof. Pickering; for example, the respective totals, including all stars down to the 10·5 magnitude, are 697,551 and 604,000, but if the 13·5 magnitude be included they are 14,582,551 and 6,761,000. Then there is a note in the Harvard publication which suggests that if stars to the fifteenth magnitude were included the total would be raised to about 18 million, whereas Prof. Kapteyn's estimate for magnitude 14·5 is 38 million, and for magnitude 15·5 98 million. A published investigation of the Greenwich astrographic plates shows agreement with Harvard for the fainter magnitudes, and strengthens the suggestion that the Groningen estimates are too high.

THE FAINT COMPANIONS OF PROCYON AND SIRIUS.—During last winter Prof. Barnard employed the Yerkes 40-inch refractor on many occasions in an endeavour to detect and measure Schaeberle's faint companion to Procyon, but only on a few occasions was he successful. The results, which are published in No. 4345 of the *Astronomische Nachrichten* (p. 13, August 7), show that during the last five or six years the angular motion of the companion has been about 5·2° per annum, but the distance has changed but little. The weighted means, for 1909·162, were 22·51° and 5·26″ respectively. Prof. Barnard states that the least atmospheric diffusion of the light of the large star hides the close companion, and then explains a device which he uses to obviate the adverse effect of the stray light. This is to place a hexagonal diaphragm over the 40-inch object-glass so that the angles of the hexagon lie on the periphery of the glass. This collects the stray light into six thin bright rays, and the small star can be more easily seen in the dark space between a pair of the rays.

A similar device was employed in observing the faint companion to Sirius, and the measures made during the period 1903–9 are given in the same journal. These show that the angle is decreasing, from 115·38°, for 1903·808, to 92·53°, for 1909·135, whilst the distance is increasing, the values for the corresponding epochs being 6·32″ and 8·75″ respectively.

PROF. LOWELL'S NEW 40-INCH REFLECTOR.—A brief description of the new 40-inch reflector which Messrs. Alvan Clark and Sons are just completing for Prof. Lowell appears in No. 412 of the *Observatory*. The focal length is 18 feet 4 inches, and the mirror, cast at St. Gobain, is 7 inches thick and weighs more than 900 lb. The cell is an iron ring with zinc blocks so arranged that the combined expansion is the same as that of the glass, thus obviating distortion. For planetary photography the reflector can be used as a Cassegrain of 154 feet, or 75 feet, focal length, whilst for stars and nebulæ it will be used as a Newtonian with the plate at the principal focus. In order to protect the instrument from the wind, and partially from large temperature changes, it will be mounted in a pit sunk 6 feet into the ground, over which is erected a hemispherical dome of wood and canvas. The requisite diurnal motion is to be imparted to the instrument by two electric motors, one for driving, the other for slow motion.

WATER VAPOUR IN SUN-SPOTS.—In the July number of the *Astrophysical Journal* (vol. xxx., No. 1, p. 44) Mr. W. M. Mitchell discusses the various researches which have led to the suggestion that water vapour exists in sun-spots. He points out that the spectroscopic evidence is not unanimous, either for or against, and is certainly not conclusive.

The affected spot lines may be due to other substances not yet identified, and giving lines of nearly similar wave-length. Then the apparent intensification may be a subjective effect, to which the varying intensities of the water-vapour lines in the normal Fraunhofer spectrum is a contributory cause. Mr. Mitchell suggests that very fine measures of the displacement of spot lines, caused by the sun's rotation, might settle the question as to the solar origin of the apparent intensification, and concludes that, as yet, the evidence adduced by various observers in favour of the presence of water vapour is by no means satisfactory.

THE PALISA AND WOLF CELESTIAL CHARTS.—Dr. Palisa announces that the second series of Celestial Charts, prepared by Dr. Wolf and himself, is now ready, the price, if ordered from him, being 30*s.*; the bookseller's price is 35*s.* After the end of November this series will cost the purchaser 40*s.*, wherever purchased. Dr. Palisa's address is "The Observatory, Vienna, Austria."

THE PIMA AND TLINGIT INDIANS.[1]

THE introduction to the twenty-sixth annual report of the Bureau of American Ethnology (1904–5), 1908, by the chief of the Bureau, Prof. W. H. Holmes, indicates that the staff are zealously carrying on the work of the department. The report itself contains two excellent

FIG. 1.—Pima woman making pottery: supporting vessel on loose sand.

memoirs, one on "The Pima Indians," by Frank Russell, and the other on "Social Condition, Beliefs, and Linguistic Relationship of the Tlingit Indians," by John R. Swanton.

As Mr. Russell's memoir is a monograph of the Pima, he naturally pays a good deal of attention to the arts and crafts and food supply of the people, his account being fully illustrated. The Pima keep an annual mnemonic record of events by means of notched sticks. "The year notches are exactly alike. . . . Dots or shallow circular pits and short notches are the most common symbols on the sticks. These have no distinctive meaning, and are used for recording a great variety of events," but they never make a mistake. One man who lost his stick continued his history with pencil and paper, and this "introduced a tendency to use pictorial symbols rather than merely mnemonic characters, such as are most easily incised on the surface of a stick."

With all their surplus energies expended in warfare, the young Pima men formerly lived exemplary lives as compared with the youths of the last generation. Before the Pimas came in contact with "civilisation" chastity was the rule among the young women. On reaching puberty there were several taboos, and there was "danger" in the girl that must be breathed out by songs ere she, the members of her family, and the community as a whole were exempt from the hazard of the lightning stroke and other perils. The youths marry "early and often." In the majority of cases the choice is made by the girl, who seeks to avoid an alliance with a lazy man. Polygyny was practised to some extent, but the division of labour was such that no great economic advantage resulted. There were no groups within the tribe between which marriage was prohibited. Divorce was easily effected. They often had large families, and twins were received with general rejoicing. Male children were preferred, because "they would grow up to fight the Apaches." So strong was the feeling of the Pimas against the abnormal that they tried in recent years to kill a grown man who had six toes. Under the head of "Baptism" we find the following information:—at child-naming the child was held aloft to receive the first rays of the rising sun. Beads were formerly held up to receive the first rays of sunlight, and were then placed about the child's neck.

Descent is traced in the male line, and there are five groups that may be called gentes, though they exert no influence upon marriage laws, nor do they manifest any evidences of organisation so far as ascertained. The

FIG. 2.—A Piman holding a Calendar Stick.

Pimas are governed by a head chief and by a chief for each village. These men are assisted by village councils, which do not, Mr. Russell believes, appoint any representatives to the tribal councils. The head chief is elected by the village chiefs. The tribe acted as a unit against the dreaded Apaches. The slaves taken by the Pimas were chiefly from the ranks of the Apaches or their allies; they were well treated. The Pimas held possession of the best agricultural land in their section of the south-west, and were compelled to fight for the privilege. There was no law among them observed with greater strictness than that which required purification and expiation for the deed that was at the same time the most lauded—the killing of an enemy. Numbers of myths and songs are cited. The Pimas are far less given than their pueblo neighbours to the outward show of religion. The sun was appealed to. At the present time two deities are recognised, Earth Magician and Elder Brother. They live in the east, dividing the control of the universe between them. The stars are living beings. Some declared that at death the soul passed into the body of an owl, others that after death it went to the land of the dead in the east. Again, souls are supposed to hang about and perform unpleasant pranks with the living.

There are fourteen geographical groups or tribes of the Tlingit or Koluschan, each of which had at least one winter village and a section of coast where they camped

[1] Twenty-sixth Annual Report of the Bureau of American Ethnology, to the Secretary of the Smithsonian Institution. Pp. xxxi+512; 58 plates. (Washington: Government Printing Office, 1908.)

in summer and behind which they hunted in winter. As a whole, they are divided into two exogamous phraties with matrilineal descent, one called Raven, the other usually Wolf, and in the north Eagle as well. One small group outside both phraties could marry into either. Each was subdivided into clans or consanguineal bands, which originally appear to have occupied a particular camp. The larger geographical groups contained members of both phraties, and usually numerous clans. Finally, the clans are subdivided into house groups. Each clan claimed a few distinctive carvings and names; occasionally they might be borrowed. The house names and clan names were generally distinct, and confined to their respective phratry, but a man sometimes claimed the right to the house name owned by his paternal grandfather's clan, so that names sometimes go out of the clan. Those of a man's own phratry are called "friends," those of the opposite phratry "opposites" or "my outside shell." A list is given of the relationship terms. The importance of the phratry system is indicated by the rules of etiquette and the hospitality shown towards members of the same phratry, and the performance by the opposite phratry of certain functions at birth and death.

A mourning feast is given to members of the opposite phratry, food being put into the fire for the spirit of the deceased. All property given away or destroyed at a feast was dedicated to some dead person, who then actually received its spiritual counterpart. A Tlingit employed his opposites to do everything—put up his house and pole, pierce the lips and ears of his children, and initiate them into the secret societies. The secret society dances were imported from the south, but their observance by no means reached the importance attained among the Kwakiutl and Tsimshian. Whistles were essential concomitants of these dances. The putting up of a house or pole, and the accompanying secret society performance, feasts, and distributions of property were all undertaken for the sake of dead members of a man's clan. Rivalries between opposing parties of dancers at a potlatch often resulted in serious conflict, but the host's people often prevented them by rushing between them bearing their emblem or making the call of the phratry animal. A. C. H.

RECENT PUBLICATIONS ON AGRICULTURE FROM INDIA AND CEYLON.

THE recent issues of Circulars and Agricultural Journal of the Royal Botanic Gardens, Ceylon, contain interesting papers on cotton, *Hevea brasiliensis*, and other native crops. Mr. Lock issues a concise guide to the plots on the Experiment Station, Peradeniya, which will prove useful to visitors, and will, we hope, be the forerunner of a work setting out the general results obtained in the Ceylon experiments and the conclusions to be drawn from them. Mr. Petch deals with certain abnormalities in *Hevea brasiliensis*. Nursery plants with twisted stems are frequently sent in for examination and report. The stem generally makes a complete turn at the base, either in a regular curve or a combination of curves and abruptly angular bends; in other cases there are two complete turns, and in a single instance three have been observed. It was found possible to reproduce some of these abnormalities by varying the position of the seed in the soil. The insect pests—which mainly attack the root, since the rest of the plant is to a large extent self-protected by the viscid caoutchouc-producing latex—are dealt with by Mr. E. Ernest Green. Mr. Bamber deals in one pamphlet with tapioca, describing its method of cultivation in Malacca, and in another with the cultivation of strong-growing plants to overrun and "choke" weeds in rubber plantations. The plants suggested are *Passiflora foetida* and *Mikania scandens*; *crotolaria* is also used. When growth has attained its maximum, and before the plants die down, the whole mass of material, usually 12 inches to 18 inches deep, can be rolled up like a huge carpet, leaving the surface soil quite free from weeds. Mr. Jowitt describes several of the oil-yielding grasses, and Mr. Stewart McCall puts in a plea for the more extensive cultivation of cotton. Altogether the papers are fully up to the high standard we have learnt to associate with Peradeniya.

It has already been remarked in these columns that the *Agricultural Journal of India* ranks for general excellence among the best agricultural publications in the world, and the recent numbers in no way alter the impression. The list of articles includes several dealing with improved methods of cultivating cotton and paddy, besides a well-illustrated paper on improved implements of home-make adapted to the special conditions of the native cultivator. Mr. Maxwell-Lefroy deals with Eri or castor silk, and Mr. Marsh discusses certain indirect benefits of irrigation not generally recognised. Among these are the possibility of substituting new sowings in case of accidents to advanced crops, the certainty of fodder for the cattle, which are among the worst sufferers in time of drought, and the general improvement of the people and country which inevitably results when the conditions of life become stable. The journal is issued quarterly from Pusa, and the articles are well written from a general point of view; it may be confidently recommended to all interested in Indian affairs.

Probably no publication could give a better idea of the enormous size of India, and the great diversity of conditions, than the two volumes of agricultural statistics brought out by the Government of India. The first volume deals with British India, and contains 429 folio pages of closely printed figures; the second contains the records of native States, and is smaller. Comparing the year 1906–7 with 1897–8, the earliest given in the volume, we find the following areas, in acres:—

	British India		Native States	
	1897–98	1906–07	1897–98	1906–07
Net area cropped ...	196,497,232 ...	214,026,319 ...	10,120,324 ...	14,923,731
Irrigated...	30,418,454 ...	36,653,003 ...	1,425,895 ...	1,982,668
Total food grains ... (Rice, wheat, maize, pulse, &c.)	182,725,689 ...	195,117,838 ...	9,126,337 ...	13,123,691
Other food crops ... (Gardens, orchards, spice, &c.)	5,773,267 ...	7,274,340 ...	369,392 ...	561,431
Total oil seeds ...	12,566,648 ...	13,965,315 ...	603,076 ...	836,335
Cotton	8,914,996 ...	13,771,214 ...	279,758 ...	625,694
Indigo	1,366,513 ...	448,594 ...	1,731 ...	18,182

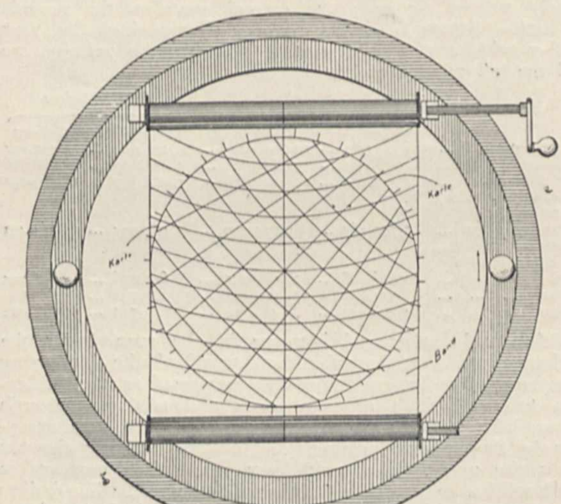
This steady, all-round increase in the area under the various crops furnishes abundant proof of the increasing prosperity of India, and must be a source of great gratification to the British administrators and advisers through whose labour it has been made possible. The one exception in the general prosperity is indigo. During the ten years the area has shrunk from more than one and a third million to less than half a million acres. The indigo planters are a highly enlightened body, and look to science to help them save the industry; their fortunes are very much involved in the contest now going on between the agricultural chemist and the synthetical organic chemist.

POSITION FINDING WITHOUT AN HORIZON.

THE Journal *Ila* of July 17—an aëronautical journal published at Frankfort—contains an article which in some respects is supplementary to that on the subject of position finding without an horizon which appeared in NATURE of July 22, or, as this article was the later in time, perhaps it would be more correct to say that it was supplementary to the one in *Ila*. The latter, which is written by Dr. Alfred Brill, relates to the reduction of observed altitudes for the purpose of finding position by means which can be quickly and readily effected in a balloon. After showing the inconvenience of the usual trigonometrical methods used on board ship, and how tiresome the use of tables must be which correlate time, latitude, declination, and altitude, he proceeds to describe his method, which is one eminently suitable and convenient, that is, where a graphic method is sufficiently accurate.

Dr. Brill employs a circular map of, say, Central Europe on transparent celluloid, the projection being one of least distortion. Before and behind this are two more sheets of celluloid, with the Sumner equal altitude circles drawn on the same projection. These sheets each have a central longitudinal azimuth line, while the map is provided with a circle of degrees round its periphery. The two Sumner sheets can be moved longitudinally on rollers like blinds, and these two and the included map may be turned in their own planes relatively to one another, so that the azimuth line of either Sumner sheet always passing the centre point of the map may be brought to any bearing in relation to the map. Now the observation of altitude of a star at a given sidereal time having been made, a table calculated for stars of that declination and for the centre point of the map is consulted so as to ascertain what is the altitude and azimuth for the particular star at the moment of observation at the mid-point of the map. One Sumner sheet is then rolled until the line representing this altitude is over the mid-point of the map, and one is turned relatively to the other until the mid-line on the Sumner sheet is over the tabulated azimuth on the scale of degrees outside the map. Then the observer at the time of observation was somewhere on the Sumner line representing the observed altitude truly projected over the map. The corresponding observation of a second star is similarly transferred and the corresponding Sumner line on the other sheet brought into position. The observer is then at the point of intersection of the two Sumner lines of observed altitudes.

It will be seen that the device and tables are of a simple character, and that by their aid the principle of the Sumner method is applied graphically, so that the position may be



seen by inspection. The figure shows the map and one of the Sumner sheets only, the one behind not being shown to avoid confusion. C. V. B.

ARCHÆOLOGICAL AND ETHNOGRAPHICAL EXPLORATIONS.

FULL details have now reached this country of the remarkable discovery made by Dr. D. B. Spooner, of the Indian Archæological Survey, in the neighbourhood of Peshawar. Hitherto the site of the great Stupa erected at the ancient city of Purushapura by the Kushan Emperor Kanishka, who ascended the throne about 123 A.D., to enshrine the relics of Gautama Buddha, was unknown. It was described by Hieuen Tsang and other Buddhist pilgrims from China as far the most famous and magnificent of the pagodas in India. A few years ago M. Foucher, the eminent French archæologist, suggested that it lay beneath certain tumuli in the neighbourhood of Peshawar. Excavations conducted by Dr. Spooner corroborate this identification.

The ruins are of great extent, and within the pagoda the relic chamber was reached. In it was discovered a metal casket enclosing a rock crystal reliquary. The outer casket, cylindrical in form, has a lid in the form of a lotus supporting three figures in the round, a seated Buddha in the centre, with a standing Bodhisattva on either side. Round it is an elaborate frieze in low relief of flying geese bearing wreaths in their beaks and figures of the Buddha, with a large, standing figure of the Emperor himself in the well-known attitude in which he appears on his coinage. The casket bears the signature of a Greek artist, Agesilaus, who describes himself as "superintendent engineer" of the monastery. Incidentally the casket throws much light upon the Græco-Indian art of the age, and supports the view that the Gandhara school was in a state of decadence.

The actual relics consist of three small fragments of the bones of the Buddha. The question of the ultimate disposal of these remains will excite much interest in the Buddhist world, and the Indian Government will doubtless consider the claims of the Burmese, Siamese, and Sinhalese religious foundations to share in the custody of relics which, like the alleged tooth of the Buddha at Kandy, are sure to receive the homage of millions of pilgrims drawn from the Buddhists of Eastern Asia.

The return is expected shortly of an expedition undertaken in 1907, under the auspices of the trustees of the British Museum and the council of the Royal Anthropological Institute, and conducted by Messrs. E. Torday, W. M. Hilton-Simpson, and N. H. Hardy, to examine the customs and culture of certain tribes in the Upper Congo region. The chief tribes which came under examination were the Batalela, Basonge, and, in particular, the Bakuba, the true name of which is now found to be Bashongo. The latest news showed that the explorers had reached the Loange river, and after exploring the hitherto unknown Tukongo people, they hoped to penetrate the Kasai region, and to return thence to Europe in September next. Large materials in the shape of photographs, maps, phonographic records, and ethnographical collections have already reached England, and a selection from them has recently been placed for exhibition in the Ethnographical Gallery of the British Museum.

Much information has been collected regarding the almost unknown Bashongos, one of the most remarkable tribes in Africa. They have preserved much of their tribal history and legends, and are particularly famous for their skill in weaving and wood-carving. Some portrait statues of their kings are remarkable works of art, exhibiting a degree of artistic skill hitherto unknown in Africa outside ancient Egypt. Their embroidered cloths, made of palm-leaf fibre, in the oldest and best examples, suggest a distinct resemblance to Celtic art. They possess a decayed form of totemism, and records of their remarkable rites of initiation, recently discontinued, have fortunately been recovered.

Mr. C. H. Read, of the British Museum, who is largely responsible for the organisation of this important expedition, may be congratulated on the successful collection of a mass of novel ethnographical material about these hitherto unknown races, which must throw much-needed light on the ethnology of Western and Central Africa.

THE MICROSCOPE AND ITS PRACTICAL APPLICATIONS.

AMONG scientific instruments, the microscope is at the present time one of the most extensively employed, either for commercial or scientific purposes. In nearly all branches of science it has now become a necessity, both as an essential factor in preliminary training and for advanced investigations or pure research work, while in commerce its uses are so wide and varied that it is difficult to see to what practical purposes it may not sooner or later be applied.

That this is the case may be due to many causes, and a by no means negligible factor is the simplification in construction and design that has in recent years been effected in the mechanical portions of the instrument and in its essential optical parts. In this respect, perhaps, a microscope differs from the majority of scientific instruments, as in most of the latter elaboration of construction—often, it must be admitted, quite unavoidable—is the usual rule; but for general purposes microscopes were never more simple in design than at the present time. This simplicity has not been obtained at the expense of loss of efficiency, but rather the contrary. The cost, too, has been greatly reduced, so that unless objectives and other optical parts of the highest class are required, a complete microscopic outfit may now be obtained of good quality and of high efficiency for a few pounds. The same, however, can scarcely be said if objectives of the finest quality are required, but this is rarely necessary for commercial purposes or for laboratory use unless work of a highly critical nature is to be carried out.

In our present state of knowledge it may almost be said that the science and practice of microscopic optics has reached such a stage of perfection that it is difficult to foretell in which direction the next improvement is to be looked for, much less the means by which such may be effected. Attempts have been made to increase optical efficiency, particularly by various dark-ground illumination methods, but it must be confessed with somewhat disappointing results. While such methods assist in demonstrating the presence of particles or isolated objects not easily seen, or even invisible by other means, the resolving power of the optical system is not improved. The most promising development has been in the apparatus introduced by Messrs. Carl Zeiss for use with ultra-violet light. This certainly held out a prospect of definite increase in resolving power being obtained, and in some directions has probably justified its existence. For the ordinary worker, however, the great cost of the necessary appliances, the more than usual skill required in its manipulation, the necessity of using special mounting materials, as well as the impossibility of observing any object mounted in the ordinary way on glass, has prevented its use for any but very special purposes.

For a long time a form of microscope stand, known as the Continental model, in which the instrument was supported on a foot of a horseshoe shape, practically held the field; but English makers, fortunately, to a large extent maintained their more stable method of support by means of a tripod foot. The latter not only admits of the microscope body being more conveniently swung, but also ensures that at any inclination of the body-tube the centre of gravity of the instrument is well within the triangle formed by the three points of support. With the horseshoe foot this is not the case, as the point of support is usually in such a position that at any considerable inclination the instrument is unstable, while in a horizontal position for photomicrography or projection, some Continental types are so unevenly balanced that they will not even stand alone, much less allow of the proper use of their various adjustments. This may be in part overcome by clamping the instrument down to some stable base for such special purposes, but no microscope with any pretension to be regarded as well designed should require that precaution.

The influence of this condition is now being felt very largely, and most Continental makers are either adopting a more stable method of support approximating to the English model, or are embodying the English type in their later makes of stands. In some cases a fusion of the two types appears to have been attempted, with certainly beneficial effects, but unfortunately the objections to the Continental model are still to be met with in some that have only in part realised the advantage of the English design. Continental microscopes have also long been open to the objection that their substage arrangements are altogether too cramped, and as it is only for very special purposes that a microscope is of necessity a portable instrument, the reason for this is not easily seen; certainly some more space underneath the stage, a greater range of action of the substage condenser, and considerably more freedom of movement of the mirror, would result in the production of a more convenient style of instrument.

It is extraordinary how widespread the applications of the microscope are at the present time. A recent article on its use in metallurgy and engineering, by Mr. W. Rosenhain, which appeared in these columns (vol. lxxx., p. 250), has sufficiently and clearly indicated its value in this direction. It is well enough known that in trades like brewing the microscope has played a very important part, and, in fact, it may be said that all trades which are concerned in the production or use of fluids for human consumption—at least where the work is carried out on anything approaching a large scale—are now compelled to have the service of a trained microscopist. Dairy workers, mineral-water makers, and all authorities concerned with the supply of pure water for drinking purposes, are equally interested in the question.

As indicative of how great is the interest in this direction, it may be mentioned that the Cunard Steamship Company and the White Star Line have inquired of well-known makers for instruments and complete outfits suitable for their use. The presumption is that they intend to initiate some method of microscopically examining the water supply on their vessels, constituting, in fact, a miniature Water Board to ensure that their water supply is as free from any bacterial or similar contamination as even that to be obtained in great centres of population.

As indications of some other directions in which microscopes are being utilised, it may be mentioned that chemists and druggists, paper manufacturers, makers of Portland and other cement, such as the Associated Portland Cement Company, foundrymen, printers and half-tone block makers for photographic reproduction purposes, quarrymen, linen, cotton, and silk manufacturers, and various other allied trades, are using microscopes at the present time. Petrological microscopes, in the development of the design of which great improvements have been made of late, are being applied now for testing stone and for supplying architects with exact information as to the structure and quality of the stone supplied by quarrymen, and as to the suitability of such material for building purposes.

As the result of a series of lectures given to laundrymen by Prof. Herbert Jackson, of King's College, an interesting further use of the microscope has recently arisen. Some large laundries and dyeing and cleaning establishments are now installing a microscopical outfit. The result of this may be fairly widespread, as it will now be possible, when a customer brings an article to be cleaned or otherwise dealt with, to determine its exact constitution before any effort is made to carry out the process. The result may be that an article which has been, for example, described originally to the purchaser as pure silk may at once be recognised by the laundryman as something totally different, and he may thus be saved from many unpleasant recriminations and possible legal claims by obtaining definite knowledge of the article before doing any work to it. One single thread detached from the article will usually supply all the information required, and will, in addition, often decide the best method or process that can most suitably be employed to effect the desired renovation.

There is still need, however, for much educational work in the use of the microscope, and it is much to be regretted that there appears to be no institution where systematic instruction in its various uses and possible applications can be obtained. Even an elementary course in the use of the instrument, suited to the requirements of the student, would be more than useful. Medical students and others, who may sooner or later engage in research work, are too often given the barest instruction in microscopic technique, and it is easy to see that, could they but have even a short course of instruction—which should be regarded, not merely as incidental to, but as an absolutely necessary preliminary portion of their class work—then much of the rough-and-ready usage seen in the course of laboratory work might be avoided. It seems almost absurd that a student who is taking a course in bacteriology or pathology, which at its best requires the very highest knowledge of the use of the microscope, should usually receive little or only the barest and most superficial instruction in the methods of use of the instrument. With the great increase in the number of applications of the microscope, it may become essential that means should be provided for teaching systematically the elements of the theory of microscopic optics and the methods of using the instrument and its optical parts, and it is to be hoped that at no distant time this necessity will be recognised in some institutions of higher education.

J. E. BARNARD.

RECENT IMPROVEMENTS IN THE INTERNAL-COMBUSTION ENGINE.[1]

III.

WE have now to consider the way in which the recent great practical improvements in the design and operation of gas engines and gas-producing plant have come about, and how they are connected with the theoretical considerations referred to in the previous articles.

Despite the multitudinous ways in which the internal-combustion engine is employed, there is a general assortment into three main groups, which may be described thus:—

(*a*) Large gas engines for gas blowing, for the generation of electric power or other power purposes, the size being usually more than 1000 horse-power.

(*b*) Smaller gas or oil engines used for workshop driving, in sizes up to about 500 horse-power.

(*c*) Petrol engines for road transport, for marine work, and for aëroplanes, the sizes being usually less than 100 horse-power.

With class (*a*) are associated pressure gas producers, frequently worked with by-product recovery plant, and schemes for the utilisation of the waste gases of coke ovens and blast furnaces. The gas engines in class (*b*) usually derive their gas from suction gas producers, which are practically always of smaller size than the 500-horse-power unit, though attempts are now being made to work with the larger units suitable to marine work. H.M.S. *Rattler* is one of the very first instances of the application of the suction gas producer to marine purposes, and it has been remarkably successful. Looming in the distance is the prospect of using suction gas producers and gas engines in smaller units for road transport, but the difficulty of finding space on the present type of motor-car for the whole of the plant is a great one. On the other hand, the considerable economy in fuel to which this development would lead is an inducement to proceed with the endeavour to overcome these difficulties.

By far the most numerous class of internal-combustion engine is that of class (*c*), which includes the thousands of motor-cars and cycles now in use in all civilised countries. The fuel used is not invariably petrol, as successful attempts have been made to run on alcohol, benzol, and the heavier elements in the paraffin series. Ordinary commercial paraffin has recently been used with extraordinary success, particularly in tropical countries, and it is even reported from Uganda that the combination there of altitude with high temperature enables paraffin to be used as a fuel in small engines without any change in the usual petrol carburettor as used in this country.

Improvements in Class (a).

The chief direct practical improvements in this class are the better proportioning of parts, so as to avoid cracking by unequal heating, and the better general design of the fly-wheel effect in conjunction with such an arrangement of cylinders as to produce a more even turning moment, and therefore less cyclic irregularity. The former is evidenced by the greater trustworthiness to-day of the big engine, and the latter is abundantly illustrated by the following extract from Messrs. Andrews and Porter's recent paper[2] before the Institution of Electrical Engineers:—

"The large gas engines at the Bruckhauser, Homecomb and Heinitz installations visited by English engineers in August last are all provided with fly-wheels to maintain a cyclic irregularity within 1/250. The two former are single tandem engines, and the latter twin tandem, but no appreciable difference in the parallel running was noticeable."

The information derived from recent experimental work on piston and wall-temperatures will probably lead to still further improvements in the mechanical design of details, as once the conditions of the heat flow are known a proper proportioning and subdivision of parts is rendered possible. The recent improved trustworthiness of operation is shared equally by the two-cycle engines (such as the Oechelhauser, Koerting, and others) and the four-cycle engines, and it is very difficult to say that either type is gaining ground at the expense of the other. By-product recovery work is becoming better understood, although there is always the difficulty that the by-products, when produced, have to be sold, and one has therefore to take into account the effect upon the market price should a largely increased output result from the extended use of such plant. The utilisation in gas engines of the waste gases of coke ovens and blast furnaces is now very usual. This is especially so in Germany and Belgium, where a great deal of work has been done in this direction; in the United States there has been a rapid increase in the adoption of this process, whilst in this country matters have moved appreciably, although, owing to the low cost of fuel in England, there is not the same economic pressure to make the change. On Tyneside an excellent plan is in operation, whereby engines running on waste gases are made to generate electric power, which is then supplied to, and paid for by, the central electric generating station. By this method of pooling the current, which, of course, cannot be economically stored, but has to be used as fast as it is produced, the complicated questions as to its utilisation are avoided.

A notable recent improvement in the ignition of gas engines of all sizes is the adoption of the electric system with either low-tension or high-tension currents. On the whole it seems likely that, as with motor-cars, the latter will in the end become the most used, though at present the low-tension system with moving contacts inside the cylinder seems to be the most popular.

Improvements in Class (b).

In both this class and class (*a*) it is noticeable that the engines designed on the Continent are more complicated in appearance than those designed here. The British desire for simplicity doubtless is, at the root, a good one. One of its most noticeable illustrations in modern life is the steam railway locomotive. As applied to the gas engine, this desire takes effect in the much simpler method of governing. The usual English plan is to govern on the "hit-and-miss" principle, that is to say, when the engine runs up to too fast a speed the cylinder for one or more cycles will get no charge of gas at all, or else (which comes to the same thing) the ignition will be cut off and no explosion take place (this, though a very simple means of governing, is wasteful in fuel). The average Continental design provides for the throttling (as in a steam engine or by varying the lift of the inlet valves) of the entering charge, so as to cause a less intense explosion. This tends towards a steadier speed, but on the other hand leads to a constant lowering of the compression ratio, and therefore to a diminished thermal efficiency and an increased rate of fuel consumption.[1] In England the difficulty of speed fluctuation, to which the adoption of the hit-and-miss principle leads, is met by increased fly-wheel effect or by dividing the power between a number of cylinders, but several well-known English makers are now governing by throttling the mixture.

The standard of achieved thermal efficiency is continually rising, although the amount of the improvement is the less easy to state on account of the very optimistic way in which certain experimental readings seem to have been taken. Much depends upon the ratio of compression, and many attempts have been made to permit of a high compression pressure without pre-ignition. This has been successfully attempted in several ways, viz. by the method of water injection, so lowering the compression temperature corresponding to a given pressure, or else by the method of supercompression, which consists of causing the in-coming charge to be at a pressure of from 5 lb. to 10 lb. above the atmosphere, so that here also a higher pressure corresponds to a lower temperature, and sometimes by the method of decreasing the proportion of hydrogen present, and so raising the temperature at which the mixture would be liable to pre-ignition. In the usual form of suction producer, the proportion of hydrogen pre-

[1] Continued from p. 203.

[2] "The Use of Large Gas Engines for Generating Electric Power." Read before the Institution of Electrical Engineers, 1909.

[1] In a specific case the reduction of the compression pressure from 170 lb. to 120 lb. led to an increase in the thermal units used per horse-power from 9500 to 11,500.

sent is usually about 20 per cent., and a method of lowering the amount which has been employed recently is to admit exhaust gases into the producer in place of the usual water supply. The CO_2 then takes the place of H_2O as an energy absorber, and the chemical composition of the resulting gas is so greatly affected that the hydrogen sinks to less than 1 per cent. Another recent improvement in the suction gas producer is the regulation of the water admitted, so that the composition of the gas may be the same, no matter whether the "draw" of the engine is vigorous or slight. Without some such device the gas tends to become "wet" at the lower loads, and the producer to "go dead." To avoid this, the water supply to the producer has to be cut off, or greatly reduced, in proportion as the governor is cutting out working strokes in the engine.

Improvements in Class (c).

These are exceedingly numerous. The most recent decided change has been the adoption of the sleeve type of valve in the Daimler engine. Despite apparent drawbacks from the theoretical point of view, it has lately undergone an extremely severe test under the officials of the Royal Automobile Club, and has emerged victorious. It is understood that a number of other manufacturers are now considering the adoption of the slide type of valve.

Another innovation is the use of air pressure to force the fuel up from low-lying tanks to the carburettor. This is claimed to be an improvement on the exhaust pressure feed, as being less likely to choke. As regards heavy oil engines, the chief improvement to be noticed is the widespread use of water injection, which is even more useful here than in a gas engine on account of the very low pre-ignition point of mixtures of oil vapour and air.

Attempts have continually been made to produce an engine working on the two-cycle principle, and there would seem to be no reason why engines of this kind should not be as practically successful as any built to operate on the four-cycle principle. One would expect that in this way a lighter engine could be built, and lightness is a great asset, particularly in the most recent use to which the internal-combustion engine has been put, viz. aëroplane work. Wonderfully light engines have already been made for this purpose. The 50 horse-power engine on the aëroplane *Silver Dart* weighs only 220 lb. without oil and water, or 4·4 lb. per horse-power. The 50 horse-power "Wolseley" V-type eight-cylinder engine, built for aëroplane work, is reported to weigh only 340 lb., or 6·8 lb. per horse-power, although the engine is fitted with a water-cooling system. The somewhat similar 80 horse-power engine fitted to Mr. Moore Brabazon's aëroplane is reported to weigh only 366 lb., or 4·6 lb. per horse-power; this is also a water-cooled engine. The possibilities of the different types of engine have lately been summarised in the technical Press[1] as follows:—

Type of engine	Weight per brake horse-power lb.	Weight of 50-brake horse-power engine lb.
Four-cylinder vertical	8 ...	400
Eight- ,, diagonal	6 ...	300
Diagonal, with several cylinders grouped on one crank pin ...	4 ...	200
Rotary	3 ...	150

From this it appears that engines amply light enough for aëroplane work have already been built, and there is not much scope left for any improvement in this direction for which the two-cycle engine would be useful, although there is still room for general improvement by the avoidance of the use in the engine parts of all heavy materials of low mechanical strength. On the other hand, the lighter the engine the better, as it means the possibility of adding additional accessories that make for constancy of operation, such as duplicate ignition, ample water-cooling arrangements, &c. The aëroplane appears to offer little chance of an "altitude stop" to permit of the engine being adjusted, and constancy of operation is therefore the one essential thing so far as the motor is concerned.

Carburettors are continually being improved, but the ideal one, which will give a constant mixture at all speeds and all loads in all weather conditions, has yet to be invented. The high-water mark as regards fuel economy that has so far been reached is the performance of the White and Poppe carburettor in the 1907 Royal Automobile Club trials of commercial vehicles. This carburettor was fitted to a Maudslay car, and showed the very high "figure of merit" of 62 gross ton miles per gallon of petrol, which is nearly twice as good as was obtained from the average car of that time. In the last two years the average has, however, risen appreciably. This, with an assumed road resistance of 50 lb. per ton, would correspond to an efficiency of power transmission between the carburettor and the road wheels of no less than 15 per cent. What the road resistance really was is not known, but now, without doubt, such road resistances ought to be accurately measured and the results applied.

[1] *Engineering*, April 16.

Conclusion.

With such a rapidly moving industry as that of the internal-combustion engine, prophesy is even more unsafe than it usually is. Writers have been bold enough to look forward to solid explosives being employed, but there one is faced with the difficulty of selecting any form of solid explosive that would have an entirely gaseous exhaust. When the gas turbine has taken practical shape, this consideration may be of less importance. Indeed, the combination of a solid explosive with a gas turbine promises this advantage, that the difficulty of the initial compression would thereby be removed. On the other hand, if we may judge by analogy with the steam turbine, provided that it were possible to keep the exhaust pressure sufficiently low, a high initial pressure would not be essential to economy. Whatever may be the outcome of the present experiments with gas turbines, or of gas producers, suitable for marine purposes on the one hand or to road transport on the other, one may be certain that the days of the external-combustion engine, the steam engine, are numbered, and that the engineers of the near future will not be satisfied with any less degree of efficiency than that which the internal-combustion engine will afford. One seems to see in the world of engineering the working of a continuous process leading to the supersession of those ideas, which, though old and tried friends, are found to produce less efficient results than those obtainable by more scientific methods. There is no reason that the writer can see to doubt the continued operation of this process during the present rivalry between the steam engine and the internal-combustion engine.

H. E. WIMPERIS.

OSMOTIC PHENOMENA AND THEIR MODERN PHYSICAL INTERPRETATION.[1]

OSMOTIC pressure is a phenomenon of such importance in the theory of solutions, and in the interpretation of all vital processes, and so much valuable work has recently been directed to its elucidation, that, although it is a somewhat thorny and difficult subject, no apology is needed for any serious attempt, however inadequate, at its explanation.

One of the earliest recorded experiments on osmotic pressure is that of the Abbé Nollet, who found that a bladder containing alcohol, when immersed in water, absorbed water so greedily as in many cases to burst the bladder. The experiment illustrates in an imperfect manner the fundamental property of all animal and vegetable membranes of allowing some substances to pass through them by osmosis more easily than others. In many cases such membranes, while freely permeable to water, are practically impermeable to certain substances in solution, and play the part of sieves in directing and controlling diffusion. It will readily be understood that results of the greatest importance to biology have been obtained by studying this property of *semipermeability*, as it is called, but the application of natural membranes to the physical study of the subject is necessarily limited on account of the difficulty of obtaining sufficiently large and perfect membranes capable of withstanding any considerable pressure.

[1] Discourse delivered at the Royal Institution on Friday, February 26, by Prof. H. L. Callendar, F.R.S.

Artificial membranes of sufficient fineness to be impermeable to such substances as sugar in solution, were first prepared by Traube by means of precipitated pellicles of substances like copper-ferrocyanide. The first quantitative measurements of osmotic pressures of considerable magnitude were made by Pfeffer with membranes of this kind deposited in the pores of earthenware pots fitted with suitable manometers for indicating the pressure developed. Pfeffer found that when a semipermeable vessel, filled with sugar solution, was immersed in water, the membrane being freely permeable to water, but not to the dissolved sugar, the solution absorbed water through the membrane by osmosis until the internal pressure reached a certain magnitude sufficient to balance the tendency to absorption. The osmotic pressure developed in the state of equilibrium was found to be proportional to the strength of the solution, and to increase with rise of temperature at the same rate as the pressure of a gas at constant volume. A few years later van 't Hoff, reviewing these experiments in the light of thermodynamics, showed that the osmotic pressure of a dilute solution should be the same as the pressure exerted by a number of molecules of gas equal to those of the dissolved substance in a space equal to the volume of the solution, that it should be the same for all solutions of equal molecular strength, and that osmotic pressure followed the well-known laws of gas-pressure in all respects. This most important generalisation was hailed as the first step to a complete kinetic theory of solution, and the osmotic pressure itself has generally been regarded as due to the bombardment of the sides of the semipermeable membrane by the particles of solute, as though they were able to move freely through the solution with velocities comparable to those of the molecules of a gas. Such a view would not now be seriously maintained, but the fascinating simplicity of the gas-pressure analogy has frequently led to the attempt to express everything in terms of the osmotic pressure, regarded simply, but inaccurately, as obeying the gaseous laws, and has done much to divert attention from other aspects of the phenomena, which, in reality, are more important and have the advantage of being more easily studied. It was very soon discovered that the gaseous laws for osmotic pressure must be restricted to very dilute solutions, and that the form of the laws was merely a consequence of the state of extreme dilution, and did not necessarily involve any physical identity between osmotic pressure and gas-pressure. Many different lines of argument might be cited to illustrate this point, but it will be sufficient to take some of the more recent experimental measurements of osmotic pressure by the direct method of the semipermeable membrane.

Morse and Frazer in 1905 succeeded in preparing ferrocyanide membranes impermeable to sugar, and capable of withstanding pressures of more than 20 atmospheres. They operated by Pfeffer's original method, allowing water to diffuse into the solution in a porous pot until the maximum pressure was developed. There are many serious experimental and manipulative difficulties which the authors carefully considered and discussed in applying this method, but they succeeded in obtaining very consistent results. As a first deduction from their investigations they considered that they had established the relation that the osmotic pressure of cane-sugar was the same as that exerted by the same number of molecules of gas at the same temperature in the volume occupied by the solvent, and not in the volume occupied by the solution. In other words, the osmotic pressure of a strong solution was greater than that given by van 't Hoff's formula for a dilute solution in proportion as the volume of the whole solution exceeded the volume of the solvent contained in it. It was a very natural extension of the gas-pressure analogy to deduct the volume occupied by the sugar molecules themselves in order to arrive at the space in which they were free to move. Unfortunately, the later and more accurate series of measurements by the same experimentalists at 0° C. and 5° C. gave nearly the same osmotic pressures as at 24° C., and would appear to show either that there is little or no increase of osmotic pressure with temperature, and that the pressures at 0° C. are much greater than those given by their extension of the gas-pressure analogy, or that one or other of the series of experiments are in error.

About the same time Lord Berkeley and E. J. Hartley undertook a series of measurements of the osmotic pressures of solutions of various kinds of sugar at 0° C. by a greatly improved experimental method, which permitted the range of pressure to be extended to upwards of 100 atmospheres. Instead of allowing the solvent to diffuse into the solution until the equilibrium pressure was reached, they applied pressure to the solution until balance was attained. The method of Lord Berkeley and Hartley possesses several obvious advantages, and it is impossible to study the original memoir without being convinced that they have really measured the actual equilibrium pressures with an order of certainty not previously attained or even approached. The pressures found were in all cases greatly in excess of those calculated from the gas-pressure of the sugar molecules in the volume occupied by the solution (according to van 't Hoff's formula for dilute solutions), or even in the restricted volume occupied by the solvent (according to Morse and Frazer's assumption).

Lord Berkeley endeavoured to represent these deviations on the gas-pressure analogy by employing a formula of the van der Waals type, with three disposable constants. Out of some fifty formulæ tested, the two most successful were those given in Table I. The constants A, a, and b were calculated to fit the three highest observations for each solution. Values calculated by the formulæ for the lower points were then compared with the observations at these points, with the results given in Table I. for cane-sugar. It is at once evident that, even with three constants, the gas-pressure analogy does not represent the results satisfactorily within the limits of error of experiment. Moreover, with three constants the equation cannot be interpreted, so that the gas-pressure analogy becomes useless as a working hypothesis or as a guide to further research. On the vapour-pressure theory, to be next explained, the results are much better represented, as shown in column C, with but a single constant, and that a positive integer with a simple physical meaning.

TABLE I.—OSMOTIC PRESSURES OF CANE-SUGAR SOLUTIONS.

Osmotic Pressures calculated by various Formulae.

Vant 't Hoff	Morse and Frazer	Lord B. (1)	Lord B. (2)	C.	Do. observed Lord B.
35·6	53·2	68·4	67·7	67·6	67·5
27·6	37·4	45·0	43·4	43·7	44·0
19·7	24·4	27·7	25·4	26·8	26·8
11·2	13·3	14·6	12·2	14·1	14·0

Lord Berkeley's equations:—

$$(A/v - P + a/v^2)(v - b) = RT \quad . \quad . \quad . \quad (1)$$
$$(A/v + P - a/v^2)(v - b) = RT \quad . \quad . \quad . \quad (2)$$

Vapour-pressure Theory.

On the vapour-pressure theory, osmotic equilibrium depends on equality of vapour-pressure, and not on an imaginary pressure which the particles of the dissolved substance would exert if they were in the state of gas at the same volume and temperature. The vapour-pressure of any substance is a definite physical property of the substance which is always the same under the same conditions of pressure and temperature and state, and is easily measured in most cases for liquids and solutions. Equality of vapour-pressure is one of the most general, as well as the simplest, of all conditions of physical equilibrium. Ice and water can only exist together without change under atmospheric pressure at the freezing point 0° C., at which their vapour-pressures are the same. Below the freezing point the vapour-pressure of water is greater than that of ice. Either is capable of stable existence separately within certain limits, but if the two are put in communication, the vapour, being mobile, passes over from the water at higher pressure to the ice at lower pressure until equality of vapour-pressure is restored by change of temperature, or until the whole of the water is converted into ice.

In the case of ice and water, equality of vapour-pressure can also be restored by a suitable increase of pressure.

This is the well-known phenomenon of the lowering of the freezing point by pressure. By considering the equilibrium of water and vapour in a capillary tube, Lord Kelvin showed that the vapour-pressure of water, or any other liquid, was increased by pressure according to a very simple law, the ratio of the increase of vapour-pressure, dp, to the increase of pressure, dP, on the liquid being simply equal to the ratio of the densities of the vapour and liquid, or inversely as the specific volumes, v and V. This relation, which may be written $VdP=vdp$, is merely a special case of Carnot's principle, and was deduced by assuming the impossibility of perpetual motion. Assuming a similar relation to apply to ice, Poynting showed that when a mixture of ice and water was subjected to pressure, the vapour-pressure of the ice must be increased more than that of the water (since the specific volume of ice is greater than that of water). Consequently, some of the ice must pass over into water, and the temperature must fall until the vapour-pressures are again equal. The lowering of the freezing point by pressure, as observed by Lord Kelvin, and calculated by James Thomson, agrees precisely with that deduced as above from the condition of equality of vapour-pressure.

Similar considerations apply to the equilibrium between a solution and the pure solvent, or between solutions of different strengths. To take a simple case, the vapour-pressure p'' of a sugar solution is always less than the vapour-pressure p' of water at the same temperature, and the ratio p''/p' of the vapour-pressures depends simply on the concentration of the solution, diminishing regularly with increase of concentration and being independent of the temperature. If separate vessels containing solution and water are placed in communication at the same temperature by a tube through which the vapour has free passage, vapour will immediately pass over from the water to the solution in consequence of the pressure difference, and will condense in the solution. The immediate effect is to produce equality of vapour-pressure by change of temperature. This takes only a few seconds. The vapour-pressure then remains practically uniform throughout. As diffusion proceeds and the temperature is slowly equalised, the water will gradually distil over into the solution, but the process of diffusion is so infinitely slow compared with the equalising of vapour-pressure that the final attainment of equilibrium would take years unless the solution were continually stirred.

The reason why equality of vapour-pressure is so important as a condition of physical equilibrium is that the vapour is so mobile and so energetic as a carrier of energy in the form of latent heat. The first effect is generally a change of temperature, but if the temperature is kept constant there must then be a change of concentration. Thus if two parts of the same solution are maintained at different constant temperatures, the concentrations will change so as to restore equality of vapour-pressure, if possible. Thus in a tube of solution the two ends of which are maintained at different temperatures, the dissolved substance will appear to move towards the hotter end. What really happens is that the vapour, which is the mobile constituent, moves towards the colder end. If the tube is horizontal, with a free space above the liquid for the vapour, this transference will be effected with extreme rapidity. In fact, it will be practically impossible to establish an appreciable difference of temperature until the transfer is effected. If the vapour has to diffuse through the solution in a vertical column heated at the top, the process is greatly retarded, but the final effect is the same, and can be readily calculated from the relation between the vapour-pressure and the concentration.

In explaining the production of osmotic pressure as a necessary consequence of the laws of vapour-pressure, there is one difficulty which, though seldom expressed, has undoubtedly served very greatly to retard progress. How can an insignificant difference of vapour-pressure, which may not amount to so much as one-thousandth part of an atmosphere in the case of a strong sugar solution at 0° C., be regarded as the cause of an osmotic pressure exceeding 100 atmospheres, or 100,000 times as great as itself? The answer is that the equilibrium does not depend at all on the absolute magnitude of the vapour-pressure, but only on the work done for a given ratio of expansion, which is the same in the limit for a gram-molecule of any vapour at the same temperature, however small the vapour-pressure. Indirectly, the smallness of the vapour-pressure may have a great effect in retarding the attainment of equilibrium, especially if obstructive influences, such as other vapours or liquids, are present. Thus mercury at ordinary temperatures in the open air is regarded as practically non-volatile. Its vapour-pressure is less than a millionth of an atmosphere, and cannot be directly measured, though it may easily be calculated. When, however, we take mercury in a perfect vacuum, such as that of a Dewar vessel, the presence of the vapour is readily manifested by its rapid condensation on the application of liquid air in the form of a fine metallic mirror of frozen mercury. The least trace of air or other gas in the vacuum will retard the condensation excessively.

Under the conditions of an osmotic-pressure experiment we have solvent and solution in practical contact, separated only by a thin porous membrane. It will facilitate our conception of the conditions of equilibrium if we imagine the membrane to be a continuous partition pierced by a large number of very fine holes of the order of a millionth of an inch in diameter. If the holes are not wetted by the solution or the water, the liquid cannot get through unless the pressure on it exceeds 100 atmospheres, but the vapour has free passage. If the solvent and solution are under the same hydrostatic pressure the vapour-pressure of the solvent will be the greater, and the vapour will pass over into the solution. Since the surfaces are practically in contact, no appreciable difference of temperature can be maintained. If the solution is confined in a rigid envelope, so that its volume cannot increase, the capillary surfaces of the solution will rapidly bulge out as the vapour condenses on them, and the pressure on the solution will increase until condensation finally ceases, when the vapour-pressure of the solution is raised to equality with that of the pure solvent. The osmotic pressure is simply the mechanical pressure-difference which must be applied to the solution in order to increase its vapour-pressure to equality with that of the pure solvent. If any pressure in excess of this value is applied to the solution, the vapour will pass in the opposite direction, and solvent will be forced out of solution. The osmotic work required to force a gram-molecule of the solvent out of the solution is the product of the osmotic pressure P by the change of volume U of the solution per gram-molecule of solvent abstracted. In the state of equilibrium of vapour-pressure, this osmotic work PU must be equal to the work which the vapour could do by expanding from the vapour-pressure p' of the pure solvent to the vapour-pressure p'' of the solution. Neglecting minor corrections, we thus obtain the approximate relation

$$PU = R\theta \log (p'/p'').[1]$$

From this point of view the osmotic pressure of a solution is not a specific property of the solution in the same sense as the vapour-pressure, or the density, or the concentration, but is merely the mechanical pressure required under certain special conditions to produce equilibrium of vapour-pressure when neither the temperature nor the concentration are allowed to vary. One might with almost equal propriety speak of the "osmotic temperature" of a solution, meaning by that phrase the difference of temperature required to make the vapour-pressure of the solution equal to that of the pure solvent. The observation of the elevation of the boiling point of a solution above that of the pure solvent is a familiar instance of a special case of such a temperature difference. It is just as much a specific property of the solution as the osmotic pressure, and would only require a perfectly non-conducting membrane for its production. No one would regard the rise of boiling point as being the fundamental property of a solution in terms of which its other properties should be expressed. By similar reasoning osmotic pressure should not be regarded as existing *per se* in the solution, and as being the cause of the relative lowering of vapour-pressure and other phenomena. This point of view does not detract in any way from the reality and physical

[1] Obtained by integrating $UdP=vdp$. Planck, "Thermodynamik," also *Zeit. Phys. Chem.*, xli. 212, 1902, and xlii. 584, 1903.

importance of the effects of osmotic pressure when it comes into play, but it puts the phenomena in their true light as consequences of the law of vapour-pressure.

Regarded as a verification of the laws of vapour-pressure, direct measurements of the osmotic pressure are of the highest value, but there are comparatively few cases known at present in which such direct measurements are possible. In other cases the osmotic pressure, if it exists, can always be calculated from a knowledge of the vapour-pressure. For the elucidation of osmotic phenomena and many other problems in the theory of solutions we are compelled to make a systematic study of the relations of vapour-pressure. Much has been done in this direction in the past, but, owing to the difficulty of the measurements, much remains yet to do. I may, therefore, be pardoned if I allude briefly to some of the methods which I have employed for this purpose, and some of the conclusions at which I have so far arrived.

It is often a difficult matter, when the difference of vapour-pressure between a solution and the solvent is small, to measure the pressure difference directly to a sufficient degree of accuracy. A method very commonly employed, which has been brought to a high degree of accuracy by Lord Berkeley and his assistants, depends on the observation of the losses of weight of two vessels, containing solution and solvent respectively, when the same volume of air is aspirated slowly through them in succession. To secure accurate results, the air must pass very slowly. One complete observation takes about a week to perform successfully, and involves many difficult manipulations. I have endeavoured to avoid this difficulty by measuring the temperature difference in place of the pressure difference, since the temperature difference remains nearly constant, while the pressure difference tends to diminish in geometrical progression with fall of temperature. The method adopted for this purpose is that indicated in the diagram of the vapour-temperature balance. The temperatures of solution and solvent, contained in separate vessels communicating through a tap, are adjusted until, on opening communication between them, there is no flow of vapour from one to the other, as indicated by a change in the reading of a pair of thermojunctions immersed in the solvent respectively. The corresponding difference of temperature is observed, and since the vapour-pressures of the solvent are known, it is easy to calculate the required ratio or difference of the vapour-pressures of solvent and solution at the same temperature. When the vapour-pressures are very small it may be difficult to observe the change of temperature on opening the tap unless the apparatus is very carefully exhausted. A more delicate method in this case is to observe the direction and magnitude of the current of vapour from solution to solvent, or *vice versâ*, by means of the "vapour-current indicator," illustrated in the companion diagram. This consists of a delicately suspended vane, the deflections of which are read by a mirror, and will readily indicate a difference of pressure less than the thousandth part of a millionth of an atmosphere.

The vapour-current indicator is so constructed that its deflections are very accurately proportional to the pressure difference, much more so, in fact, than any form of electric galvanometer. It can also be employed for direct measurements of small differences of vapour-pressure. The chief difficulty in this case is to ensure the absence of air or other disturbing factors. A method of avoiding this difficulty is to work at atmospheric pressure, and to measure the pressure difference between two vertical columns of air saturated with the vapours of the solvent and solution respectively.[1] The temperature difference may be adjusted to balance, and is preferably measured by means of a pair of differential platinum thermometers, which permits a higher order of accuracy to be attained than the thermoelectric method.

Vapour-pressure in relation to Molecular Constitution.

The well-known law of Raoult, according to which the relative lowering of vapour-pressure of a solution is equal to the ratio of the number of molecules n of the solute to the number of molecules of solvent N in the solution, has thrown a great deal of light on the molecular state of the dissolved substance in dilute solutions, but fails notably in many cases when applied to strong solutions. In the case of homogeneous mixtures of two indifferent volatile substances, such as benzol (C_6H_6) and ethylene chloride ($C_2H_4Cl_2$), which mix in all proportions without mutual action, a slightly different but equally simple law is known to hold very accurately throughout the whole range of concentration from 0 per cent. to 100 per cent. The vapour-pressure of each ingredient is simply proportional to its molecular concentration. In other words, the ratio of the partial vapour-pressure p' of either constituent at any concentration to its vapour-pressure p_0' in the pure state at the same temperature is equal to the ratio of the number of its molecules n' in the solution to the whole number of molecules $n'+n''$ of both substances in the solution. Such is evidently the form of the simple mixture law. For substances which form compounds in the solution, or the molecules of which are associated or dissociated, this simple law is widely departed from. In a recent paper, "On Vapour-pressure and Osmotic Pressure of Strong Solutions" (Proc. R.S.A., vol. lxxx., p. 466, 1908), I have endeavoured to extend this simple relation to more complicated cases by making the obvious assumption that, if compound molecules are formed, they should be counted as single molecules of a separate substance in considering their effect on the vapour-pressure. With this proviso the vapour-pressures of strong solutions are well represented by a natural extension of the simple mixture law, and it becomes possible to investigate the nature of the compounds formed in any case. To take a simple instance, suppose that each of the n molecules of the dissolved substance combines with a molecules of the solvent, the total number of molecules of the solvent being N. The ratio of the vapour-pressure p'' of the solvent in the solution to the vapour-pressure p' of the pure solvent at the same temperature will then be the same as the ratio of the number $N-an$ of molecules of *free* solvent in the solution, to the whole number of molecules $N-an+n$ in the solution, each compound molecule being counted as a single molecule.

With the simple formula

$$p'/p''=(N-an+n)/(N-an),$$

the values of the vapour-pressure are very easily calculated from the molecular concentration n for simple integral values of the hydration factor a. The osmotic pressures are also readily deduced from the ratio of the vapour-pressures (p'/p'') by the formula

$$PU=RT\log(p'/p'').$$

The value $a=5$ fits the osmotic pressures for cane-sugar very well, as shown in the column headed C in Table I. The value $a=2$ fits Lord Berkeley's observations on dextrose equally well up to pressures of 130 atmospheres. The same value $a=5$ for cane-sugar also fits the observations on the depression of the freezing point and the rise of the boiling point, as it necessarily must, since these phenomena also depend on the vapour-pressure. The freezing-point method is the easiest for getting the ratio of the vapour pressures to compare with the formula. At the freezing point of an aqueous solution the vapour-pressure of the solution must be the same as that of ice, provided that ice separates on freezing in the pure state. The ratio of the vapour-pressure of ice to that of water at any temperature below 0° C. is easily calculated. All the best recorded results, except those of a few associating substances, give simple positive integral values of a. Even in the case of associating substances, like formic acid and acetone, the curves are of the same type, but the value of a is negative. Dissociating substances, like strong electrolytes, present greater difficulties, on account of the ionisation factor; but, allowing for the uncertainty of the ionisation data, they seem to follow satisfactorily the same law of vapour-pressure.

It appears from the form of the proposed law that the hydration factor a makes very little difference to the vapour-pressure in weak solutions, which follow Raoult's law as a limiting case, but it makes a very great difference in strong solutions, when nearly all the free water is used up, and the denominator $N-an$ is small. Thus

[1] I first showed this experiment ten years ago, in illustration of the delicacy of the apparatus, at a Friday Evening Lecture at the Royal Institution.

the depression of the freezing point of a strong solution of calcium chloride is more than five times as great as that calculated from the number of ions present in the solution. Each ion appears to appropriate no less than 9 molecules of water. The factor $a=9$ gives a very good approximation to the freezing-point curve, as far as the uncertainty of the data permit. When $N=an$, the vapour-pressure would be reduced to zero, according to the formula, but the formula ceases to apply when the vapour-pressure of the compound molecules themselves becomes equal to that of the solution. At or before this point the molecules will dissociate with the formation of lower hydrates. Many analogous phenomena are already known, and a more complete study of the vapour-pressures of strong solutions may be expected to throw additional light on the subject.

The essential point of the theory here sketched is that the equilibrium existing in a solution is one between definite chemical compounds and the solvent, giving rise to a simple vapour-pressure relation by means of which the phenomena may be studied and elucidated. There is a great deal of work to be done before such a theory can be regarded as established, but in the meantime it may serve very well as a working hypothesis for correlating experimental results and suggesting new lines of investigation. Regarded in this light, the vapour-pressure theory may serve a useful purpose, and, judging by the experimental data at present available, I think I may fairly claim to have made out a good *primâ-facie* case for the theory.

NOTE.—The vapour-current indicator is a development of the old smoke-jack. A light spiral vane with a mirror attached is suspended in a tube, which nearly fits it, by means of a quartz fibre. Joule (Proc. Phil. Soc., Manchester, vii., 35) employed a wire spiral suspended by a silk fibre for indicating air currents, but does not seem to have adapted it for purposes of exact measurement. The instrument shown in the lecture gave a deflection of 30° (500 mm. at 1 metre) for a velocity of air current 0·01 cm./sec. The sensitiveness might easily have been increased, but the above amply suffices for most purposes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

REUTER'S Agency states that the Hong Kong and Shanghai Bank has made a donation of about 4500*l.* to the Hong Kong University.

PROF. W. OSLER, F.R.S., will deliver the inaugural address of the winter session of the London School of Tropical Medicine on Tuesday, October 26.

MR. W. H. HADOW, fellow and tutor of Worcester College, Oxford, has been appointed principal of Armstrong College of Durham University at Newcastle-on-Tyne, in succession to Sir Isambard Owen, who has accepted the Vice-Chancellorship of Bristol University.

WE learn from *Science* that the College of Agriculture of the University of the Philippines, situated at Los Banos, opened on June 14 last with about sixty students. Prof. E. B. Copeland is dean and professor in botany; Prof. H. Cuzner, professor of agronomy; Prof. E. M. Ledyard, professor of zoology; and Prof. S. B. Durham, professor of animal husbandry.

A CORRESPONDENT asks us to mention that a man with a science training and degree is wanted for a vacant post in an advanced mission college in South China. The Chinese are eager to acquire the secrets of Western power, and a teacher with the science qualifications required would have a fine opportunity of assisting to make history in that great land.

WE learn from the *Pioneer Mail* that on July 14 the Governor of Madras opened a new agricultural college and research institute at Coimbatore. The building is designed both for teaching and research work. A special set of rooms is set apart for chemistry, botany, entomology, and mycology. A physical laboratory is provided, as well as ample accommodation for the Madras herbarium and a library. The cost of the new institution, including the surrounding farm, has been eight lakhs. The Governor, during the course of his remarks, said that as the demands of scientific agriculture grow and the necessity for expansion arises, the Government will not hesitate to increase the capacity of the institution.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 9.—M. Bouquet de la Grye in the chair.—The thermal effects of moistening soils: A. **Müntz** and H. **Gaudechon.** Certain dry soils, when moistened, give out an appreciable amount of heat, and it is possible that this thermal phenomenon may have an effect on the growth of plants. Measurements with different soils gave an evolution of heat varying from 0·9 to 6·6 calories per kilogram, and a systematic levigation showed that the finest particles caused nearly all the heat evolution.—Magneto-anodic phenomena: M. **Gouy.** The phenomenon described accords to a certain extent with the theory of M. Fortin, which regards the magneto-kathode rays as formed of spirals of electrons.—Discontinuous singularities of uniform analytical functions: A. **Denjoy.**—Tides and the crust and the elasticity of the terrestrial globe: Ch. **Lallemand.** The author has shown in a previous note that the principal modes of determination of the rigidity of the globe lead to different results. The theory developed in the present paper removes this anomaly.—The different species of asymmetrical intensities, observed for the magnetic components, polarised circularly, of the absorption bands of uniaxial crystals: Jean **Becquerel.**—The decomposition of carbon dioxide by the ultra-violet rays: H. **Herchefinkel.** The decomposition of carbon dioxide into oxygen and carbon monoxide by the action of the ultra-violet rays has been proved; a similar result has been obtained with the radium emanation, confirming the observations of Ramsay and Cameron.—The intervention of osmotic pressure in dyeing: M. **Rosenstiehl.**—A method for the rapid estimation of metallic aluminium: E. **Kohn-Abrest.** The metal is heated to 300° C. first in hydrogen, and then in pure hydrochloric acid gas, followed again by hydrogen. The aluminium is volatilised as chloride, and the metal determined indirectly by a determination of the chlorine.—Attempts at benzidination in the diphenyl, diphenylamine, and diphenylethane series: H. **Duval.**—The ethyl acetal of tetrolic aldehyde: P. L. **Viguer.** Dibromo butyric aldehyde was obtained by the addition of bromine to crotonaldehyde; the application of Claisen's method to this aldehyde gave, not the tetrolic aldehyde desired, but its ethyl acetal.—Some parasitic diseases of *Cinnamomum zeylanicum* of Ceylon: D. **Bois** and C. **Gerber.**—Vaccination of cattle against tuberculosis: M. **Rappin.** The bacilli used in these injections were modified by the action of sodium fluoride; it has been shown that the resistance of the animal to tuberculous infection is increased by the treatment almost to the point of immunisation.—The glucoses of the urine: F. **Landolph.** Each species of glucosuria or diabetes corresponds, in the urine, to the presence of mixtures of several kinds of sugars, and it may be supposed that these differences correspond to diseases of different organs.—The preservation and increase of digestibility of distillery pulps and of green ensilage by a rational fermentation by inoculation: J. **Crolbois.**—The suprarenal capsules and their exchanges between the blood and tissues: J. **Athanasiu** and A. **Gradinesco.** The experiments on a dog and a cat described lead to the conclusion that the death of animals deprived of the suprarenal capsules is due to the arrest of the exchanges between the blood and the tissues.—Contribution to the study of urinary indosis in diabetic subjects: H. **Labbé** and G. **Vitry.**—The variation of an oxidising enzyme during metamorphosis in *Limnophilus flavicornis*: Xavier **Roques.**

CAPE TOWN.

Royal Society of South Africa, June 16.—Dr. R. Marloth in the chair.—Some points in the morphology and biology of a new species of Haworthia: Dr. S. **Schönland.** The author gives a full description of the only species of Haworthia with strictly distichous arrangement of leaves. The leaves are to a large extent underground, the exposed parts resembling small pebbles, so that this plant may be classed amongst the so-called "mimicry-plants." The structure of the leaves is adapted to the peculiar mode of life of the plant. The truncate apex is without chlorophyll, thus forming a "window," through which light can reach, by way of the central transparent tissue, the assimilating tissue which extends to the underground basal parts of the leaves.—The absorption of water by the aërial organs of some succulents: Dr. S. **Schönland.** The author describes numerous experiments, from which he has drawn the following conclusions:—*Mesembrianthemum barbatum* and *Anacampseros flamentosa* cannot absorb any appreciable quantity of water through their aërial organs. *Crassula cymosa* can do so to a small extent, which, however, cannot be of any practical importance under natural conditions. The marginal papillæ of this species are certainly not water-absorbing organs.—Note on an abnormal seedling of *Widdringtonia cupressoides*: E. P. **Phillips,** and a brief account of the vascular system of the normal seedling: H. S. **Morris.**—Some new South African succulents, part ii.: Dr. R. **Marloth.** Among the succulents described in this paper are a few with a very peculiar structure of their leaves. Last year the author exhibited a species of Bulbine with window-leaves, pointing out that such a structure had not been observed as yet on any other plant. The very succulent, nearly egg-shaped leaves of the plant remain embedded in the ground, hence the blunt apex only becomes visible. Here the green tissue is absent, being confined to the sides of the leaf. As the sides are surrounded by soil, the light cannot reach them in the ordinary way, but only by entering through the window at the apex, illuminating the leaf from within. Since then the writer found five other species of plants with such window-leaves. They are all stemless succulents, their leaves remaining embedded in the ground, and showing only the flat or convex apex, which is entirely devoid of green tissue. Hence, as in the case of the Bulbine, the light can reach the green tissue of the leaf only through the window, illuminating the leaf from within. It is considered that this structure is principally a contrivance for the protection of the green tissue against the destructive action of too severe sunlight.

NEW SOUTH WALES.

Linnean Society, June 30.—Mr. C. Hedley, president, in the chair.—Studies on Tunicata, No. 1: H. L. **Kesteven.** One genus allied to Polyclinum and Sidnyum (Polyclinidæ), and three species referable to the genera Corella, Molgula, and Dendrodoa, from Tasmania or New South Wales, are described as new, and detailed descriptions are given of *Ciona intestinalis*, var. *sydneiensis*, Stimpson, and var. *diaphnea*, Quoy and Gaimard.—Second supplement to the "Revision of the Cicindelidæ of Australia": T. G. **Sloane.**—The hexone bases of egg-white: Dr. J. M. **Petrie** and Dr. H. G. **Chapman.** This paper deals with the separation and estimation of the hexone bases among the products of the hydrolysis of the proteins of egg-white. By the method of Kossel and Patten, arginin, histidin, and lysin were isolated and identified from egg-white digested with 25 per cent. H_2SO_4. The amounts of lysin, histidin, and arginin present in 100 gm. protein of egg-white were:—lysin, 3·19 gm.; histidin, 0·66 gm.; and lysin, 2·39 gm. Certain improvements in the method of separation are also described.—Notes on the native flora of New South Wales, part vii., eastern Monaro: R. H. **Cambage.** The general botany of the area lying chiefly to the east of Cooma and Nimitybelle is reviewed. The absence of forest growths on the Monaro plains, which are largely basaltic, is a striking feature, and it is suggested that the rigid winter climate, dry summer atmosphere, moderate rainfall (being less than 20 inches annually at Cooma), together with the basic nature of the rocks, in view of the low rainfall, all contribute to hinder the growth of large trees. Where the formation contains a high percentage of silica forest trees are found, and this is thought to be possibly owing to physical properties rather than to chemical constituents, resulting in capillarity being induced by the siliceous particles in the soil, thereby enabling it to supply moisture in dry times better than the soils formed from the basic rocks. The unexpected occurrence of a rare species of Eucalyptus, *E. pulvigera*, first discovered by Allan Cunningham nearly ninety years ago at Cox's River, and now known to occur only in three localities, was of interest. The abrupt change in the flora, where the eastern and western aspects meet on the Main Dividing Range near the head of the Kybean River, is commented upon.—Description of a new species of Eucalyptus from the Monaro district, N.S.W.: R. H. **Cambage.** This species, for which the name *Eucalyptus parvifolia* is suggested, has so far only been found near the head of the Kybean River, on eastern Monaro. It frequents the flats in company with *E. stellulata*, attaining a height of from 20 feet to 30 feet, and having a smooth gum-tree bark. Its most remarkable feature is that it retains a large percentage of the juvenile foliage until the trees are nearly full-grown, the length of these leaves being rather less than 1 inch.

CONTENTS.