THURSDAY, AUGUST 20, 1908.

## HEREDITY.

*Heredity.* By Prof. J. Arthur Thomson. Pp. xvi+605. (London: John Murray, 1908.) Price 9*s.* net.

WE all know books on science which we ought to read with pleasure, but to which we turn with shrinking. Full, perhaps, of new facts and ideas, they are so expressed as to bore consumedly. "Heredity" belongs to another category. He who runs may read, even if he be a beginner, and he who reads will probably not cease to run until he has traversed the last page. It contains nothing very new, but most of the facts on which we found our notions of heredity are set out lucidly and in orderly array, as are almost all the theories ever based on them. It is dedicated to "Francis Galton and August Weismann, whose magistral studies on heredity have made us all their debtors." Prof. Thomson is very loyal to the masters.

The outstanding feature of the book is its great, perhaps its excessive, kindliness and toleration. Probably few biologists agree so thoroughly with so many of their fellows as the author. Practically the only hard things he has to say are about "hereditary tendencies" and "principles of heredity," which seem to him "in part the old story of explaining the working of the clock by 'principle of horology' and in part a pedantic way of saying 'we don't know.'" But for many years no serious student of science has used the word principle except as a synonym for that brief and comprehensive summary of facts which is otherwise termed a "law." We speak of the "principles of psychology," the "principles of geology," and so forth; and surely the germ of a mouse develops into a mouse, and not into a beetle, because it has, among other things, a tendency, a "predisposition" to do so. "Predisposition" is, oddly enough, approved by Prof. Thomson, who pronounces predispositions to be "mysterious" but not "mystical." No doubt they are quite as mysterious but not more mystical than eyes and noses.

The book has many merits, not the least of which are its comprehensiveness and literary charm. Its principal defect is lack of that "rigorous deductive inference of consequences" by means of which we link together and test hypotheses and so ascertain whether they are in harmony with one another and "with the conceived system of reality." It is not sufficiently critical. Theories, even when incompatible, are set out with an appreciation that is equally cordial. The law of ancestral inheritance, the theory of the continuity of the germ-plasm, and the theory of recapitulation are conspicuous examples. A statistical inquiry led Galton to the conclusion that, on the average, progeny resemble progenitors in certain degrees, whence he drew the deduction that the heritage of descendants is compounded in the stated proportions of ancestral contributions. I have ever been doubtful of the precise meaning of the term "contribution," but apparently it implies more than mere resemblance, or it would not be used. Readers of "Heredity" will be sure to conceive a contribution as an actual something contributed to the germ-plasm by the progenitor.

Passages like the following abound:—"We know . . . that the parental heritages include ancestral contributions which may be expressed in development or lie latent." But this notion will be hard to reconcile with the idea that "the parent is rather the trustee of the germ-plasm than a producer of the child." If, however, readers elect to regard "contribution" as synonymous with Weismann's "ancestral plasm" (a collection of determinants similar to that which controlled the development of the ancestor), they will be puzzled to reconcile the statement that "an individual inheritance is a mosaic of parental and ancestral plasms" with the theory that "the individual development, especially in the stage of organ-forming, is in some measure a recapitulation of the racial history," a theory which represents ancestral contributions, not in the form of a mosaic, but in that of a series. Must we assume, then, that the remote ancestors, in whom the organs were evolved, contributed to a series, but more recent ancestors to a mosaic; or is it the right view that, since the characters of the organism vary independently, retrogression in some characters, combined with progression in others, produces, in part at least, the *appearance* of a mosaic?

Every generation follows more or less closely in the developmental footsteps of the preceding generation, and every progressive variation prolongs development by adding itself to the sum of those already made and preserved during phylogeny. Of course, therefore, development is, with large reservations, a recapitulation of the life-history. Preservation (*i.e.* reproduction) implies recapitulation. Presumably the germ-plasm can lose as well as gain; that is, failure to complete the recapitulation of the parental development in any particular may be due to true variation, not merely result from injury received during development as Prof. Thomson seems to imply. Suppose an individual varied in such a way as to lapse the progressive variations of many ancestors; then, as regards the character in question, he would be in the position of a more or less remote ancestor. Is this reversion? If not, why not? According to Prof. Thomson only the reappearance of a latent character constitutes reversion. He would find it hard to justify his position.

He insists, as others have done, that "filial regression has nothing to do with reversion," because "there is a levelling up as well as a levelling down." But the fact, admitted by him, that cessation of selection tends to be followed by retrogression, indicates that on the whole there is a greater tendency to level down than to level up. In other words, retrogressive variations tend to predominate over progressive variations. If, then, development is modified recapitulation, it is plain that filial regression has something to do with reversion. At any rate, the attempt to link the two together is not necessarily due to misunderstanding. Doubtless regression is not always a

"biological term," but when we speak of filial regression it is.

He gives full weight to the question of the transmission of acquirements, but declares that "some subtle minds have found satisfaction in maintaining that the distinction between an acquired modification and an inborn variation is a distinction without a difference." He is mistaken. It has been maintained merely that the erroneous terms "innate" and "acquired" obscure rather than reveal the very real and immensely important difference between the two classes of characters.

He discusses the Mendelian experiments which demonstrate that in certain cases descendants tend to reproduce the unlike characteristics of ancestors in the well-known proportion, and alludes to the "increased subtlety of Mendelian interpretation." The facts are compatible with a theory of segregation or with one of latency of the recessive in the pure dominant, and *vice versâ*. He does not mention, however, the crucial instance of the reappearance of latent ancestral characters in *pure-bred* varieties in which can have occurred no re-union of previously separated colour (or other) factors.

One of the principal topics discussed is the question of the causation of variations. The evidence is that some are due to the direct action of the environment (nutriment, toxins and the like) on the germ-plasm, while others are spontaneous in the sense that they result from a tendency to vary as much inherent in the germ-plasm as its tendency to grow and divide. But what is the origin of the great mass of variations, those on which racial change is founded? If variations are *usually* caused by direct action, then a human race, constantly exposed to a virulent toxin (*e.g.* that of malaria) or to such a complex of ill-conditions as that found in the slums of great cities, should deteriorate steadily. Natural selection could have no scope, for every generation would be inferior to its predecessor. The race would drift helplessly. If, on the contrary, variations are, with rare exceptions, spontaneous, and occur all round the specific mean, natural selection has scope, and every race, or section of a race, tends to become resistant to the ill-conditions to which it is exposed. Prof. Thomson holds the first opinion, and draws his arguments mainly from medical sources. From time immemorial doctors have attributed all sorts of filial and racial degeneracy to all sorts of parental mishap. Lately, however, a rapid change of opinion has occurred, as may be seen by examining the report (just published) of the Royal Commission on the Care and Control of the Feeble-minded. The Commission follows Sir E. Ray Lankester, who declares that "no facts are known which support these imaginative teachings." Alluding to the rather widely known fact that every race is resistant to every ill-condition precisely in proportion to the length and severity of its past experience of it, it declares that "It is not to be conceived that a race which deteriorates in every generation can emerge from the struggle not weakened, but strengthened." In truth, the hypothesis that variations are usually due to direct action is wholly incompatible with the theory of natural selection, which, nevertheless, Prof. Thomson upholds. If additional evidence be needed it is furnished by plants, which, when propagated asexually and taken to all climates of the world, hardly vary until the first seminal generation, and then not more apparently than if no such long and diverse exposure of the germ-plasm had occurred. Obviously variations occur normally precisely when they are useful—at the genesis of a new individual when they furnish materials for natural selection. It seems reasonable to conclude, therefore, that they are under the control of natural selection, a superior or inferior tendency to vary being in itself a variation liable to selection. This hypothesis is strongly confirmed by the fact that retrogressive variations tend to predominate over progressive variations—an immensely useful tendency, for, while useful variations and structures are preserved by natural selection, useless variations and structures are planed away without elimination of individuals.

When cultivated in non-living media, the parasitic microbes of disease gradually lose their virulence, which is nothing other than the means by which they protect themselves from the cells of the body. Non-virulent saprophytic micro-organisms, introduced under fit conditions into the living body, gradually acquire virulence. In the one case, apparently, retrogression follows cessation of selection, in the other progression follows selection. The widely accepted hypothesis that microbes "acquire" and transmit virulence in the Lamarckian sense is demonstrably untenable. How could the direct action of the environment on the bodies of the microbes cause them to "acquire" the mechanism necessary for the production of such adaptive and elaborate chemical compounds as toxins? Presumably all parasitic microbes have evolved from saprophytic types. Men have made the microbes of human diseases virulent, and each human disease has made the race exposed to it resistant to itself. While races (*e.g.* British and Negro) which have evolved in conjunction with their familiar diseases (*e.g.* tuberculosis and malaria) are able to persist when exposed to them, other races (*e.g.* Polynesians and Red Indians) tend to perish. Disease supplies the only instance in nature in which we are able to see natural selection actually at work, and the study of diseases reveals a multitude of very beautifully adjusted and unmistakable adaptations. The facts are not disputed; the inferences, I believe, are indisputable. Prof. Thomson thinks, however,

"It would be a subtler and more convincing line of argument to say that, throughout the ages, man has been selecting the microbes, lessening the virulence, in a sense taming them—sometimes to death—as his phagocytes were strengthened by more suitable food, or as his 'opsonic' index improved, again also in relation to food."

He means that man has somehow selected the weaker, the less protected, of his persecutors for survival, that his present food would have been more suited to his ancestors than that which evolution fitted them to consume, and that negroes are more resistant than Englishmen to malaria because they are better

fed, Englishmen more resistant than negroes to tuberculosis for the same reason, and Polynesians less resistant than both races to a multitude of diseases because they are worse fed.

G. ARCHDALL REID.

## EGYPT AND BABYLONIA.

*Egypt and Western Asia in the Light of Recent Discoveries.* By L. W. King and H. R. Hall. Pp. viii+480; illustrated. (London: Society for Promoting Christian Knowledge, 1907.) Price 10s.

THIS handsome volume from the pens of Messrs. King and Hall, of the British Museum, is intended as a supplement, or, as the authors modestly express it, "an appendix or addendum," to include all the most recent results of discoveries in Egypt and Western Asia, and thereby bring up to date the three volumes of Prof. Maspero on "The Ancient History of the Peoples of the Classic Orient," which the Society for Promoting Christian Knowledge issued between 1894 and 1896.

The period since the last volume of Prof. Maspero's history appeared has been one very rich in discovery, and archæologists have been busy with the spade in the Greek islands and mainland, in Asia Minor, the Euphrates and Tigris valleys, as well as in Egypt and Nubia, with most startling results. In 1894 we were almost in the dark as to Egyptian history prior to the time of Snefru, the last king of Manetho's Third Dynasty, and prehistoric Egypt was practically unknown. The so-called Minoan civilisation of Crete was undreamt of, and hardly anything was known about the early peoples of Syria and Asia Minor. Now, thanks mainly to the work of M. de Morgan, Prof. Flinders Petrie, Dr. Arthur Evans, and Prof. Winckler, we can extend our vista far beyond the horizon of 1896.

It is with the discovery of prehistoric Egypt that the volume before us opens, and here the authors bring together the latest results of the explorer in the field of prehistoric antiquities in the Nile Valley. They finally dispose of the old theory maintained by Petrie and Blankenhorn that the desert plateaus on both sides of the valley were in Palæolithic days clothed with forest, and they bring forward the more reasonable one promulgated by Beadnell that the torrents which are sometimes experienced in the desert at the present day would have been enough to have cut out the deep ravines or *wadis* in the limestone rock such as we see at Thebes in the famous ravine called the Valley of the Tombs of the Kings. Whether Palæolithic man in Egypt—where he is represented by thousands of flint tools from the desert plateaus—was contemporary with the Cave man of Europe we do not know; nor are there any data whereby even a rough estimate can be made as to when the Palæolithic period was succeeded by the Neolithic. For a considerable time anterior to the First Dynasty, copper as well as stone weapons were in use, so that even before the beginning of the historical age the Egyptians were living in the "Chalcolithic" period. The beginning of the Dynastic age is placed by Messrs. King and Hall at about 4500 B.C. (p. 13), but this does not at all agree with the latest researches into the vexed question of Egyptian chronology, which tend rather to diminish than to lengthen out the hitherto accepted chronology. A most important monograph on this subject was written by Prof. Eduard Meyer in 1904, and is printed in the *Abhandlungen* of the Konigl. Preuss. Akademie der Wissenschaften (with a *Nachträge*, 1908); but this the authors do not seem to know, nor do they refer to Prof. Breasted's concise summary of the facts relating to Egyptian chronology in the first volume of his "Ancient Records." A perusal of Meyer's or Breasted's works will show that there is very good reason for placing the beginning of the First Dynasty at not earlier than about the year 3500 B.C.

Regarding the question as to the origin of the Egyptians, Messrs. King and Hall point out that in the early dynastic period two races lived in Egypt which differed considerably in type and also in burial customs. The Dynastic people, they believe, came originally to the Nile Valley from the shores of the Red Sea by way of the Wady Hammamat, to Koptos and Kûs.

"From many indications," they say, "it would seem probable that these conquerors were of Babylonian origin, or that the culture they brought with them (possibly from Arabia) was ultimately of Babylonian origin."

The Lower Egyptians, who were conquered by the Dynastic race, were possibly of Mediterranean stock, akin to the primitive inhabitants of Palestine, Greece, Italy, and Spain.

The second chapter deals with Abydos and the first three Egyptian dynasties, but the authors do not appear to have any very clear idea as to the real history of this early period. On p. 73 it is said that the "King Sma" is "possibly identical with Aha or Narmer, more probably the latter." There is, in fact, no evidence whatever that Sma is the name of a king or even of a person at all, while, on the other hand, it is a well-known title meaning "consort," and was often assumed by queens. On pp. 61–62 it is said that Narmer is not represented at Abydos, yet at least half-a-dozen monuments bearing his name have come from there. There has been much discussion as to the validity of Dr. Borchardt's identification of King Aha with Menes, the traditional founder of the monarchy; Messrs. King and Hall dismiss the subject by saying (p. 76): "Whether Aha was called Men or not it seems evident that he and Narmer were jointly the originals of the legendary Mena." The nomen of Khasekhem, we note, is given as "Besh," but this is very doubtful; the name of the last king of the First Dynasty is transliterated everywhere as Qa, whereas, surely, the right reading is Qa-a, "the high of hand."

In the third chapter the authors discuss recent discoveries relating to Memphis and the Pyramids, and advance the theory that the city of Memphis was built by Merbapa, the Miebis of Manetho's list, and not "by the legendary and confused Mena." In support of this it may be noted that Merbapa heads the list of kings of the Sakkara Canon.

The fourth, fifth, and sixth chapters are devoted to

an account of recent research in Western Asia, and are important as giving a summary of all the latest results achieved by explorers in the valleys of the Tigris and Euphrates. The authors repeat the view recently brought forward by Mr. King that the first Babylonian dynasty was in part contemporaneous with the second, and that the latter consisted of Sumerian kings who had established themselves in the Sea Country. This contemporaneity of the first and second Babylonian dynasty, of course, brings down the chronology of Babylonian history, and this fact must henceforward be borne in mind by Egyptologists, for there are several synchronisms between Babylonian and Egyptian history which have been well established. The authors deal in the sixth chapter with early Babylonian life and customs, and this is certainly the most interesting part of the book. Since Prof. Maspero wrote his history, two new sources of information have been made available which have greatly increased our knowledge of the constitution of the early Babylonian State, and of the conditions of life of the various classes of the population. The most important new source is the great Code of Laws drawn up by Hammurâbi for the guidance of his people, and defining the duties and privileges of all classes of his subjects. This was discovered by M. de Morgan at Susa, and is one of the most remarkable documents that has ever fallen to the lot of an excavator to unearth. The other new source of information consists of a series of royal letters written by kings of the First Dynasty to the governors and officials of various great cities in Babylonia. These tablets are now preserved in the British Museum, and the range of subjects with which they deal is enormous, and, as the authors say, "there is scarcely one of them which does not add to our knowledge of the period."

The three last chapters are devoted to the most recent discoveries in connection with the history of the later periods of the Egyptian and Assyrian Empires. A good summary is to be found here of all the latest finds at Thebes, including those in the Valley of the Tombs of the Kings, which have so enriched the National Museum at Cairo.

## *POTENTIAL ENERGY AND THE FIGURE OF THE EARTH.*

*Das mechanische Potential nach Vorlesungen, von L. Boltzmann bearbeitet,* und *Die Theorie der Figur der Erde, zur Einführung in die höhere Geodäsie.* By Dr. H. Buchholtz. Erster Teil. Pp. xvi+470. (Leipzig: J. A. Barth, 1908.) Price 15 marks.

AN intimate knowledge of the theory of potential energy is of undoubted value to the student of theoretical geodesy, and it is with this object that Dr. Buchholtz has given us in this book a complete and exhaustive treatise on the subject since its inception by Newton down to the present day. But it is not alone to those interested in the complex study of the figure of the earth that this portion of the book will appeal; for in the application of the potential theory, not only is gained a knowledge of some of the most elegant mathematical theorems, but at the same time a deep insight into nature is obtained.

It would be difficult to over-estimate the excellent treatment of the subject by Dr. Buchholtz, who in his preface acknowledges his debt of gratitude and inspiration to his former teacher, the late Prof. Boltzmann, to whom is due a great number of the explanations and theorems met with in the book.

The author takes his reader through the whole history of the subject, and the demonstrations and mathematical proofs are very clearly put. Indeed, it is the clearness and fulness of the several mathematical steps, which are so often omitted in treatises of this nature to the consequent disappointment and discouragement of the majority of students, that make the book so generally attractive.

After giving the necessary definitions and explanations of the various terms and formulæ due to all the learned philosophers who have made this subject their particular study, Dr. Buchholtz completes the first portion of the book with two very able chapters on the theory of the attraction of the ellipsoid and the potential of the La Place spheroid. In both chapters nothing has been omitted which could help the student fully to understand the complexity of this difficult question.

In the second portion of the book, which deals with higher geodesy, Dr. Buchholtz has been content to follow closely on the lines adopted by Col. Clarke in his "Geodesy." Nothing, indeed, could be more flattering to the famous English geodesist than the full use he has made of his work, from which nearly all the numerical examples dealing with the subject have been taken in their complete form.

Dr. Buchholtz, however, does not give an historical account of the various geodetic enterprises which have supplied the data for the solution of the many problems introduced, and which form by no means the least attractive portion of the English work.

The two chapters which make up this second portion of the book are confined to pure theory, but let it be said at once that the treatment is most thorough and complete, and the mathematical proofs extremely clear and easy to follow. In this respect the book is much more one for the beginner than Clarke's.

The first chapter gives a sketch of the classical theories of the form of the earth; and the various proofs by Clairant and La Place, which are of great historical interest and on which are based their respective important theorems, are fully treated. This is especially the case in the sections dealing with the well-known formula for the value of gravity at any latitude, with La Place's law of density and the deduction from it, and the observed constant of precession of the earth's ellipticity. The determination of the figure of the earth as a form of equilibrium is also fully dealt with in this chapter.

The second chapter is devoted to the calculation of distances, azimuths, and triangles on the spheroid and to "geodetic lines." It is chiefly taken from Clarke, and indeed a large portion of it is a literal translation of this work. In the matter of dealing with "geodetic lines," Dr. Buchholtz has given a far more exhaustive discussion than is to be found in most books on geodesy, the section dealing with the geometrical properties of the geodetic being excellent.

On the whole, the book should fulfil the wishes of the author—to supply a long-felt want in the German language in the shape of a short treatise on higher geodesy—though, as explained by Dr. Buchholtz in his admirable preface, many important and recent acquisitions to our knowledge of this subject have not been treated in the present volume, and remain to appear, we may hope, in a further contribution from the author.

It remains to mention that the whole book is excellently supplied with diagrams for the help of the student. W. J. J.

## ELEMENTARY SCIENCE.

(1) *The Principles of Physics.* By A. P. Gage. Revised by A. W. Goodspeed. Pp. viii+547. (Boston and London: Ginn and Co., n.d.) Price 6*s.* 6*d.*

(2) *Die Elektrizität als Licht und Kraftquelle.* By Dr. P. Eversheim. Pp. viii+121. (Leipzig: Quelle and Meyer, 1907.) Price 1.25 marks.

(3) *Elementary Science for the Certificate Examinations.* Edited by W. Briggs. Introductory Section. Pp. iv+256. Price 2*s.* 6*d.* Section A, Chemistry. Pp. vii+192. By H. W. Bausor. Price 2*s.* Section B, Physics. By John Satterly. Pp. viii+352. Price 3*s.* (Cambridge: University Tutorial Press, 1908.)

(1) THIS is a revised edition of a book which appeared in 1895, and the plan has been considerably altered in order to bring it into line with modern requirements. Sections have been omitted which in the opinion of the reviser are of little use to elementary students. These omissions consist chiefly of experiments to be performed by the student and the more remote applications of principles. New sections have been added describing in an elementary way the results of recent researches and practical applications. The plan adopted throughout the book has been to avoid so far as possible proofs of mathematical formulæ, and to explain the principles by experimental and descriptive methods. The first 150 pages are devoted to the subject of experimental mechanics. Sound, heat, light, including the elementary parts of interference, diffraction and polarisation, and electricity and magnetism form the rest of the volume. The statement on p. 229 is evidently an error, viz.:—

"Since liquids must be contained in a vessel of some sort the *observed* expansion is usually not that of the liquid alone, but a value *greater* than the real expansion of the liquid by the increase of volume of the vessel."

Again, on the same page india-rubber is cited as having a negative coefficient of expansion. An example of this kind should certainly be avoided with elementary students, the apparent contraction when heated being due to change in the elastic constant. The statement in italics on p. 278 is likely to confuse an elementary student, viz. "The illuminating power of light diminishes as the square of the distance from the light source increases." "Intensity of illumination" is better, "illuminating power" being regarded as a constant for the source of light.

The book is very well printed, and the illustrations are clear. It may be safely recommended to students who take up physics as part of their general education.

(2) "Elektrizität," by P. Eversheim, is a small book describing some of the present-day applications of electricity. It is intended for the general reader, or for those who have only a very slight acquaintance with the elementary facts of electricity.

The author first describes the various methods by which a current of electricity may be produced, and then proceeds to explain the phenomena of electromagnetic induction and the principles of the dynamo and motor. Practical applications are then dealt with, the subjects treated including electric lighting and various types of lamps, transmission of power, the electric telegraph, cable telegraphy, the telephone, electric waves, and wireless telegraphy.

As a rule, the explanations of phenomena are clear and accurate, and should be intelligible to the general reader, but the diagram on p. 9 will not give him a correct idea of the magnitude of thermoelectric currents, viz. a single couple with junctions at 0° and 50° joined to an ammeter reading one ampere. Again, in a book of this size one cannot expect full historical treatment, but the omission of the name of Faraday from the chapter on electromagnetic induction cannot be passed over without comment, especially when that of Lenz is included.

In Fig. 56, p. 113, "Braun" system of wireless telegraphy, the "earth connection" is in the wrong place. The "Aërial" should be earthed. In Fig. 58 the "earth connection" or "balancing capacity" are omitted. At the end of the book is a short section referring the reader to larger treatises on the subject of electricity and its applications.

(3) These three manuals comprise a course in elementary science suitable for the certificate and preliminary certificate examinations for 1909. The introductory section deals with the elementary measurement of length, area, volume, mass, density, &c.; properties of matter; thermometry and expansion; nature and composition of air and water; action of acids on metals, and of heat on some organic substances. The fundamental facts are well illustrated throughout by simple experiments to be performed by the student.

Section A is a further continued course in chemistry. The properties and interactions of some common substances are dealt with experimentally, and the fundamental laws of chemistry explained. The author has avoided formulæ and equations of reactions so far as possible in the text, introducing them in an appendix at the end.

Section B is a continuation of the physics course; mechanics, heat, light, electricity and magnetism are dealt with, the facts being well illustrated by simple laboratory experiments. The explanation of multiple reflections from thick mirrors avoids a very common error usual to text-books, but it is not true to say that all the images are on the normal to the mirror through the object. Fig. 33, p. 337, is misleading if intended to illustrate the probable result of the experiment numbered 37.

## OUR BOOK SHELF.

*The Sanitation of Recreation Camps and Parks.* By Dr. Harvey B. Bashore. Pp. xii+109. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1908.) Price 4*s.* 6*d.* net.

THIS small work may be read with interest and profit by those who camp out, and also by those who, for motives of sport, &c., roam about country districts. The sanitation of military and labour camps is not dealt with, but the author occasionally makes military experiences his text for the need of the sanitary precautions which he impresses. The sanitary rules advocated for camps embrace the careful screening of food from flies and dust until it is consumed; the avoidance of all brook or creek waters for drinking purposes, unless a careful survey has been made of the source of the brook or creek, and this has disclosed no access of harmful pollution; the daily burning or burying of all waste, solid and liquid; the desirability of carefully selecting a special area for the disposal of fæces, the exclusive use of this particular area, and the prompt covering of all dejecta by "mother earth." In districts where mosquitoes are troublesome and dangerous, adjacent brooks or pools should be treated with kerosene every ten days, and weeds and grass kept short around the camp.

The work is well illustrated, and by the avoidance of technical terms and the presentation of the subject in an interesting and pleasing style the writer has provided a most readable and useful little work. One of the occasional digressions to be noted makes reference to the very common practice in towns of exposing food to view in public places, without any protection whatever from the gross contamination involved in street dust. Certainly the practice cannot be defended; from the hygienic standpoint it is dangerous; to the contemplation of the refined it is disgusting; and from the commercial standpoint it is wasteful, for it must lead to a far quicker deterioration of the article than would take place if food were properly protected by glass.

*The Eye, its Elementary Anatomy, Physiology, and Optical Constants.* By Lionel Laurance. Pp. 100. (London: The Orthos Press, 1908.)

THIS little book, according to its preface, has been written for students in optics, and the author guarantees the precision of the facts therein contained on the ground that Mr. Lindsay Johnson has passed the proofs. The anatomy of the eye is fairly well described, but we cannot say as much for the physiology. On p. 21 we learn that "the visual purple, which is quite sufficient to enable one to see in bright sunshine, is altogether inadequate to see in a dim light. It is found that . . . none is found at the fovea. The function therefore of the purple appears to be to enable one to see better in a dim light." The definition of the angle $\alpha$ is erroneous; the angle described is that termed $\beta$ by precise ophthalmologists. The estimation of distance is due very little to the function of accommodation, but almost entirely to that of convergence, as can very easily be proved.

The subject of colour-blindness is indifferently well described, as no mention is made of Dr. Edridge-Green, although some of his results have been given. Students of optics will have much to complain of in the last ten pages of the book on optical constants. No proper use is made of algebraic signs; thus the anterior and posterior focal lengths of a refracting system are both expressed by the same sign, so that they both apparently lie on the same side of the system. Again, the focal length of the lens of the eye is measured from its surface, a correction having been introduced for its thickness; yet in the calculation on p. 90 the value assigned to $F_e$ should be the principal focal distance measured from the corresponding principal point.

*Before Adam.* By Jack London. Pp. 308. (London: T. Werner Laurie.) Price 6*s.*

IN Mr. London's story a man has persistent dreams, in which he sees "visions of myself roaming through the forests of the younger world; and yet it is not myself that I see, but one that is only remotely a part of me, as my father and my grandfather are parts of me less remote. This other self of mine is an ancestor, a progenitor of my progenitors in the early line of my race, himself a progeny of a line that long before his time developed fingers and toes and climbed up into the trees. . . . An instinct is a racial memory . . . there must be a medium whereby these memories are transmitted from generation to generation. This medium is what Weismann calls the germ-plasm. It carries the memories of the whole evolution of the race."

Mr. London's theory of heredity is out of date. Nevertheless his book is extraordinarily vivid and convincing, and altogether delightful. Admirable as fiction, it is also, by virtue of good psychology and imaginative insight, in its way an inspiring work of science. Reading it, one finds it hard not to believe that our very distant ancestors lived just such a life as Mr. London portrays—full of intense but transient emotions, replete with danger and terror, but replete also with joys half human and half brute.

## 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.*]

### Bimetallic Mirrors made by Electro-deposition.

APROPOS of Mr. Cowper-Coles's exhibit at the recent soirée of the Royal Society of metallic searchlight reflectors made by the electro-deposition of copper upon a silver film chemically deposited on glass, it may be interesting to mention that some forty years ago (I think in the year 1865) I spent a considerable time in experimenting in the same direction. My object was to make a true "flat" for the second reflection of a Newtonian telescope, with silver surface as bright as that in contact with silvered glass and without degradation from the true figure of the glass. The last condition I was unable to fulfil. It had been rightly judged that the outside surface of the silver film used by M. Foucault could scarcely have the truth of figure or the brilliancy of polish of the glass on which it had been deposited, hence the desirability of the object sought.

However firmly and closely the silver film had adhered to the glass, the moment the copper deposit commenced upon it it became detached from the glass owing to the contraction of the copper, and the surface which had been plane became convex.

This convexity seemed to be much the greatest in the usual sulphate of copper solution, with free acid, giving a tough deposit. With one containing little or no free acid and giving a crystalline deposit little contraction took place and the face continued fairly flat, but, of course, the process was tedious in the days of Daniell's cells, and I doubt if I ever obtained a true enough surface for my purpose.

The problem, however, which Mr. Cowper-Coles has set himself is a very different one. Extreme accuracy of figure is relatively of smaller importance, and with the devices of rotation of mirror and continual agitation of the solution, which, I believe, he has resorted to, and the latter of which I found much improved the results, he may

arrive at a figure nearly as good as that of the matrix, of rather greater focal length, it may be, but nearly equally lengthened in all its parts. ROSSE.

Birr Castle, Parsonstown, August 14.

### The Form of a Dirigible Balloon.

ALTHOUGH it is not likely that dirigible balloons will be of much practical value except for purposes of amusement and to a limited extent for military observations, it seems a pity that the designs of such as are made should not embody existing knowledge as to the conditions which govern the resistance and stability of submerged bodies.

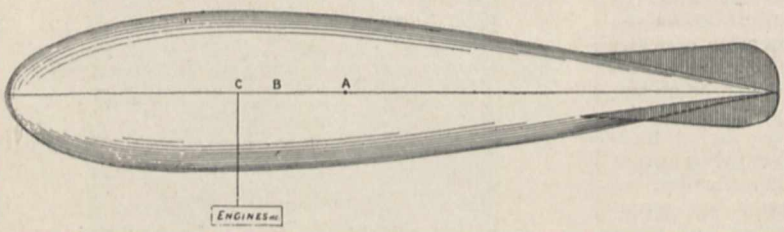
The resistance of a submerged body is a far less complex quantity than the resistance of a ship (inasmuch as no question of surface waves is involved), and can be stated simply as the sum of the resistances due to surface friction and wake, both of which vary very nearly as the square of the speed.

The surface friction resistance cannot be reduced below a certain limit, for the surface exposed cannot be less than the surface of a sphere which will hold the required volume of gas.

The wake or eddy-making resistance can, however, be very largely reduced by giving the balloon a shape gently tapering towards the stern, a shape which is adopted by all animals (birds, fish, whales, seals, &c.) the habits of which require them to move rapidly as submerged bodies.

The shape of the head of the balloon does not matter much so long as the profile is a fair curve. The important thing for reducing the wake is that from some position in front of the maximum diameter of the balloon the radius of curvature of the profile should increase, slowly at first, but continuously, towards the stern.

With regard to stability, it should be borne in mind that a submerged body, whether a sphere or elongated surface of revolution, is naturally unstable when moving in air or other real fluid, and will not without guidance continue to move in a straight line owing to the instability of the motion of the wake.




A, Centre of gravity of balloon. B, Centre of buoyancy of balloon.

This form of instability may be got rid of by providing small fins near the stern the planes of which contain, or are parallel to planes passing through, the axis of figure of the body.

Their number must not be less than three, but there is no objection to a greater number except on the ground of extra surface friction.

In the accompanying sketch a form is shown which would be suitable for a dirigible balloon so far as resistance and stability are concerned.

If it is assumed that the total lifting power of such a balloon is to be 2000 lb. (including its own weight), its capacity must be something under 30,000 cubic feet, and if the length is five times the greatest diameter, its dimension will roughly be :—diameter, 30 feet; length, 150 feet; and superficial area, 7000 square feet.

The surface-friction resistance at twenty miles an hour will require less than 2 horse-power. I have no data for the eddy-making resistance of such a form, but it would probably be less than half that of the bolster-like shapes generally adopted, which are hardly less resistful than a flat end would be (this applies to the stern only, not to the head).

The framework necessary to give the balloon the shape figured in the sketch would undoubtedly add to the dead weight, but would more than "pay for its carriage" by lessening the resistance, and thus allowing of the use of lighter engines, and I think that perhaps the most valuable part of Count Zeppelin's work has been to show that it is practicable to construct a balloon the shape of which is moulded by internal frames. A. MALLOCK.

6 Cresswell Gardens, S.W., August 12.

### The "Sky-coloured Clouds" or Twilight Glows.

THERE can, I think, be no doubt that the numerous descriptions which have appeared of the recent twilight phenomena relate to essentially the same phenomenon as the "sky-coloured clouds," or, as the late O. Jesse called them, the "luminous night-clouds." On June 30 and July 1, which seem to have been the principal dates, I was unfavourably situated for observing the phenomenon, but I may point out that I directed attention to it in your issue of June 11, p. 127.

The displays that have been noted in former years have been marked by a very striking appearance as of cirrus clouds, only (as O. Jesse ascertained) at a much greater altitude, viz. fifty-one miles. From the descriptions this year the cirrus-like appearance has evidently not been so well marked, although it is mentioned by some observers, and I noticed it myself (partly here and partly in Scotland); but sometimes the aspect of the light was uniform, and not striated like cirrus. In former years I have also sometimes observed the same when there was evidently a tendency to the formation, and yet the clouds did not appear, but only the luminosity. M. Félix de Roy, in the *Gazette Astronomique d'Anvers*, No. 8, p. 63, is of opinion that this year the phenomenon was not the same as that investigated by O. Jesse, but he calls it an "extraordinary twilight." In either case, no doubt the cause is essentially the same—*i.e.* reflection—some substance being at such a height in the atmosphere that the sun can shine upon it when far below the horizon of the observer. The coloration, although varying in intensity on different occasions, is also the same in either case, viz. red or red-orange near the horizon, gradually changing through orange, yellow, and green to blue above. This is the ordinary coloration of a clear twilight sky, the difference between which and the recent phenomenon being mainly that of the height of the substance reflecting the sun's rays.

It has never been ascertained what the substance is, and it may be that in different years it has not been the same. This might account for the appearance this year being less like cirrus than formerly. It has been suggested that it may be meteoric dust. T. W. BACKHOUSE.

Sunderland, August 11.

### August Meteors of 1908.

THE conditions this year were all against any bright or plentiful exhibition of the Perseids. Apart from the presence of the full moon, the sky at Bristol on August 11 and 12 was full of thin white clouds, amid which it was only possible to distinguish bright meteors. On August 10, however, the firmament was clear, but the Perseid shower was evidently influenced by the luminous atmosphere, for only about twelve per hour were visible before midnight. The radiant point was in the usual position at 43°+57°. A few brilliant meteors were seen from Perseus on August 11, but clouds prevailed to such an extent that it was impossible to judge as to the strength of the display.

Mr. J. H. Elgie, of Leeds, had a clearer sky, and observed on August 10 and 11 a pretty numerous display of bright Perseids. Watching for an hour at about midnight on August 11, he saw twenty meteors. Reports from other places state that although some brilliant meteors were seen, they fell short in point of numbers with those observed in previous years in better circumstances. At Bristol the radiant point moved from 25°+53° on July 26 to 43°+57° on August 10. Watching was resumed early on the very clear nights of August 15 and 16, but meteors were found to be scarce, and the Perseid shower gave little sign of continued activity. W. F. DENNING.

## SOLAR VORTICES.

SOME preliminary investigations of Prof. Hale on the gyratory forms assumed by the hydrogen flocculi on the sun were described in a recent number of NATURE (vol. lxxviii., p. 200). The photography of the sun, through the hydrogen line Hα, using specially bathed red sensitive plates, by means of the 5-foot spectroheliograph of the Mount Wilson Observatory, gave promise of being of great value. Already the promise is kept. A copy of a paper which is to appear as No. 26 in a series of "Contributions from the Mount Wilson Solar Observatory" has been forwarded, together with illustrative photographs. After realising the advantage of the Hα line over the line Hδ previously used, the daily programme was modified to allow of a full series of photographs under the new conditions. A distortion due to heating of the mirror, now more continuously used, was eliminated by the use of a smaller aperture.

After obtaining new slits adapted to the Hα line, the first photograph of the entire solar disc by the modified method was obtained on March 28, 1908. The remarkable solar "vortex" previously reproduced in NATURE was secured by Mr. Ellerman, who was in charge of the routine work with the instrument, on April 30. Further information relative to this phenomenon appears in the more recent communication. On a less successful exposure made on April 29 the same large storm area is fairly well shown. A comparison with the afternoon photograph of April 30 recently made in the stereocomparator, together with the measurement of the latitude and longitude of objects identified on both dates, "seem to show the existence of a gyratory motion, in a direction opposite to that of the hands of a watch (north, east, south, west)." In Prof. Hale's first note on the same object, he remarks (NATURE, vol. lxxviii., p. 200) of the dark flocculi surrounding this area that "their appearances strongly suggest the effect of a great whirl rotating clockwise." The identification of objects on both plates is a matter of great difficulty, and the evidence for direction of rotation is admittedly weak. Further discussion of these plates is postponed until additional data become available.

The present communication from Prof. Hale is concerned chiefly with the phenomena recorded, by the aid of Hα, in the neighbourhood of a spot which reached the east limb of the sun at 8h. 16m. a.m. on May 26, 1908. The changes which took place about it, in many cases rapid though not especially violent, were followed until June 2, when the attendant "whirl" was very marked. A long dark flocculus had persisted near the spot during this period. "On June 3, in an interval of about ten minutes, a remarkable transformation occurred. The long dark flocculus, which had been gradually changing in form and position, was suddenly drawn into the spot." The three photographs here reproduced illustrate this remarkable occurrence. They were taken on July 3 at 4h. 58m. 16s., 5h. 13m. 54s., and 5h. 22m. p.m. respectively. The times given refer to the transit of the spots across the primary slit of the spectroheliograph, while the scale is such that the sun's diameter would be represented by 14 inches. The definite incurving of the eastern end of the flocculus almost precludes the idea that it is a casual change at a level remote from that of the spots. Spectroscopic evidence of the motion of the flocculus *down* into the spot, during the period, would have been of interest. The records were obtained by Dr. C. E. St. John with the 5-foot spectroheliograph during Mr. Ellerman's absence on vacation. When the whirl was best seen its radius was about equal to the distance of the western extremity of the flocculus. Apparently the eastern end did not fall definitely under the influence of the whirl until its distance was about 140,000 km. from the spot. The fact that the western extremity lay, during the whole period, outside this magic radius may account for its escape. The mean of six

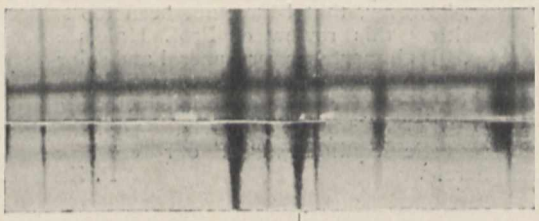

FIG. 1.—A hydrogen flocculus drawn into a solar whirl.
A at 4h. 58m. 16s. p.m.; B at 5h. 13m. 54s. p.m.; C at 5h. 22m. p.m.

measures of the velocity of approach of the flocculus gives 106 km. per second, which, it is suggested, is the order of the maximum velocity in the vortex. It is stated that, except in the case of the large flocculus, motion towards the spots, even along apparent lines of flow, has not made itself obvious.

Many visual observations of the drawing of photospheric matter into spots have been made, among others by Sir Norman Lockyer more than forty years ago, who described the apparent drawing of a willow leaf into a dark spot,[1] and the late Father Secchi, who was convinced that a swirl and a kind of suction existed in them.

A notable feature of a photograph taken after this indrawing, on June 5, is the amount of "bright eruptive hydrogen in the region surrounding the two spots." These opposite phenomena together strongly suggest Sir Norman Lockyer's sun-spot theory of a cooler central downrush with the later encircling *splash* of dissociated matter.[2] A gyratory motion in spots has been suggested by many observers. A number of problems as to the levels at which the activities recorded take place are suggested by the photographs. The remarkable fact of the non-participation of the high-level hydrogen in the differential rotation with latitude would at once follow if the equatorial acceleration were due to a fall of material from greater equatorial heights in the solar atmosphere. If the hydrogen is ascending in consequence of dissociation from the denser materials of the fall, it cannot show the same forward velocity as the falling material, to which velocity Lockyer ascribes the more rapid equatorial movement of the photosphere.[3]

The known correlation of the meridian passage of large spots or disturbed areas and the sudden changes in the magnetic elements has given currency to theories of the magnetic nature of this spot influence.



6302·71

FIG. 2.—Widening of spot line due to Zeeman effect.

A direct magnetic effect was negatived by Lord Kelvin on account of the excessive amount of energy required. A causal relation of this nature, whatever the intermediate step or steps, has been almost undoubted.

It is suggested by Prof. Hale that a segregation of positively or negatively charged particles caught into the stream of a solar vortex would give rise to magnetic lines of force at right angles to the plane of the swirl.

If such a field of force existed in a spot, the analogy of terrestrial experiment would suggest that the period of vibration of the ions emitting light in such a field should suffer modification. The light emitted from a spot near the sun's centre would be along these lines of force. The doubling of spectrum lines with the components circularly, and oppositely, polarised would be expected. Prof. Hale promised to make spectroscopic search for this Zeeman effect on the first opportunity. In a more recent letter he announces the complete success of his search.

Spectra of the light of a spot and of the photosphere were taken with the tower telescope and 30-foot spectrograph, having a Fresnel rhomb and Nicol prism mounted in front of the slit. The Zeeman doublets in the spot spectrum photographed under these conditions should change in relative intensity as the Nicol is rotated. When the spot was near the limb of the sun the results were uncertain, but when about 45° from the centre the characteristic changes were observed. The accompanying figure shows a pair of photographs in the region of the iron line λ 6302·71 taken on June 27. They are enlargements, the resulting scale being 1 Ångström = 9 mm. The widening in the central spot bands of the line marked represents a true doubling. In the reproduction it will probably only be seen with difficulty that the relative intensities of the components are reversed in the two photographs due to the turning of the Nicol through 45°.

The separation of the components ranges from 0·018 to 0·216 Ångströms. In several cases a tripling of lines was observed.

Every care was taken, of course, that the variations were not instrumental. Similar effects were found with other lines, though a remarkable and unexplained paucity of them occurred in the blue and violet regions. Further details are promised in a forthcoming paper of these exceedingly interesting discoveries.

The systematic recording of the solar magnetic fields for comparison with simultaneous records of terrestrial magnetism is suggested as desirable.

The ease, apparently, with which these varied records of solar activity can be obtained gives hope that soon will exist ample material for the discussion, and it is to be hoped the solution, of many of the outstanding solar problems.

From the perfect equipment at Mount Wilson much is expected, but no one will think of minimising the great credit due to Prof. Hale for the progress towards more intimate knowledge of the stupendous activities in the neighbourhood of the sun.

T. F. C.

## *SOLAR MAGNETIC FIELDS AND SPECTRUM ANALYSIS.*

PROF. GEORGE E. HALE, of Mount Wilson Solar Observatory, with great kindness has sent me a letter of date July 6, together with a copy of a manuscript destined for publication in NATURE, on "Solar Vortices and the Zeeman Effect." Prof. Hale's paper is accompanied by two photographs on glass of the double lines in the spot spectrum between two comparison spectra of penumbra and photosphere of the region λ 6250–λ 6360. The position of the Nicol in the arrangement used was changed 45° between the first and the second of these photographs.

Prof. Hale asks me to examine the photographs of spectra, and to send a note to NATURE expressing my opinion as to the interpretation of the results. I can say at once that I have come to the conclusion that Prof. Hale has given what appears to be decisive evidence that sun-spots are strong magnetic fields, the direction of these fields being mainly perpendicular to the sun's surface. Light received from a spot at the centre of the sun would in this case be parallel to the lines of force.

A source of light in the laboratory, and placed in a uniform magnetic field, emits, in the most simple case covered by the elementary Lorentz theory, parallel to the lines of force, two rays circularly polarised in opposite directions. Each spectral line is split up into a doublet of two circularly polarised lines, the one polarised clockwise, the other anti-clockwise. We may imagine that for further analysis a Fresnel rhomb and Nicol are mounted before the slit of the spectroscope, the arrangement actually used by Dr. Hale. The two circular vibrations of the doublet are

1 *Monthly Notices*, vol. xxv., June, 1865, p. 236.
2 "The Chemistry of the Sun," p. 412. (Macmillan and Co., 1887.)
3 *Ibid.*, pp. 422 and 424.

transformed by the Fresnel rhomb in two normal and linear vibrations. It depends upon the position of the Nicol which of the components of the doublet is the more quenched.

The initial position of the Nicol determines the angle through which it is to be turned in order to reverse the relative intensities of the two components. Only widened lines and no doublets, and correspondingly only a shift and no extinguishing of components by turning the Nicol, will be observed, either from want of uniformity of the field or from want of homogeneity of the light.

The phenomena observed by Prof. Hale in the double lines and the widened lines of the sun-spot spectrum, and exemplified in the photographs under review, are identical in character with those observed in the laboratory under the specified conditions with somewhat broad lines or in a rather non-uniform field. The behaviour of a spectral line emitted in these circumstances by iron vapour between the poles of an electromagnet cannot be distinguished from the radiation of iron vapour immersed in the interior of a Hale (electronic or corpuscular) solar vortex at a distance of 149 million kilometres.

So far as we know, only a strong magnetic field can resolve a single line into a doublet, having components circularly polarised in opposite directions. Are we not compelled, then, to admit that where these unique and characteristic phenomena are present a magnetic field must be their cause? The evidence is of the same nature (but still more convincing by the unique character of the polarisations) as that for motion in the line of sight from the Doppler displacement of spectral lines in the case of moving stars or molecules.

The absence of any shift of the red telluric lines by the rotation of the Nicol, or of measurable displacements of the cyanogen flutings, as reported by Prof. Hale, considerably strengthens the argument and excludes instrumental and other errors.

A quantitative comparison of the magnetic separations of the iron lines as observed in the laboratory and in the sun will be necessary to complete the argument and to make it, if full correspondence exists, almost insuperable. A small probability, of course, must be left open that under the conditions existing in the solar furnace, dissociation processes or something of the kind (Lockyer) occur, so as to alter the whole vibrating system of the atoms and therefore also the relative separations of the different lines.

Being in the country I unfortunately cannot supply now the magnetic separations of the region of Prof. Hale's photograph.

The iron spectrum in the magnetic field has been examined by Becquerel and Deslandres, Reese, Kent, and Hartmann (Thesis, Halle, 1907), but the lines investigated are not far enough in the red.

Recently Miss van Meurs made in the Amsterdam laboratory a rather extensive study of the radiation of iron in the magnetic field, which will be published shortly; her observations in the red are still unfinished.

In order to obtain an idea of the order of magnitude of the magnetic force within the Hale solar vortex, we can only compare the largest separation of an iron line observed by Prof. Hale, viz. 0·22 A.U., with that of one of the larger separations of iron lines measured in the laboratory. The separation of $\lambda$ 4144·05 is 0·67 A.U. in a field of 29,740 Gauss. This gives for the magnetic force nearly 10,000, which may be reduced to, say, 6000 Gauss, if Dr. Hale's line presents such exceptionally high separation as some zinc lines.

If we might identify the Hale vortex with a solenoid with axis parallel to that of the vortex, and having one layer of one winding per cm., a current of 5000 amp. would be necessary for generating the 6000 Gauss field.

This current at first sight seems rather large. The actual case is approached more nearly by substituting for the one winding per cm. a gaseous conducting circular disc, one cm. thick, and of suitable radius, though all calculations here are merely tentative and extremely rough. Let the radius of this disc be chosen equal to that of the earth, viz. $6{\cdot}4 \times 10^8$ cm. (representing a solar vortex of, according to Hale's photographs of the solar vortices, extremely moderate dimensions), then the current of 5000 amp. in the disc is to be distributed over an area of $6{\cdot}4 \times 10^8$ cm$^2$., giving $0{\cdot}8 \times 10^{-5}$ amp. per cm$^2$.

The kathode rays issuing from the spot of lime (say one square *milli*metre area) in a Wehnelt tube carry something like $10^{-5}$ amp. (I quote from memory). Hence the solar vortex would not be too crowded with electrons even if the magnetic force to be accounted for were much higher.

In the last paragraph of my very first paper (1897) concerning radiation in the magnetic field, I wrote:—"Further inquiry must also decide as to how far the strong magnetic forces existing, according to some, at the surface of the sun may change its spectrum." Since I always entertained the expectation, sometimes amounting almost to conviction, that some day a cosmical application of the magnetic separation of the spectral lines would be discovered by astronomers. This might suggest that I am too favourably disposed towards any evidence in such a direction.

I trust, however, that I have not been too sanguine while writing this review of Prof. Hale's splendid discovery. Its importance for general and solar physics must be very great, and not less for the theories of meteorology and terrestrial magnetism, affording, as it does, a *vera causa* for the perturbations of the electric and magnetic equilibrium of our earth and its atmosphere.

P. ZEEMAN.

## *THE LIQUEFYING OF HELIUM.*

ON July 10 Prof. H. Kamerlingh Onnes, of Leyden University, and his assistants had the satisfaction of seeing a considerable volume of liquid helium remain for some hours. This conquest over the last and most refractory gas was made known within a day or two, but few details were given until the appearance of the official publication, from which this note[1] is taken.

Prof. Onnes points out that the first step necessary was the determination of isothermals of helium, and in particular of those at temperatures obtainable only with liquid hydrogen. From these the *a* and *b* of van der Waals's theory can be obtained, and the Boyle point, *i.e.* the temperature at which the minimum of $pv$ occurs with very small densities, be found. This point also occurs at one-half the absolute temperature of the Joule-Thomson inversion point at low densities. With these data he was able to apply a theorem developed in 1896 from an earlier and more general theorem of 1881 during the endeavour to liquefy hydrogen statically. The theorem shows that the Boyle point of helium lies somewhat above the lowest temperatures obtainable with hydrogen, and hence that a regenerative process, as applied by Linde and Hampson to air and by Dewar to hydrogen, could be effective with helium.

Ever since 1883, when Prof. Onnes commenced his

[1] From the Special August Supplement to the Dutch Proceedings of the Royal Academy of Amsterdam. The note has been approved by Prof. Onnes.

work at Leyden, there has been continuous effort to reach the nadir of temperature. It has taken some years to get the necessary data for helium together. In 1905 much help was obtained from the Commercial Intelligence Office at Amsterdam under the direction of Mr. O. Kamerlingh Onnes, who obtained a sufficiency of the monazite sand, used for the preparation of helium, at a cheap rate. The helium is obtained from this by heat, and is then most carefully purified. The first isotherm determinations on helium were made in 1907. It was owing to Olszewski's and Dewar's failures that various methods, such as the helium motor with vacuum glasses as cylinder and piston, were considered, but these were abandoned, owing to the results of the isotherm determinations, which pointed to a critical temperature of about 5° to 6° K. This result was in better agreement with Dewar's estimate of 8° K. obtained from experiments of absorption by charcoal than with Olszewski's of below 2° K.

However, the conclusion from the isotherms was not quite decisive, as those at the lowest temperature indicated a lower critical temperature than those at higher temperatures, and this appeared to throw some doubt upon the strict applicability of the law of corresponding states to helium. At all events, just before the experiment was undertaken it was shown that the Boyle point, though below the boiling point of hydrogen, was somewhat above 15° K., which is obtainable with liquid hydrogen under reduced pressure.

The time had hence arrived to reap the fruit of the many years of work devoted to building up the cryogenic laboratory for the use of prolonged accurate measurements in liquid gases, with all the circulations so arranged that the gases remain pure. This is particularly important in the hydrogen cycle, where 4 litres of liquid can be dealt with per hour and a supply can be obtained in a state of great purity and stored for use.

In the arrangement of the experiment constant use was made of the theory of van der Waals. The apparatus was made as small as possible, but there was a practical limit which was fixed by its necessary relation to the other apparatus in use. To compress the helium the special mercury pump was used which was completed in 1888, and was used to give baths of static oxygen in 1894. It compresses to 100 atmospheres, which, with the critical pressure below 5 atmospheres for helium, is a high reduced pressure. This pump circulates 1400 litres per hour, which is sufficient with the dimensions of the apparatus taken, and has a capacity with connections of about 200 litres. For this experiment it was not possible to run the helium and hydrogen cycles at the same time, so that sufficient liquid hydrogen had to be made before the experiment on helium was commenced. However, now that the main difficulties are overcome, it will be possible to work the two cycles simultaneously.

In directing attention to Sir J. Dewar's work for this and similar researches Prof. Onnes points out especially the use he has made of the selective absorption of charcoal for gases in the purification of gases under pressure, and to the advantage of silvered vacuum glasses.

Such glasses are used at every stage of the work. For example, the liquid hydrogen is collected in an unsilvered glass placed in liquid air contained in a silvered glass with a strip of clear glass left to enable the interior to be seen. The liquid hydrogen is transferred by pressure through a fine tube into the experimental apparatus.

A detailed description is given in the paper of this apparatus, which is, however, simple enough in principle. The regenerator spiral, through which the compressed helium is expanded, is contained in the upper part of a vacuum glass also containing lower down the upper bulb of a helium thermometer. The helium glass is contained in a second which is filled with liquid hydrogen and connected to the hydrogen circulation. This glass in turn is contained in another filled with liquid air, and this finally in one containing alcohol. All these glasses are unsilvered, so that a clear view is obtained of the central glass and its contents.

The day before the successful experiment, July 9, was devoted to the preparation of 75 litres of liquid air, and at 5.45 a.m. on July 10 the work was commenced to obtain the necessary liquid hydrogen. By 1.30 p.m. 20 litres were standing in the special vacuum glasses. Meanwhile the helium and hydrogen circulations were pumped free of air and washed through with their respective gases, and a start was made to cool the liquid-air glass. At 2.30 hydrogen cooled by liquid air was taken through the hydrogen glass, and by 3 p.m. the temperature was down to −180° C. At 4.20 the helium circulation was started, liquid hydrogen was introduced into its glass, and the pressure lowered until at 5.20 p.m. it reached 6 cm., at which it was kept. Between 5.30 and 6.30 the pressure of helium in the spiral was gradually raised to 100 atmospheres. At 6.35, when the pressure was allowed to fall rapidly to 40 atmospheres, the helium thermometer indicated a temperature below that of the liquid hydrogen; nearly 6° K. was read once. At this time the last reserve of liquid hydrogen was connected, and no liquid helium had been seen. A quicker expansion was allowed, and the temperature fell and constantly returned to the same temperature of less than 5° K. It was as though the thermometer stood in liquid.

Somewhat later, at about 7.30, the surface was seen at the top of the vacuum glass. The liquid having been found under ordinary pressure there was no doubt that the critical pressure was more than 1 atmosphere. The surface was illuminated from below, and had the appearance of a liquid near the critical state in a Cagniard de la Tour tube, cutting the walls like knife-edges, though in this case the diameter was 5 cm. There was also a marked contrast between the helium and the hydrogen in the next outer tube. Some of the evaporated helium was now collected and used for a density determination giving 2·01. At 8.30 the pressure on the helium was reduced, and 2·3 cm. was measured. The pumps, however, can give 2 mm., and it is quite possible that as little as 7 mm. was reached, but no solid could be seen. At 9.40 only a few c.c. of liquid helium remained. Thus liquid helium, starting with an amount exceeding 60 c.c., had been under observation for more than two hours.

All the evaporated helium was collected into three portions, which gave densities of 2·04, 1·99, and 2·02. As a further test of purity a special comparative spectroscopic investigation was made with known mixtures of hydrogen with helium, and it proved that not more than 0·008 per cent. hydrogen was present. This high degree of purity is also confirmed by the easy working of all cocks, which would have been stopped by a very little frozen hydrogen, and also by the condition of the last remaining liquid. The thermometer was also controlled by a measurement of the boiling point of oxygen, which gave 89° K. instead of 90° K.

The properties found are as follows:—A boiling point of 4°·3 K. on a constant volume helium ther-

mometer with a pressure of 1 atmosphere at about 20° K. Corrected to the absolute scale the best value would appear to be 4·5° K. The triple point, if it exists, is certainly below 1 cm., perhaps below 7 mm., at which, by corresponding states, the temperature would be about 3° K., and the liquid remains very mobile.

Liquid helium has a density of 0·15, which gives *b* a value of 0·00017, about twice that which has been assumed before from then known properties and used in calculations. From this, again, the critical pressure must be about 2 to 3 atmospheres, so that helium under 5000 would correspond with carbon dioxide under 100,000 atmospheres. At the boiling point the ratio of vapour to liquid density is 1 : 11, which indicates a critical temperature of not much more than 5° K., and a critical pressure of about 2·3 atmospheres. Lastly, the value of *a* will be about 0·00005, the smallest value known, but a most interesting confirmation of van der Waals's contention in 1873, that there must be some attraction between the molecules of all substances.

FRANCIS HYNDMAN.

## *THE ETIOLOGY OF TRYPANOSOMIASIS.*

IN a communication to the Paris Academy of Sciences on February 24, some remarkable discoveries concerning the development of pathogenic trypanosomes in tsetse-flies are brought forward by M. E. Roubaud, member of the Mission Française d'Études de la Maladie du Sommeil. Experimenting with four species of pathogenic trypanosomes, namely, *Trypanosoma gambiense, T. dimorphon, T. brucei*, and *T. cazalboui*, and with *Glossina palpalis*, Roubaud found that immediately after the fly has fed on the blood of an infected animal, its proboscis contains blood in which the trypanosomes are moving actively. In a very short time, however, the trypanosomes attach themselves to the wall of the proboscis and undergo changes of structure, becoming Herpetomonas-like, with the kinetonucleus in front of the trophonucleus. The undulating membrane has disappeared, and the flagellum, as the organ of fixation, is greatly thickened, so as to resemble a small stalk to the body. These changes are complete in five minutes after ingestion of the blood. The attached parasites at first exhibit active movements of the body, but soon become quiescent; no phenomena of conjugation could be observed, either before or after these changes. But the parasites multiply actively in this situation, forming little tufts or colonies, so that at the end of one hour they have become excessively numerous; they are found attached to the internal face of the labrum, sometimes chiefly at the base of the proboscis, in other cases along its whole length as far as the point. When observed in the salivary fluid they appear immobile, but when treated with serum or with physiological salt-solution they vibrate rapidly and may become free, in which case they swim with the flagellum forward and the hinder part of the body rigid, thus differing greatly in appearance from the original trypanosome-form. The free parasites have a great power of attachment, and when under observation they may fix themselves firmly to the slide.

The author regards this development as a temporary culture or "culture d'attente" of the parasites. Both by observation and experiment he shows that the forms in the proboscis are not derived from trypanosomes regurgitated from the digestive tract of the tsetse. *T. brucei* was found to die out without multiplication in the intestine of *Glossina palpalis* in a short time. The culture in the proboscis was found to persist beyond forty-eight hours in the case of *T. brucei*, and for five or six days in the case of the other three species of trypanosomes. Only about ten per cent., however, of the tsetses fed on infected animals developed a culture of the trypanosomes in the proboscis. On the other hand, the power of multiplying in the proboscis was found to be a specific relation between the trypanosomes and the tsetse.

These observations lack as yet the crucial test of an experimental infection by means of the proboscis-culture, but nevertheless they throw great light on the problem of the transmission of pathogenic trypanosomes. It has been shown by previous experimenters that the transmission is effected by the direct or mechanical method, and all attempts to prove experimentally an indirect or cyclical mode of transmission have given negative results. That being so, it was difficult to understand why the power of direct transmission should be possessed, apparently, by tsetse-flies alone, and not by other biting insects to an equal degree. Roubaud's observations show that the pathogenic trypanosomes have a quite specific power of adapting themselves to the salivary secretions of the tsetse, and thus explain the peculiar relation between these flies and the spread of diseases caused by trypanosomes in Africa. Moreover, a very important new line of investigation is indicated by the author's discoveries.

E. A. M.

## *NOTES.*

ABOUT a year ago Sir William Ramsay and Mr. A. T. Cameron announced that they had observed the production of the alkaline metals and lithium in solutions of copper salts submitted to the action of the radium emanation, and concluded that in the presence of the emanation copper underwent a degradation into the elements potassium, sodium, and lithium. In the current number of the *Comptes rendus* of the Paris Academy of Sciences, Mme. Curie and Mlle. Gleditsch give an account of the attempts they have made to repeat this experiment. They first point out the extreme difficulty of obtaining chemical products free from lithium. This metal was found in distilled water and in nearly all the reagents. If a reagent, free from lithium, is allowed to stand in a glass vessel, traces of this metal are found after some time. Even fused quartz is not a safe material, since both opaque and transparent quartz were found to contain notable amounts, the latter furnishing the larger proportion. The experiments had therefore to be carried out in such a manner that the solutions came in contact with platinum only; the water and the acids necessary for the experiment were re-distilled from platinum and preserved in platinum bottles, and after this treatment no lithium could be detected in the residue from 25 c.c. of the nitric acid, 25 c.c. of hydrofluoric acid, and 250 c.c. of water. The quantities of copper and radium emanation were about the same as those used in the original experiment. The salt residues obtained weighed 0·4 and 0·5 milligram, the control experiments giving 0·3 and 0·2 milligram. Spectroscopic examination of this residue showed it to consist of salts of sodium with a little potassium; the presence of lithium could not be proved. Direct experiments on known mixtures of sodium and lithium sulphates showed that the amount of lithium present in the residue, if any, must be less than $0{\cdot}6\times10^{-5}$ milligrams. In conclusion, the authors state that they have been unable to confirm the experiments of Messrs. Ramsay and Cameron. It is impossible to state that no trace of sodium or lithium is formed in this experiment, but they consider that the fact of the formation of these elements cannot be considered as established.

FOR the second time during the present summer a drought has occurred over England, and the present occurrence is of considerable duration. At Portland Bill absolutely no rain fell from July 17 until Tuesday, August 18—a period of thirty-two days—and at Jersey the aggregate measurement of rain for the period was only 0·07 inch. In London the total measurement of rain for thirty-one days is 0·22 inch, which fell on three days. Rain has fallen rather more frequently in Scotland and Ireland, but in these parts of the kingdom the shortage of rain is considerable. At Leith the measurement for twenty-four days is 0·11 inch, whilst at Roches Point it is only 0·08 inch for twenty-three days, and even at Valencia the aggregate measurement of rain this month is 0·11 inch. The Weather Summary issued by the Meteorological Office shows a considerable deficiency of rain for the present summer. In the extreme south of England, the English Channel stations show a deficiency of 3·26 inches, whilst for the south-west district of England the deficiency is 3·07 inches, and in the south of Ireland 3·01 inches. In most districts the aggregate rainfall since the commencement of the year is less than the average, the deficiency amounting to 5·7 inches in the English Channel, and exceeding 4 inches in the south-west of England and in the south of Ireland.

THE International Historical Congress has accepted the invitation of the British Academy to meet in London in 1913.

DR. H. MORIZE has been appointed director of l'Observatoire de Rio de Janeiro in succession to the late Prof. L. Cruls.

REFERRING to the subject of the standardisation of time, a correspondent points out that in Antwerp there is a system by which, at various prominent points of the city, clocks are shown "connected electrically with the observatory."

SOME interesting experiments on coal-dust explosions have been started, under the direction of Mr. W. E. Garforth, at the Altofts Colliery, Yorkshire. An experimental explosion was witnessed on August 14 by Mr. E. Reumaux (Lens), Dr. J. A. Holmes (United States Geological Survey), Captain Desborough, H.M. Inspector of Explosives, and a number of experts from France and the United States. The cost of the experiments is borne from a special fund of 10,000*l.* contributed by colliery proprietors.

WE regret to see the announcement that Prof. F. Paulsen, professor of moral philosophy in the University of Berlin, died on August 14, at sixty-two years of age. Prof. Paulsen was the author of several important volumes on philosophy and ethics, and he wrote extensively on educational subjects, among these works being "Die deutschen Universitäten," "Geschichte des gelehrten Unterrichts auf den deutschen Schulen und Universitäten," and a volume on past and present German education, of which a translation into English has been published recently.

WE regret to see the announcement of the death, at the age of sixty-two, of Prof. Alfred Giard, professor of general biology at the Sorbonne, Paris, and member of the Paris Academy of Sciences. He was a student at the Superior Norman College in 1867, and became a Doctor of Science in 1872. In the following year he became professor of natural history at the Industrial Institute of the North of France, in 1880 professor of zoology in the University of Lille, founder of the marine biological laboratory at Wimereux in 1884, and professor at the Sorbonne in 1887. His researches and lectures on general embryology and the evolution of living forms gave him a high position among biologists. Prof. Giard was elected vice-president of the Société de Biologie in 1896, and president of the Société entomologique in the same year. In 1900 he became a member of the Paris Academy of Sciences in succession to Prof. Milne-Edwards.

DR. CHARLES TAYLOR, the master of St. John's College, Cambridge, who died suddenly at Nuremberg last week, was a man of varied and sound learning, which has secured for him a permanent place in mathematical as well as in theological literature. His larger book on geometrical conics is remarkable for its elegance, its well-arranged historical notes and prolegomena, and its treasury of examples. The smaller treatise does not suit every kind of student, especially for examination purposes, but it has enjoyed considerable popularity, and is, in many respects, one of the most attractive and enjoyable works on the subject. While thoroughly at home in the methods of the ancients, Dr. Taylor never fully absorbed the projective theory of the moderns; for example, his notes on the circular points at infinity are merely ingenious trifles, and obscure, rather than elucidate, the geometrical meaning of these ideal elements. Apart from this, he rendered a real service to mathematics by devoting so much time to a limited subject with which he was specially competent to deal, and his *magnum opus* in this field is not likely to be superseded.

THE measures devised by Sir Henry Hesketh Bell, Governor and Commander-in-Chief of Uganda, for combating the spread of sleeping sickness are, according to Reuter's Agency, meeting with a considerable measure of success. During 1907 there were no new cases among Europeans, and the deaths among natives during the twelve months numbered less than 4000. The whole of the population has been removed from the shores of the Victoria Nyanza, and it is hoped that the disease-carrying fly in that belt, if not re-infected, will gradually cease to be a source of danger. Several thousands of the sufferers from sleeping sickness are being maintained in segregation camps, but the treatment by atoxyl is not proving of much avail. Consistent and vigorous action will be necessary for some years to come if sleeping sickness is to be stamped out of the country.

WE learn from the *British Medical Journal* that, on October 15, the University of Bern will initiate a great festival in celebration of the two hundredth anniversary of the birth of the great physiologist, botanist, and poet, Albrecht von Haller. Prof. Steck will deliver an address on the personal characteristics of Haller, Prof. Kronecker will discourse of Haller's Bernese home and of his method of working, and Prof. Fischer will treat of Haller's relations with the scientific men of his time, and especially of his relations with Linnæus. On October 16 a monument to Haller's memory will be unveiled on the ground facing the new university buildings. Haller was elected a Fellow of the Royal Society of London on October 25, 1739, when he was only thirty-one years of age; and Prof. Arthur Gamgee, F.R.S., will present, in the name of the society, a Latin address to the University of Bern.

REPORTS as to progress of experiments in wireless telephony appeared in the daily papers during the past few days. The Paris correspondent of the *Times* states that experiments made at the Champ de Mars have established communication with Mont Valérien at a distance of 8 kilo-

metres, Villeneuve St. Georges at 20 kilometres, and Mélun at 50 kilometres. The *Daily Chronicle* correspondent at Milan states that Prof. Majorana is engaged in installing his system of wireless telephony between Rome and Sardinia, after a successful series of experiments between Montemario, the military fortress in Rome, and the Porto d'Anzio Lighthouse, during which communications were distinctly heard over the intervening distance of thirty-six miles. The Central News Agency reports that three French naval officers have succeeded in constructing an apparatus by which they claim to be able to hear singing and speaking distinctly between Paris and Dieppe, a distance of 100 miles. This is announced as a remarkable achievement, but we learn from the *Electrician* that effective wireless telephonic communication was established some time ago between Syngby, near Copenhagen, and Weissensee, near Berlin, a distance of 260 miles.

In the *Times* of August 15 Dr. R. Munro records the discovery of a second lake-village in the neighbourhood of Glastonbury, where excavations have been in progress since 1892 under the supervision of Mr. A. Bulleid. The village recently discovered is situated at Meare, about two miles north-west of Glastonbury. It is clear that the area occupied by these villages was originally a sheet of water, the overflow from which found its way into the Bristol Channel fourteen miles distant. The objects hitherto discovered at Meare consist of long-handled weaving combs, clay sling-bullets, and a few articles of bronze, including a curious finger-ring, with bones and teeth of domestic animals. The manufactured specimens belong to what has been termed the "late Celtic" period, of which sporadic "finds" have occurred in various parts of the country; but Glastonbury is the first inhabited site which has furnished evidence of the entire social life of a late Celtic community. Dr. Munro appeals for funds and the assistance of archæologists in the excavation of this interesting site.

Prof. Milne reports to the *Daily Mail* the occurrence of a seismic storm at the end of last week. On August 13 he recorded three earthquakes at Shide; and on August 14 there was a fourth, which commenced at 1.8 a.m. and attained its maximum twenty-six minutes later. The records indicated that the origin of the disturbance was at a distance of 3800 miles. A message from Prof. Michie Smith to the *Daily Mail* states that at the Kodaikanal Observatory on August 17 an earthquake was recorded commencing at 11.3 a.m. (Greenwich Time). The long waves began at 11.35 a.m., and the maximum was reached at 11.38. At 6 a.m. on August 18 a violent earthquake occurred at Terni, in the province of Perugia. Very strong shocks were also felt at Messina, in Sicily, and the surrounding country. It is also reported that fissures half a mile in length were caused by an earthquake which occurred at the town of Eureka, California, on the morning of August 18.

The French expedition to Antarctic regions, under the command of Dr. François Charcot, left Havre on August 15 in the *Pourquoi Pas*. The French Parliament made a grant of 32,000*l*. for the expedition, and the Prince of Monaco, the Paris Geographical Society, and other scientific bodies have assisted in its organisation and equipment. From the Paris correspondent of the *Times* we learn that Dr. Charcot expects to be absent about two years. One of his objects in returning to the regions of the South Pole is to bring back specimens of the fossils to which Dr. Nordenskjöld has already directed attention. He intends to transport them to one of the open ports of the Antarctic continent, either Port Lockroy or Port Charcot, and then to go on to Loubet Land to begin his exploration of the regions to the south. He has taken with him provisions for twenty persons for more than two years. The *Pourquoi Pas* is expected to arrive face to face with the southern ice about December 15, at about 800 kilometres south of Cape Horn. Dr. Charcot's staff includes M. Bougrain, who will make the astronomical observations; M. Rouch, specialist in meteorology and oceanography; M. Godefroy, who will study the hydrography of the coast and the tides; M. Gourdon, geologist; and Dr. Jacques Liouville, marine zoologist and botanist. Six automobile sleds will, it is hoped, enable the expedition to make its way well into the interior along the glaciers, and supplement the services rendered by the skis. The *Pourquoi Pas* is 41 metres long, 9·20 broad, and has a tonnage of 800.

The surviving members of the Denmark Greenland Expedition arrived at Bergen on August 15, and Lieut. Trolle, master of the *Denmark*, the vessel of the expedition, has given further particulars of the lamentable death of the leader and his two companions. It appears from a Reuter message that a harbour for the ship was found in latitude 76¾°. Mr. Erichsen, Lieut. Hagen, and Mr. Brönlund perished in November, 1907, in an attempt to return from the north coast of Greenland over the inland ice, having been obliged to remain on the north coast through the summer, owing to the state of the weather. A sledge expedition was organised in the spring of 1907, under the command of Mylius Erichsen, to explore the unknown part of the north-east coast of Greenland. The expedition consisted of ten sledges in four batches. Three of these returned before the beginning of summer, and in September, 1907, an expedition was sent out to find the fourth party, which had not returned. At 80° the expedition found open sea close to the coast. In the course of the autumn numerous sledge expeditions started, and in March, 1908, a fresh rescue party set out, which brought back definite news of the fate of the missing sledge party. During the spring several other sledge journeys were made on the inland ice towards the south, as far as Ardencaple. The coast of Greenland was explored as far as Cape Bridgman, 83½°, and into Peary Channel to Cape Glacier. The coast line took a much more easterly direction than was expected, and connection was made with Peary's landmark on Peary Land. At Cape Glacier the Danish flag was hoisted, and the country taken possession of for Denmark, and called King Frederic VIII. Land. No living people were encountered. Scientific expeditions were continuously made into the district surrounding Port Denmark, and also from the ship. On the road large collections were made, and a mass of scientific material was collected; numerous sketches, paintings, and photographs of the country were also made.

A little pamphlet entitled "Die neuere Tierpsychologie," by Dr. Otto Zur Strassen, has been received from Mr. B. G. Teubner, of Leipzig and Berlin. The essay, though general in form, contains numerous references to experimental results. The author cannot, however, be considered to have proved the conclusion which he eventually reaches, viz. that a physicochemical explanation of animal behaviour is possible and sufficient from the protozoa to the primates.

In a paper on the variations and genetic relationships of the American garter-snakes, forming Bulletin No. 61 of the U.S. National Museum, Mr. A. C. Ruthven ex-

presses the opinion that the work of systematic naturalists should be more specially directed towards throwing further light on the problems involved in the origin of species. The barrenness of general results in this direction, particularly in work on reptiles, cannot be entirely attributed to lack of facts, but, in some degree at any rate, is due to the methods employed. Garter-snakes follow the usual laws of geographical distribution, closely related forms on the same line of descent generally inhabiting adjacent regions. Originating apparently in northern Mexico, the garter-snakes became there differentiated into four main groups, which subsequently radiated in all directions, but principally to the northward. Wherever they entered different regions, the different environmental conditions acted unfavourably, retarding growth, and differentiating the group into dwarfed forms.

IN a paper on the ancestry of the tailed amphibians, published in the June number of the *American Naturalist*, Dr. R. L. Movelic comes to the conclusion that the labyrinthodonts or stegocephalians should be split up into two distinct groups, namely, the Branchiosauria of the Carboniferous and Permian, on the one hand, and a second group, embracing the Microsauria, Aistopoda, and the more typical labyrinthodonts, on the other. The first group is regarded by the author as representing the ancestral stock of the modern tailed amphibians, whereas the second is closely related to reptiles, and should not improbably, indeed, be included in that class. From the Microsauria, in which the ribs are long and curved, the Branchiosauria, as typified by the minute Protriton (Brachiosaurus) of the European Permian, are distinguished by their short ribs, which articulate with the transverse processes of the vertebræ. The Branchiosauria agree, in fact, with the modern Amphibia Caudata in their short, straight ribs, the stout transverse processes arising from the bodies of the vertebræ, practically in the number of the presacral vertebræ, as well as in the structure of the skull and pectoral and pelvic girdles, in the number of the toes (four in front and five behind) and of their component segments, as well as in the structure of the long bones, the shape of the body, and the existence of a lateral-line-system. In skull-characters, as well as in the shoulder-girdle, the modern tailed amphibians exhibit marked signs of degeneration, and they may accordingly be regarded as degenerate derivatives of the Branchiosauria. Similarly, the Aistopoda are provisionally regarded by the author as a degenerate branch of the Microsauria.

THE Uganda Protectorate comprises numerous districts, such as Busoga, Bukedi, Unyoro, Toro, Ankole, &c., and the kingdom of Uganda. In the "Official Gazette of the Uganda Protectorate," vol. i., No. 6 (June 15), the following notice appears:—"The Secretary of State for the Colonies has approved of the use officially of the name Buganda for the Kingdom of Buganda, as distinct from the word Uganda, which is still to be used as designating the whole of the territory included within the Protectorate." As an example of the great strides that civilisation is making in Central Africa, it may be noted that in the same "Gazette" tariffs are quoted for motor-waggon and motor-car fares between Entebbe and Kampala.

A GREAT deal has been written about the antiquity of the use of iron in China. Commandant Bonifacy (*Bull. Soc. d'Anth.*, Paris, 1907, p. 512), from a study of the languages of numerous tribes in south China, finds that since a long period of time the metals have borne sometimes a Chinese name and sometimes a particular name which varies according to the tribe, from which he naturally concludes that certain of these metals were introduced by the Chinese, whereas others were known to the tribe before its contact with Chinese civilisation; iron belongs to the latter group, and copper and bronze to the former. Hence the tribes of south China and of Indo-China knew iron before copper. They employed worked flint in China 2200 years B.C., when iron was already known. China has not passed through an age of bronze or copper.

IN the *Essex Times* of August 8, the Rev. J. W. Hayes, of West Thurrock Vicarage, Grays, has directed attention to some old underground workings for chalk at Hemel Hempstead, which in his opinion throw much light on the origin and use of dene-holes generally. It appears that in order to obtain chalk suitable for lime-making it was until recently the practice in parts of Hertfordshire to work the chalk in subterranean chambers reached by deep shafts. One pit, dug as lately as 1882, attained a depth of 90 feet. A vertical shaft, of circular section, about 5 feet in diameter, was sunk through superficial deposits until the hard chalk was reached, and from the bottom of the shaft three so-called "arches" were struck out. These arches were chambers, which in some cases were more than 12 feet high. The chalk was mined in these drifts for a length of twenty to twenty-five yards, and when the distance of the working face from the bottom of the shaft became inconveniently great, or when the roof proved unsound, a new pit would be sunk. The centre of the industry was the parish of Hemel Hempstead, but many abandoned pits are to be found in the country between Tring on the west and Shenley, near Barnet, in the south.

WE have received copies of a new publication, *Neue Weltanschauung*, published in Stuttgart under the editorship of Dr. W. Breitenbach, with the object of diffusing the results of modern scientific research in its application to philosophy and culture. The editor contributes an article on modern theories in connection with heredity and their scientific foundation, in which he discusses the "pangenesis" theory of Darwin, de Vries's theory of "pangenes," and Haeckel's conception of "plastidules." An appreciation of Charles Darwin, and a photographic reproduction after Collier's drawing, have been evoked by the Darwin jubilee.

A LIST of rare shrubs for growing in the open garden, compiled by the Hon. Vicary Gibbs, is published in the Journal of the Royal Horticultural Society (vol. xxxii., part ii.). The author prefaces the article with the intimation that his remarks refer to plants grown in Hertfordshire on a cold, clay soil where severe frosts are experienced in late spring. *Rosa ferruginea* among the roses, *Colletia cruciata*, *Cotoneaster acutifolia*, and *Sambucus canadensis* are some of the plants receiving special commendation; several species are selected under the genera Berberis, Spiræa, Ribes, Syringa, and Ilex. The author also mentions the tree pæonies, varieties of *Paeonia Moutan*, that he has imported directly from Japan. In the same number of the journal Mr. J. Hudson discusses the subject of plants for terrace gardening. He supplies useful notes on the methods of training scented geraniums, and recommends the species *radula major*, "Clorinda," and *capitatum*. *Aloysia citriodora* is another choice, and some bamboos, palms, and species of Phormium are suggested.

THE Philippine Weather Bureau has just issued part ii. of the annual report for 1905. Besides the Central Observatory at Manila, the Bureau controls forty-four

secondary stations, seven being of the first order. The report contains the daily meteorological observations made at all these stations during 1905. At the first- and second-order stations the observations are made six times a day; at the third- and fourth-order stations twice a day. The data are collected into monthly batches, but although the monthly means are there, they are not brought together so as to form annual summaries for the various stations.

In a letter we have received from Mr. H. H. Scott, meteorological observer for Launceston, Tasmania, some interesting observations on the sinking of stones are recorded. In the course of the day Mr. Scott twice traverses in full daylight a piece of public land between two thermometer screens. Much of the surface of this land is charged with brick dust, and on it fragments of diabase have been scattered. In the absence of frost the path between the screen remains firm and compact. During June last twenty-one of the first twenty-nine days commenced with frost, and outside thermometers read as low as 19°·3 F. Later in the day bright sunshine followed, and the reading of the solar thermometer sometimes reached 101° F. Consequently, the ground was first frozen, then soaked with moisture, and afterwards warmed considerably. Mr. Scott noticed that day by day the earth round the fragments of diabase appeared to be lifting slowly. On June 29 he found some fragments to be 18 mm. to 20 mm. below the surrounding surface, and in the case of unusually large pieces of rock even deeper. No earthworms were at work in the neighbourhood of the stones, and the alteration in level appeared to be due wholly to atmospheric agency.

In the "Album der Natuur" Dr. J. G. van Deventer writes on the Warner Powrie method of colour photography, and refers to an article in NATURE, October 24, 1907 (vol. lxxvi., p. 642). In this method, coloured lines replace the coloured dots of the Lumière process, about 320 lines being the average to the centimetre. The advantages are that the colour screen is more regular with alternating colour-bands, and that positive prints can be made on paper. The colour screen is prepared from bichromatised gelatin by exposure under a screen of bands divided by spaces half their width. The resulting ridges of gelatin are stained with appropriate dyes, and then present a series of coloured bands of which the relative thicknesses are as 1, 2, and 3 for the colours violet, green, and orange, the absolute thickness varying from 5 to 40 microns. Sensitive emulsion is then deposited over this screen, and a transparent positive obtained as with the Lumière method. To obtain further positives, use is made of the already known Uto paper. In this the sensitive layer is mixed with three organic dyes complementary to those in the screen, and mixed with anethol. This gives the property that the absorption of a colour causes the same coloured dye to become colourless. In this way a positive coloured print is obtained. Dr. Deventer does not think that ordinary Uto paper containing silver can be used. He shows how Powrie uses two mirrors at an angle of 110° with a thin glass plate between the positive plate and the paper, obtaining the combination empirically which results in giving the best intensification and elimination of any dark bands. The paper ends with a description of the method of obtaining the *clichés* for three-colour printing.

We have received new catalogues of electrical and other apparatus from Messrs. Siemens Bros. and Co. and from the Cambridge Scientific Instrument Co. which should prove useful to those who are considering the purchase of apparatus for the coming winter. The latter catalogue is in the form of a file, with an arrangement at the end to enable sheets issued in the future to be readily attached. It also gives more information about the sensitiveness of the various instruments described than we have seen previously in any instrument maker's catalogue.

The attempts which have been made in the past to substitute some instrument for the eye in accurate photometry have not been very successful owing to the methods adopted not having proved so sensitive as the eye. M. Charles Féry appears to have overcome this difficulty by an arrangement he described to the Société française de Physique in May, which is given in the August number of the *Journal de Physique*. The light to be tested is placed a metre away from a lens, which forms an image of the source on the receiving disc of a Boys radiomicrometer. Between the lens and disc the light passes through a layer of water 4 cm. thick, containing copper acetate of such strength that there is 1 gram of copper in a litre of solution. This solution, the author finds, cuts out of the beam those radiations which do not affect the eye, and the instrument gives results for different sources which are in close agreement with those given by the Lummer-Brodhun photometer. It also enables the optical efficiency of the source, *i.e.* the ratio of the luminous to the total radiation, to be readily found.

Prof. J. C. McLennan, University of Toronto, described in NATURE of May 14 (p. 29) some experiments which led him to conclude that the radio-activity of potassium and its salts is not connected with a *normal* atomic property of the metal. The salts used were those ordinarily sold by the best makers as chemically pure, and in arriving at the conclusion mentioned it was assumed that the salts used possessed, at least approximately, the high degree of purity claimed for them. Prof. McLennan now writes to say that analysis has proved this assumption to be incorrect. A comparison of the percentage by weight of potassium in several salts with the radio-activities of the salts has shown that the salts which contained the most potassium were those which exhibited the strongest activity, and that for the more active ones the radio-activity was almost directly proportional to the amount of potassium present.

Messrs. Crosby Lockwood and Son send us the first number of a quarterly circular of engineering and technical literature (classified under subjects) just published by them. The circular contains particulars of the most important works in engineering, science, and technology published during the past three months in England and in America, and as it will be repeated every quarter it should prove of assistance to engineers.

The nineteenth annual general meeting of the Institution of Mining Engineers will be held at Edinburgh on September 2–4. The following papers will be read, or taken as read:—coal-dust to date and its treatment with calcium chloride, H. Hall; on the practical use and value of colliery rescue-apparatus, G. Blake Walker; the Wemyss coal-field, J. Gemmell; the working of oil-shale at Pumpherston, W. Caldwell; deep diamond boring, J. Thomson.

In the Bulletin of the Johns Hopkins Hospital for July (xix., No. 208), Prof. Howard Kelly, in an article entitled "The Barred Road to Anatomy," gives an interesting account of the "body snatchers," Burke and others, and of the times in which they lived, from the point of view of the study of anatomy.

MESSRS. BURROUGHS, WELLCOME AND CO. have issued an interesting and well-produced guide, with descriptive catalogue, of their exhibits at the Franco-British Exhibition; also pamphlets describing their laboratories, and the research work that has been carried out in them.

THE *Philippine Journal of Science* for April (iii., No. 2) contains a number of important papers relating to medical science—on cholera, on typhus fever, on the virus of cattle plague, and on the venom of the "habu," a venomous snake found in some of the Japanese Islands.

IN No. 33 of the Scientific Memoirs of the Government of India Colonel Bannerman discusses the production of alkali in broth culture media by the plague bacillus, which may reach an amount equivalent to 1·5 per cent. to 2·5 per cent. of normal sodium hydroxide.

## *OUR ASTRONOMICAL COLUMN.*

ANOTHER LARGE SUN-SPOT GROUP.—The renewal of the sun-spot activity illustrated in these columns last week is being well maintained. On Wednesday, August 12, the large groups shown on our photograph had reached the western limb of the sun's disc, and on Thursday bad weather prevented observations entirely at South Kensington; but on Friday morning it was seen that a large scattered group of small spots had broken out near the centre of the disc, whilst numerous small spots were scattered over the surface. This new group was visible to the naked eye, and has apparently evolved from a prominent group of faculæ which was observed near the eastern limb earlier in the week.

THE TOTAL SOLAR ECLIPSE OF DECEMBER 22–23.—Further particulars concerning the possibility of observing the total eclipse of the sun in the Antarctic, in December next, are contained in a letter we have received from Prof. Wilhelm Krebs.

Prof. Krebs points out that both Bouvet Island and the more northerly Thompson Island lie outside the real ice limits, and that only small, isolated icebergs were observed by the expedition ships that have recorded them. Thus, with a totality lasting, according to his calculations, 11·3 seconds, it might be possible to secure pictures of the corona at Bouvet, or Thompson, Island in December. Meteorological and magnetic observations could be carried out, as also could observations of the shadow bands and of the radiation variations. The approximate times of mid-eclipse in different longitudes are shown below:—

| Longitude ... | W. 60° | 40° | 20° | 0° | 20° | 40° | 60° E. |
|---|---|---|---|---|---|---|---|
| | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| G.M.T. Dec. 22–23... | 22 15 | 22 37 | 23 11 | 23 45 | 0 15 | 0 43 | 1 6 |

ONE HUNDRED NEW DOUBLE STARS.—Prof. R. G. Aitken's twelfth list of double stars is published in No. 134 of the Lick Observatory Bulletins, and brings the total number now discovered up to 1800. All the double stars in this list were discovered and measured with the 36-inch refractor, and attention is directed to Nos. 1745, 1746, and 1777, which add closer companions to OΣ 190, Σ 1224, and Σ 1579 respectively.

THE NIGHT-GLOWS AT THE BEGINNING OF JULY.—In No. 4266 of the *Astronomische Nachrichten* (p. 297, August 1) Prof. Max Wolf discusses the night-glows which attracted so much attention about July 1. On that date Prof. Wolf was unable to carry out his usual programme of photography because the sky-glare was far too bright, and in the north only such stars as Capella and α and β Ursæ Majoris were easily visible to the naked eye. At first Prof. Wolf suspected that a display of aurora was taking place, but failure to observe the aurora spectrum or any fluctuations of the light led him to conclude that the phenomenon was due to the peculiar high cirrus cloud that prevailed.

THE EMPLOYMENT OF SELENIUM CELLS IN PHOTOMETRY.—Readers of these columns will remember that some time ago Messrs. Stebbins and Brown, of the Illinois University Observatory, made photometric observations of the moon's light, using selenium cells (see NATURE, January 16 and 30, pp. 258 and 302), and subsequently showed that the great differences found were due to the different colour-sensibilities of these cells (NATURE, May 7, p. 18). Referring to these observations in No. 1, vol. xxviii., of the *Astrophysical Journal* (p. 83, July), Prof. Pfund points out that the curves determined by Mr. Stebbins are not true sensibility curves, because the energy curve of the spectrum employed was not taken into account. He also suggests that, at the present time, the use of selenium cells is unwarranted except in observations of the variations of a light source of which the effective area alone changes. A method of employing selenium cells in combination with colour screens for the determination of stellar magnitudes has been devised by Prof. Pfund, and will be fully discussed in a future publication.

ECLIPSES OF SATURN'S SATELLITES.—During the coming opposition of Saturn, Rhea and the inner satellites will be eclipsed. The following times of eclipse are taken from a paper published by Dr. H. Struve in No. 120 of the Publications of the Astronomical Society of the Pacific:—

| | Disappearance | | | Reappearance | | |
|---|---|---|---|---|---|---|
| | h. m. | ″ | ° | h. m. | ″ | ° |
| August 22 ... | 13 6 ... | 4·3 ... | 218 | 14 15 ... | 2·1 ... | 193 |
| ,, 31 ... | 14 11 ... | 3·0 ... | 211 | 14 59 ... | 1·8 ... | 193 |

The distances are measured from the planet's limb, and the position-angle from the N. point of the minor axis towards E. (the *Observatory*, No. 399, p. 326, August).

A LARGE PROMINENCE.—In No. 1, vol. xxviii., of the *Astrophysical Journal* (July, p. 79), Mr. Evershed describes a large prominence of which a series of photographs was obtained with the Kodaikánal spectroheliograph on February 18. The first plate was secured at 8h. 23m. (Indian Standard Time), and showed no unusual disturbance, but a supplementary photograph at 9h. 38m. showed that a prominence faintly showing on the first plate had developed enormously, the disturbed area extending from position-angle 89° to 127°. Visual observations showed prominence matter on Hα, and the sodium and magnesium lines were also observed bright within the affected region. Twenty "limb" spectroheliograms were obtained during the day, the last being taken at 18h. 2m., when the sun was less than 3° above the horizon, and, of these, fourteen are reproduced. These show that the increase in size took place quite gradually, and that the velocity with which the great mass left the sun was, after the first outburst, consistently accelerating. The main mass of matter was joined to the sun by a fine filament, situated at the edge of the disturbed area, which appeared to act as a flexible cord holding one end of the mass to the sun and forcing it to swing out in a curve. The greatest height shown on the photographs was 585 seconds of arc, or more than 260,000 miles.

## *THE WATER OF THE METROPOLIS.*

THE report of the Water Examination Committee (July 18, 1908), and the first report on research work by Dr. Houston, the director of water examinations, Metropolitan Water Board, contain matter of considerable interest. The first details the results of the chemical and bacteriological examinations, many hundred in number, of the raw water and of the filtered supplies delivered to the consumers within the area of the Water Board for the year ending March 31, 1908. The matter is arranged in tabular form, and, *inter alia*, much information is given respecting the distribution and types of *Bacillus coli*, the effects of subsidence and filtration on the bacterial content of the water, and the composition of the media employed in bacteriological research in the Board's laboratories.

Dr. Houston's report deals with the important question of the vitality of the typhoid bacillus in artificially infected samples of raw Thames, Lee, and New River water, with

special reference to the question of storage. Full details are given of the experimental methods employed. Taking cultures of 100 cubic centimetres of water as the final guide, it appears that, starting with an initial number of typhoid bacilli varying from 40 per c.c. to 8,000,000 per c.c. in the infected water, the typhoid bacillus could not be recovered from 100 c.c. of the water in any of the eighteen experiments after nine weeks, *i.e.* in this period the organism had died out so far as experiment could ascertain, and in sixteen out of the eighteen experiments the organism had died out in eight weeks. If, therefore, the water before distribution to the consumer could be stored for an adequate period, it would seem that the risk of conveyance of typhoid, supposing the water were infected, would be practically eliminated.

At present the Water Board's existing storage reservoirs are capable of holding in the aggregate 8883·7 million gallons, which is forty times the average daily supply of 219 million gallons, and powers have been obtained for the construction of storage reservoirs for another 6000 million gallons. When these are completed, the storage capacity would be adequate for the storage of the water for the eight or nine weeks necessary to eliminate the typhoid bacillus. Even in existing circumstances the conditions are by no means unsatisfactory. Unfortunately, however, the storage capacity at the different works is very unequal, and some have to take their water after only a limited period of storage. If the different reservoirs could be connected, and the supplies so "pooled," a better condition of things would result. Adequate storage of water also presents advantages of a general character, apart from the elimination of typhoid, *e.g.* subsidence of particulate matter which tends to block the filter-beds, reduction in the total bacterial content, &c.

R. T. H.

## *SOME RESULTS OF THE NORWEGIAN HERRING INVESTIGATIONS.*

"UNSERE Heringsstämme und ihre Wanderungen" is the title of a paper written for the Bergens Museum Aarbog, 1908, by Hjalmar Broch, dealing with some of the results of the Norwegian investigations into the herring fisheries. Extensive and detailed observations made by the *Michael Sars*, the Norwegian vessel for the international investigations, supplemented by information from other vessels, have yielded some valuable and interesting information as to this fish. One of the chief objects in view was to distinguish clearly the different races or varieties of herrings that are to be found in the North Sea, for it has of late been becoming more and more evident that each race of herring must be studied by itself, the characteristics and the direction and extent of the wanderings of the different shoals being very different. Following the method used by Heincke to accomplish this object, Broch has made a series of biometrical observations on numerous fish, and so determined their differences of structure, and these, accompanied by observations on sex, maturity, and fatness, have added considerably to our previous knowledge of the subject. Tables of the measurements are given, and the differences between the corresponding average measures on fish from different races, with their probable errors, are printed in the text, so that we are able at a glance to estimate the real significance of these differences. The inclusion of these in this form is of real value. For example, the differences between the averages of most races are considerably greater than their probable differences, but there is no conclusive proof as yet whether or not the varieties known as spring and large herring are really of the same race.

The following kinds of herring and their characteristics are now well known:—

(1) The Dogger Bank herring in the central North Sea.

(2) The Bohusläns herring in the Skager Rak.

(3) The Shetland herring in the northerly and westerly parts of the North Sea.

(4) The Norwegian spring and large herring along the Norwegian west coast and the north-easterly part of the North Sea.

(5) The Beitstad Fiord herring in Trondhjems Fiord.

There is a short section on the age investigations, which are as yet not advanced enough to give many results. Age is determined by means of the annual rings in the herring scales. An examination of plate ii. shows that the length of a herring is not by any means a simple function of its age, the growth rate being very different for the several kinds. The Beitstad Fiord herring, which is supposed to spend its whole life within the area of the fiord, is found to grow much more slowly than those races which frequent the open sea. In its fifth year it seldom exceeds a length of 22 cm., whilst the herrings of the Norwegian seas may become 24 or 25 cm. even in their second year.

The distribution of the various shoals and their movements at different times of the year have been studied. For instance, the spawning-places of the spring and large herring are found along the Norwegian coasts from Trondhjems Fiord to Risør, and the shoals gather here in early spring. The spent herrings then move into the open sea, and later in June they appear on the North Sea slopes. In autumn, 1905, they were discovered on the coastal banks between Stadt and Lofoten, whence in December they moved in a southerly direction towards the spawning-places along the coast.

The value of these investigations is not for the man of science alone; they are of great importance to the practical fisherman, who, knowing exactly when and where the various shoals spawn, is able to catch the herring when they are prime and avoid them in their spent condition. Many interesting questions, such as the relation of the herring migrations to the distribution of plankton, yet remain to be solved, and these must be the object of further investigations.

R. M. L.

## *ARCHÆOLOGICAL RESEARCH IN INDIA.*

A WRITER who has enjoyed unusually favourable opportunities of examining the conditions under which archæological research in India is being conducted has recently contributed to the *Times* a series of reports of his observations. Archæology in India is now at last, after a period of vandalism and neglect, being conducted on business and scientific principles. For this we are indebted to Lord Curzon.

The first serious attempt to collect information dates from the appointment, in 1862, of General Cunningham as Director of Archæology. Owing to the wide extent of the sphere of operations and the difficulty of securing the services of qualified assistants, the result was far from satisfactory. A long series of reports was issued, which, though they contain some valuable material, are ill-arranged and overloaded with useless matter. Besides this, under the régime of General Cunningham the work of conservation of existing buildings formed no part of the proceedings undertaken by the Government of India. After the retirement of General Cunningham little progress was made until, under Lord Curzon's scheme, in 1901 the post of Director was conferred upon Mr. J. H. Marshall, who, though without any Indian experience, had been trained in the Cambridge School of Greek Archæology. Since his appointment the work of conservation has gone on side by side with that of exploration, and important buildings like the Taj Mahal at Agra and the palaces at Fatehpur-Sikri have been judiciously restored. The most noteworthy excavations now in progress are those at the Buddhist monastery at Sarnath, near Benares, the buried city of Sravasti in northern Oudh, and the Græco-Buddhist remains in the neighbourhood of Peshawar. On the results of these excavations excellent periodical reports have been issued.

It is hardly realised what a wealth of archæological material still remains to be explored. Kapilavastu, the birthplace of Buddha, which lies just within the Nepalese Terai; Pataliputra, the Maurya capital, in the neighbourhood of the modern Patna; and numerous sites of the first importance in the Punjab and the United Provinces of Agra and Oudh, such as Taxila, near Rawalpindi, still await exploration. Research at many of these sites is certain to unearth inscriptions and sculptures which will

serve to fill up many a gap in the early history of the country. The main hindrances to progress are at present:—first, the exclusiveness of both Hindus and Mohammedans, who object to the examination of buildings which are still used for worship; secondly, the fact that many important ancient buildings are situated within the territories of native States, where it has up to the present been impossible to arrange satisfactory schemes for conservation and excavation. In spite of these drawbacks, archæological research in India has now been placed upon a sound footing, and in the immediate future a large amount of fresh material, in the shape of sculptures and inscriptions, will be at the disposal of students.

## *ON ICE AND ITS NATURAL HISTORY*[1].

DURING the Antarctic cruise of the *Challenger* in the early part of the year 1874 I carefully examined the chemical and physical properties of sea ice. The melting temperature of the ice varied with the samples, but it was always below 0° C., and it was found impossible by any means to produce pure water by melting it. These two facts were for me convincing evidence, at that date, that the salt was present in the ice in the solid state, and that, consequently, the crystalline body, formed by freezing sea-water and similar saline solutions, was not pure ice.

About nine years later Dr. Otto Petterssen, having his attention directed in a similar way to the same subject, arrived at the same conclusion. His observations and their discussion are embodied in a remarkable paper on the properties of ice and water (Publications of the *Vega* Expedition, 1883). In the careful study which I made of this work the following passage arrested my attention:—"A thermometer immersed in a mixture of snow and sea water, which is constantly stirred, indicates −1°·8 C."

If this statement was exact, it was clear that the evidence furnished by the melting temperature of the sea ice was not entitled to the weight which I attached to it, and that the conclusion at which we had independently arrived was open to doubt. On repeating the experiment, I was able to confirm Petterssen's statement. I then proceeded to investigate the subject in detail. The principle which guided the investigation was the following:—if the crystalline body, which is formed when a non-saturated saline solution is partially frozen, is pure ice, then pure ice of independent origin, such as snow, must, when mixed with the same saline solution, and heat is supplied, melt at the same temperature when the concentration is the same.

This was found to be the case; and the result of the research was definitively to establish, on experimental evidence, the validity of the principle that, when a non-saturated saline solution is partially frozen, the crystals which are formed are pure ice; and, by consequence, that the salt from which it is, in practice, impossible to free them, belongs to the adhering brine.[2]

It was not until after this had been established, in 1887, that it became legitimate to say "the freezing point of *water* is lowered by the presence of salt dissolved in it," instead of saying "the freezing point of a *saline solution* is so much lower than that of pure water." The former of these statements expresses the fundamental principle of cryometric chemistry.

Shortly, *I define the freezing and melting temperature of a substance to be the temperature at which it as a solid passes into itself as a liquid, and as a liquid passes into itself as a solid.* In terms of this definition the freezing and melting temperature of the substance $H_2O$ is 0° C. In order to represent the *temperature at which ice melts*, this definition requires a double qualification. At constant pressure the temperature at which ice melts depends on the nature of the medium in which it melts, and if the nature of the medium be constant, the temperature at which ice melts depends on the pressure. Of the two modifying agencies, the influence of the medium preponderates in nature. Indeed, inasmuch as perfectly pure water is rarely, if ever, met with, it is probable that, *in nature, ice never melts and water never freezes exactly at* 0° C.

The principle that the temperature at which ice melts depends on the nature of the medium in which it melts is the key to the natural history of ice, and it forms the theme or text of this discourse. It at once brings into order the anomalies frequently observed in the experimental determination of many of the physical constants of ice, such as its coefficient of thermal expansion, its specific and its latent heat. When the ice or the water in which it is immersed contains any impurity, the temperature at which the ice begins to melt is below 0° C., and the substance under examination, which is taken for pure solid ice, is in reality a mixture of ice and impure water.

In discussing this subject, chloride of sodium is taken as the representative impurity, because it is the most widely disseminated ingredient of natural waters. It has also been more thoroughly studied than other salts in its behaviour to ice, water, and steam. In discussing the influence which this salt exercises over the apparent physical properties of ice a constant quantity of it is considered, and the quantity of ice on which it acts is varied. The constant quantity of the salt is 1·5105 grams, which contain 0·9167 gram of chlorine. The specific gravity of pure ice is taken as 0·9167 referred to that of water at the same temperature as unity.

It will be recognised that when 1000 c.c. of ice containing 1·5105 grams NaCl are melted, they furnish a water which contains chlorine in the proportion of 1 : 1000 by weight. The coefficient of cubic expansion by heat of pure ice is taken as 0·00016, and it is assumed to be constant at the temperatures under consideration. The volume occupied by the 1·5105 grams NaCl is disregarded. The cryohydric temperature of NaCl solution is taken as −21°·72 C., and its cryohydric concentration as 29·97 grams salt to 100 grams water.

Using these constants, we will apply the principle to the calculation of the apparent variations of volume of a block of ice the volume of which at 0° C. is 1000 c.c. It contains diffused through it 1·5105 grams NaCl, which we assume to be provisionally in the *inert* state, in which it is deprived of the power to induce the melting of ice at temperatures between 0° C. and −21°·72 C. Let the temperature of the block containing the inert NaCl be reduced to −23° C.; its volume will be reduced to 996·320 c.c., and as the temperature is below the cryohydric temperature, the salt is by nature inert; at such temperatures ice and common salt are indifferent to each other. Let the temperature of the block of ice be now raised to −22°; the salt remains inert, and the volume of the ice increases to 996·48 c.c. If the temperature is further increased to −21°·721, the NaCl will still remain inert, and the volume of the ice will become 996·525 c.c.

If the heating is continued the temperature rises exactly to the cryohydric point, −21°·72, at which temperature the indifference of chloride of sodium to ice ceases, and induced melting at that temperature takes place. It will then be observed that the temperature remains constant for a time, while the volume of the block diminishes. When the temperature begins to rise, the volume of ice melted will be 5·498 c.c. As this produces 5·040 c.c. water, the diminution of volume is 0·458 c.c., and the apparent volume of the block is 996·067 c.c.

Let us now go back to the initial state, in which we have the block of 1000 c.c. ice, containing 1·5105 grams inert NaCl diffused through it, at the temperature 0° C. Let the temperature be reduced to −21° C., the ice remaining inert. The volume of the ice will then be 996·64 c.c. Let the NaCl recover its activity, it will melt 5·629 c.c. ice, producing 5·160 c.c. water under a contraction of 0·469 c.c., so that the apparent volume of the ice at −21° C. is 996·64−0·469=996·171 c.c. Proceeding by steps in this way, we obtain, for different temperatures $t$, the volume of the ice containing inert salt V, the volume of ice melted by the salt when its activity is

[1] Abridged from a discourse delivered at the Royal Institution on Friday evening, May 8, by J. Y. Buchanan, F.R.S.

[2] The results of the research which I began in the year 1886 were communicated to the Royal Society of Edinburgh in a paper "On Ice and Brines," which was read on March 21, 1887, and was published in the Proceedings of the Society, vol. xiv., pp. 129–149. A full account of it was also published in NATURE, 1887, vol. xxxv., p. 608, and vol. xxxvi., p. 9. The whole subject of the influence of dissolved salt on the state of aggregation of the substance $H_2O$ at temperatures below its normal freezing and melting point and above its normal boiling and condensing point was passed in review in my chemical and physical notes in the "Antarctic Manual," 1901, pp. 73–108.

restored $v$, the contraction so produced $c$, and the resulting apparent volume of the ice $U = V - c$. The values of $v$ are derived from the observed freezing points of specified NaCl solutions. The results calculated for certain values of $t$ are given in Table I. :—

TABLE I.

| $t$ | V | $v$ | $c$ | U | $t$ | V | $v$ | $c$ | U |
|---|---|---|---|---|---|---|---|---|---|
| ° C. | c.c. | c.c. | c.c. | c.c. | ° C. | c.c. | c.c. | c.c. | c.c. |
| −23 | 996·320 | 0 | | 996·320 | −8 | 998·720 | 12·531 | 1·044 | 997·676 |
| −22 | 996·480 | 0 | | 996·480 | −7·2 | 998·848 | 13·884 | 1·157 | 997·691 |
| −21·721 | 996·520 | 0 | | 996·520 | −7·0 | 998·880 | 14·195 | 1·183 | 997·697 |
| −21·72 | 996·520 | 5·498 | 0·458 | 996·067 | −6·8 | 998·912 | 14·628 | 1·219 | 997·693 |
| −21 | 996·640 | 5·629 | 0·469 | 996·171 | −1·0 | 999·840 | 98·350 | 8·196 | 991·644 |
| −20 | 996·800 | 5·825 | 0·485 | 996·315 | −0·1 | 999·984 | 998·35 | 85·196 | 916·788 |

If we study this table we see that *between the temperatures −23° and 0° the coefficient of apparent dilatation of the ice changes sign three times—namely, twice at the cryohydric temperature, and once at a higher temperature.* Between −23° and the cryohydric point −21·°72 the expansion is uniform, the coefficient being 0·00016. At the cryohydric point the addition of heat produces contraction without change of temperature; the coefficient, therefore, is $-\infty$. Above the cryohydric temperature the volume increases with the temperature, but at a gradually diminishing rate, until at −7°·0 the increase of volume due to simple expansion of the ice is exactly balanced by the contraction due to induced melting. At this temperature the coefficient of expansion changes sign, and between −7°·0 and −0°·1, at which the ice has practically all melted, the coefficient of expansion is negative.

If the block of ice contained salt in the proportion 29·97 grams NaCl to 100 grams ice, it would expand uniformly on being warmed from −23° to −21°·72, and would then melt completely at that temperature. In the same way, if it contained no salt or impurity whatever, it would, on being warmed, expand uniformly, while its temperature rose, until, at 0° C., it would melt completely. If the ice contains salt in a less proportion than 1·7164 : 100 by weight, then we witness the three changes of sign in the coefficient of dilatation when the temperature rises from below the cryohydric point to the temperature at which the ice is finally liquefied. When the block contains, per 100 parts by weight of ice, less than 29·97 and more than 1·7164 parts of NaCl, the coefficient of apparent expansion is negative at all temperatures above −21°·72.

In Table II we have the upper critical temperature ($\tau$) at which the coefficient of apparent dilatation changes sign for blocks of ice having volumes ranging from 100 cubic centimetres to 100 cubic metres, each containing 1·5105 grams NaCl. Under $V_0$ we have the initial volume of the block of ice supposed pure and solid at 0° C., and under $v$ the volume of ice which can be melted under the inducing influence of 1·5105 grams of chloride of sodium at the critical temperature $\tau$, at which the apparent coefficient of cubic expansion of the ice is equal to 0.

TABLE II.

| $V_0$ | $v$ | $\tau$ | $V_0$ | $v$ | $\tau$ | $V_0$ | $v$ | $\tau$ |
|---|---|---|---|---|---|---|---|---|
| c.c. | c.c. | ° C. | c.c. | c.c. | ° C. | c.m. | c.c. | ° C. |
| 100 | 5·73 | −20·5 | 1000 | 14·20 | −7·0 | 0·01 | 41·83 | −2·3 |
| 200 | 6·74 | −16·6 | 2000 | 20·00 | −4·9 | 0·1 | 136·3 | −0·725 |
| 400 | 9·85 | −10·75 | 4000 | 27·80 | −3·5 | 1·0 | 438 | −0·2275 |
| 600 | 11·75 | −8·65 | 6000 | 32·24 | −2·95 | 10·0 | 1377 | −0·0725 |
| 800 | 12·85 | −7·8 | 8000 | 37·57 | −2·55 | 100·0 | 4306 | −0·02275 |

A block of 100 c.c. of ice, which contains 1·5105 grams of NaCl diffused through it, furnishes on being melted 91·67 c.c. of water, which contain 0·9167 gram of chlorine, dissolved in it as chloride of sodium. This water contains chlorine in the proportion 1 gram to 100 grams of water, and represents a concentration about one-half that of average sea water. When the volume of ice, $V_0$, is 1 cubic metre, the water produced by its melting contains chlorine in the proportion of one part to one million parts of water by weight.

Waters which contain dissolved matter equivalent to no more than 1 gram of chlorine in 10,000 grams of water are in the category of ordinary fresh waters, and we see that the critical temperature of ice which furnishes such water lies as low as −2°·3. When the dissolved matter is equivalent only to 1 gram of chlorine in 100,000 grams of water, the critical temperature is −0°·725. The other waters are in the category of distilled waters, and it is doubtful if, by any chemical means whatever, we could determine as little dissolved matter as 1 gram chlorine in one ton of water; yet the critical temperature of such ice lies nearly a quarter of a degree below the melting temperature of pure ice. The critical temperature of expansion of ice affords a means of detecting impurity equivalent to quantities of chlorine as small as one gram in ten tons, and even one gram in one hundred tons of water.

*Influence of Impurity on the Apparent Latent Heat of Ice.*

This is illustrated by the numbers in Table I. Thus, at −1° C., the apparent volume of the block of ice is 991·644 c.c., and it is made up of 901·49 c.c. ice and 90·154 c.c. water. When this is warmed to −0°·1, we may take it that the whole of the ice is melted. Taking the latent heat per unit volume of ice as 66·5 at −0°·1, and its specific heat per unit volume as 0·45, the heat required to raise the ice from −1° to −0°·1 is 365·1 gram-degrees (gr.°); that required to raise the temperature of the water by the same amount is 81·14 gr.°, and the heat required to melt the ice at −0°·1 is 59949 gr.°, the total heat used being 60395·2 gr.°. If we ignore the possibility of partial melting, and assume that we have 999·84 c.c. solid ice at −1°, and that its temperature is raised to 0°, at which temperature it melts, we have the following expenditure of heat:—for rise of temperature 449·9 gr.°, and for melting 66489·3 gr.°, making together 66939·2 gr.°, as against 60391·5 gr.°. If from 60395·2 gr.° we deduct the heat calculated for warming the ice in the second case, 449·9 gr.°, we obtain 59945·4 gr.° as the heat required to melt 1000 c.c., or 916·7 grams, of ice at 0°, whence the latent heat would be, per unit volume, 59·94, and per unit weight 65·39.

This example illustrates also the effect of impurity on the apparent specific heat of ice.

*The nature of the medium is responsible* in the case of sea ice for depressions of freezing and melting temperatures of thirty, forty, or even more degrees of Celsius's thermometer, while the greatest pressure to which fresh-water ice is exposed in nature cannot produce an alteration of freezing and melting point amounting to much more than one degree.

If we pick up a piece of ice floating in the Polar Sea we know that it will prove to be very far from homogeneous. It may have a foundation of genuine primary sea ice, but the ice forming the superstructure is sure to consist of snow, frozen spray, and very likely fragments of land ice, all cemented together into a species of conglomerate. When this is exposed to warmth it begins to melt at a temperature which may be one or two degrees below the melting point of pure ice, and the liquid so furnished is salt water. The further melting takes place in ascending order of temperature, the salt ice of low melting point disappearing first, and the purer ice melting later. We thus see how ice can be cemented by ice, just as metallic objects may be united by solder. In both cases the substance of the binding material differs from that of the objects united, chiefly in being more easily fusible.

If we have a number of cubes of pure ice which fit each other exactly, and if, after being moistened with salt water, they are exposed to frost, they will solidify to a single block. If this be exposed to the sun the cementing salt ice will melt first, and, when it ceases to bind, the constituent cubes of pure ice will fall asunder, having themselves suffered practically no diminution due to melting.

Now this is precisely what happens when a block of sound glacier ice is exposed to the rays of the sun for a short time, and it is one of the most striking and instructive experiments that can be made. Under the influence of the sun's rays, the binding material melts first, the continuity of the block is destroyed, the individual grains become loose and rattle if the block be shaken, and,

finally, they fall into a heap. A block of glacier ice is a geometrical curiosity. It consists of a number of solid bodies of different sizes and of quite irregular shapes, yet they fit into each other as exactly and fill space as completely as could the cubes above referred to.

Particulars with regard to the size of the grain of the Aletsch and the Bossons glaciers will be found in an article in NATURE (1901), vol. lxiv., p. 399.

*Disarticulation of the Grains of the Glacier by Solar Radiation.*

In the Mergelin See, glacier ice can be studied in a way that is possible in no other place. The fragments of the Aletsch Glacier which float in it are veritable ice-bergs. In the middle of summer they are exposed to a very powerful sun, and the weathering and disintegration, as well as the melting, proceed at a very rapid rate.

The action of the sun's rays on glacier ice is two-fold; it disarticulates the ice into its constituent grains, and it splits the individual grain up into laminæ perpendicular to the principal axis of the crystal, and bounded by the planes of fusion described by Tyndall. These planes are the distinguishing characteristic of the individual ice-grain.

Under the influence of radiant heat an ice-grain begins to melt at the surfaces which separate these laminæ, and the process of disintegration and decay is directed by their plane. On the other hand, an ice-grain, floating in water and losing heat, generates ice laminæ which are directed by the same planes, which form the continuation of the corresponding laminæ of the parent crystal. As the grains in a block of glacier ice are distributed quite irregularly, the water-line of a floating block necessarily cuts a great number of grains, all of which are oriented differently. The ice which is formed during the night along this line is oriented crystallographically by the grain with which it is in contact, and from which it appears to spring in continuation of its crystalline laminæ. This produces a remarkable pattern of lines on the surface of the lake ice contiguous to a block of glacier ice.

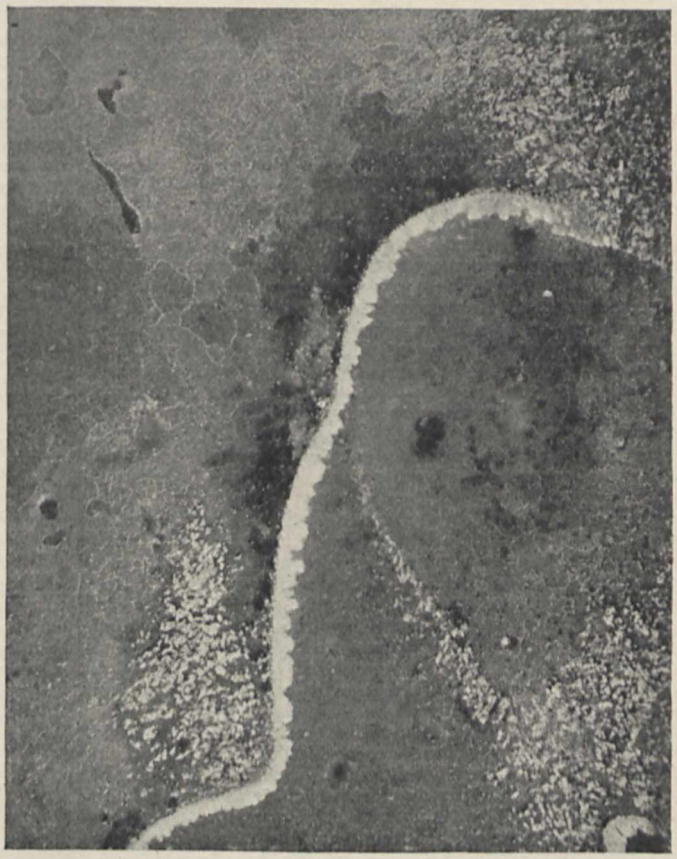
Tyndall has described and figured the minute features of the disintegration of the crystal under the absorption of radiant heat. Similar and complementary features are observed when ice is generated from an existing crystal under the dissipation of heat. To do justice to them, however, would require the services of a skilful, patient, and resourceful artist.

The disarticulating and analysing action of the sun's rays is not accomplished without selection and the expenditure of energy. Accordingly we observe that one grain protects another. The disarticulation into separate grains, although very thorough near the surface of a glacier, does not penetrate far. A stroke or two with an ice-axe reveals the fresh blue ice. In the case of an ice-berg, whether floating in a lake or in the ocean, only the grains that are exposed to the sky and above water are disarticulated, and prolonged exposure of this kind reduces a grain to the last stage of dilapidation. The grains beneath the surface, *whether of ice or water*, are almost completely unattacked.

The importance of direct skylight for the disarticulation of glacier ice into its constituent grains is very well seen in the artificial grottos which are maintained at easily accessible parts of most popular glaciers. The thickness of the layer of completely disarticulated ice is so small that it is hardly noticed, and the whole grotto appears to be cut out of pure blue ice. If the observer, on penetrating for a few paces, turns round and looks outwards, he sees the surface of the ice-walls of the grotto etched with strange line figures. These are most strongly marked near the opening, and they extend as far as direct skylight strikes the ice. The lines so developed are formed by the intersection of the surface of the ice-wall of the cave with the separating surfaces of contiguous ice-grains. The picture thus presented is one of very great interest.

*Delineation of the Grain by Hoar-frost.*

After the autumnal equinox very little melting of ice takes place, and by the end of October it has, as a rule, ceased entirely. The etched figures on the walls of the entrance of the grotto, which were developed by solar radiation during summer, disappear quickly with the arrival of winter; but the winter brings with it another means of delineation of the grain which does not depend on solar radiation. Even at the lowest of winter temperatures the atmosphere contains vapour of water, which it is prepared to relinquish under the same conditions as those under which dew is formed in summer. In the Alpine winter, however, it is deposited, not as dew, but as rime, that is, not as water, but as ice. It is well known that very fine etching on a polished surface, which can with difficulty be seen without assistance, at once becomes visible if the surface be breathed on. In winter



Grain of the glacier on the roof of the grotto in the Morteratsch Glacier elineated by hoar-frost, January, 1907.

the walls and roof of the grotto are cold, dry, smooth, and polished like glass. The winter air entering from without and circulating in the grotto *breathes* on the polished surface of ice and develops the figure of the ice by the rime which is deposited on it. As rime always settles by preference on sharp edges, it seeks out the lines of separation between the grains and settles on them, showing the whole granular structure. In January, 1907, there was a wonderful exhibition of this natural damascening on the roof of the cave of the Morteratsch glacier; in January, 1908, however, it was quite inferior, and would not have struck the eye. The illustration represents a portion of the roof of the cave which I photographed in January, 1907. As the roof is not flat, but made up of shell-like cavities worn by the hot air in summer, the delineation of the grain is sharp in some parts of the photograph and faint in others.

A precisely similar phenomenon was observed in 1886

by Prof. Forel in the remarkable natural grotto of the Arolla glacier, of which he has given so fascinating a description in the *Archives des Sciences physiques et naturelles, Genève,* 1887, xvii., p. 498. The delineation of the etched figures by rime was observed by him in the month of July in a remote and secluded chamber nearly 250 metres from the entrance of the grotto. In artificial grottos like that of the Morteratsch glacier, in which the air circulates freely, the hoar-frost disappears very quickly with the end of winter.

*The Grain of Lake Ice.*

It is not glacier ice alone which suffers disintegration when exposed to a powerful sun. Lake ice behaves in a similar way. Beautiful examples of this can be seen in Alpine seas every winter. During the harvesting of the ice from the lake, the blocks often lie for a day or more before they are carted away to the ice-houses. Occasionally some of them get overlooked and remain for many days exposed to the powerful sun of February, while maintaining the low temperature of the air usual in that month. No melting takes place, but after even a few hours' exposure to the sun the block shows the figure of its grain in development. It is being etched by the sun's radiation.

The grain of lake ice has a very different appearance from that of glacier ice, but both are individual crystals. The difference in their appearance is to be traced to the difference of treatment which they have received during their existence. The glacier grains have been practically rolling over each other during their descent, while those of the lake have established themselves at right angles to the surface of the water, and have remained there. So long as the ice is increasing in thickness, the temperature of its upper surface is very low. It is perfectly transparent, and its surface is smooth, dry, and polished like glass, and it shows no trace of crystalline figure. When the ice is undisturbed this develops itself only at the end of the season when the thaw sets in. Then the whole ice-sheet rises to its melting temperature, and is at the same time exposed to the direct radiation of the sun. This produces disarticulation of the ice into groups of vertical prisms which are then floating independently; they are kept together only by crowding. Ice in this state is said to be rotten; and it will be recognised that, however thick the ice-sheet may be, when it gets into this condition it is dangerous. In the neighbourhood of the outflow the crowding is relieved, the disarticulated groups become disengaged, the smaller groups and individual prisms are able to assume their attitude of stability and to float on their sides. All then drift towards the outlet. The ice "breaks up," and the lake is cleared in an astonishingly short time.

If it were not for the law that even impure water in freezing always forms pure ice, the impurity remaining in the liquid and generally entangled in the interstices of the grains, and that the pure ice which is in contact with this impure liquid melts at a lower temperature than that which is in contact with nothing but the water formed by its own melting, the ice-covering of a lake would be a continuous sheet offering no points of weakness, and it would have to melt as a whole. It is doubtful if lakes such as those, met with in the Upper Engadine, would get rid of their ice-covering at all. On the Silser See the ice is usually more than 60 centimetres thick when the thaw sets in, but when once the ice begins to break up the lake is cleared in a day. Sixty centimetres of ice would take a long time to disappear on the basis of surface melting alone.

While the winter lasts, the ice on the lake shows no crystalline structure. This develops only after removal from the water and exposure to the sun. The ice then splits up into prisms in a vertical plane. These are at first of irregular section, and as sun-weathering proceeds the thicker prisms split up into thinner. When a block has lain exposed to the February sun and cold it may fall to pieces, each piece being a long, thin, triangular prism, with some resemblance to a razor-blade. When the ice is cold and dry the outlines of the grains are lines; when the ice has a temperature of 0° C. it melts preferably round the grain, forming troughs in which the water collects, and the aspect is that of a dark polygon surrounded by light-coloured canals. The columnar grains have their striation like those of the glacier. In one piece, which was much weathered, I counted twenty-four such grains in an area of 9 square centimetres. In a slab which had not been lying long I counted twenty-three grains in an area of 150 square centimetres, giving an average area of 6·5 square centimetres per grain; the largest had an area of 12 square centimetres. In another slab there was a very large grain which measured 7 centimetres in one direction and 4 centimetres at right angles to it. In a slab in which the sun-weathering had proceeded very far I counted 113 grains in a disc of 5 centimetres radius, which gives 0·69 centimetre as the average area per grain.

In the absence of actual experience, one is apt to expect a slab of lake ice, when subjected to sun-weathering, to be disarticulated into hexagonal columns; but this expectation is quite gratuitous. Ice may crystallise in a form bounded by plane faces, according to the laws of its crystallographic system, if it has the freedom which it possesses when crystallising out of an independent medium such as a saline solution or air. But the foreign matter dissolved in fresh water is present in so small quantity that what we have before us is the solidification rather than the crystallisation of ice, and each column as it tries to develop itself is interfered with by its neighbour, and the resulting slab of ice is made up of elementary prisms crowded together, but preserving parallelism of crystallographic axis.

The second part of the discourse dealt with the part played by glaciers and rivers in modifying the features of the surface of the earth, but it cannot be usefully condensed so as to be included in this communication.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE University of Jena, at its recent jubilee, conferred the degree of M.D., *honoris causa*, on Sir William Ramsay, K.C.B., F.R.S.

MR. W. J. HORNE, lecturer in physics at the South African College, Cape Town, has been appointed to the inspectorate of the Transvaal Department of Public Education as organiser for technical education.

UPON the authority of the *Cologne Gazette*, a Reuter correspondent states that the question of the admission of women to university study in Germany has been settled. Women who are subjects of the German Empire will be admitted on the same footing as men, but women of other countries will require the permission of the Minister of Public Instruction for matriculation.

A PAPER on the educational aspect of domestic subjects was read recently by Prof. A. Smithells at Bradford, the occasion being the fourth annual meeting of the Northern Union of Domestic Economy Associations. A verbatim report appears in the first August number of *Education*, and we learn therefrom that Prof. Smithells considers that the increased attention being paid to the teaching of domestic subjects is very gratifying. He wishes to bring such subjects within the purview of universities, as it is desirable to connect every branch of education with what should be the most abundant and vivifying springs of knowledge. The introduction of domestic subjects into the normal educational curriculum for girls would add a much wanted ingredient, as in the household arts we have a direct educational instrument for conferring upon girls the very great gift of manipulative skill, and of doing it by teaching the very work that will lie nearest to them in their normal daily life when they have left school. Domestic subjects include much that affects the cultivation of the moral and æsthetic side of human nature, and a good teacher will make them mentally stimulating.

THE *Revue scientifique* for August 8 reproduces the address given by Prof. Paul Appell, the president of the French Association for the Advancement of Science, at the meeting at Clermont-Ferrand on August 3. As we mentioned in our issue of August 13, the address deals with the teaching of science and the formation of the scientific

spirit, and insists on the necessity of the latter as the foundation for those powers of initiative and of intelligent activity without which progress is impossible. Prof. Appell points out that the object of higher education is three-fold—to make, to teach, and to apply science—and considers in detail how far the educational system of France attains these objects. He finds much overlapping, and directs special attention to the large amount of teaching of pure science which goes on in technical schools the principal function of which, he urges, should be to teach technical applications to pupils already well grounded in science at the universities or other schools of university type. Those interested in higher education in this country will find much food for thought in Prof. Appell's address, and many will ask, Are our institutes for higher education carrying out their duty of making science as they ought? while more will want to know how much of the energy of our polytechnics and technical schools is devoted to teaching pupils the laws of motion or how to solve simple equations.

THE latest article of a series published by the *Times* on American life is devoted to "Colleges and Character." After mentioning the rapid growth of the universities, which in 1904 already had 119,496 undergraduates, the writer agrees with the Rhodes scholar who reported that from the sole standpoint of scholarship it was not necessary for him to leave America. On the other hand, the author of the article lays blame on the "elective" system, which presupposes that the average youth of eighteen, fresh from school, has defined aptitudes, understands himself, has adequately given shape to his ultimate purpose, and can be depended upon to select the studies best adapted to the achievement of his destiny. Nevertheless, he considers that the fundamental idea of electives is sound, but that the reaction from the old rigid courses of instruction has gone too far. A student may graduate by passing in four entirely disconnected subjects in each of four successive years; moreover, there is a temptation to seek "soft options." On the other hand, we may observe that it is commoner in America to find commercial men who, by pursuing the somewhat haphazard sampling of studies which the elective system permits, have acquired intelligent appreciation of, say, comparative religion and Röntgen rays. In England men of the same class rarely attempt any university study. The author expects that "electives" will never be disallowed in the future, but will be intelligently restricted, so as to secure that all students—not merely such as choose—will be subjected to the discipline proper to university life on its intellectual side.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, June 18.—"An Electrical Method of Counting the Number of α Particles from Radio-active Substances." By Prof. E. **Rutherford**, F.R.S., and Dr. H. **Geiger**.

(1) By employing the principle of magnification of ionisation by collision, the electrical effect due to a single α particle may be increased sufficiently to be readily observed by an ordinary electrometer.

(2) The magnitude of the electrical effect due to an α particle depends upon the voltage employed, and can be varied within wide limits.

(3) This electric method can be employed to count the α particles expelled from all types of active matter which emit α rays.

(4) Using radium C as a source of α rays, the total number of α particles expelled per second from 1 gram of radium have been accurately counted. For radium in equilibrium, this number is $3{\cdot}4 \times 10^{10}$ for radium itself and for each of its three α-ray products.

(5) The number of scintillations observed on a properly prepared screen of zinc sulphide is, within the limit of experimental error, equal to the number of α particles falling upon it, as counted by the electric method. It follows from this that each α particle produces a scintillation.

(6) The distribution of the α particles in time is governed by the laws of probability.

The authors have previously pointed out that the principle of magnification of ionisation by collision can be used to extend widely the already delicate methods of detection of radio-active matter. Calculation shows that under good conditions it should be possible by this method to detect a single β particle, and consequently to count directly the number of β particles expelled from radio-active substances.

Further work is in progress on this and other problems that have arisen out of these investigations.

### EDINBURGH.

**Royal Society**, July 13.—Prof. Crum Brown, vice-president, in the chair.—An improved method of esterification: G. E. **Gibson**.—Nitric anhydride as a nitrating agent: G. E. **Gibson**.—The significance of maximum electrolytic conductivity: Prof. John **Gibson**.—The variation of Young's modulus under an electric current, part ii.: Henry **Walker**. In these experiments it was shown that the curious changes in the value of Young's modulus when the iron, steel, copper, or platinum wire was heated by an electric current were not observed when the wire was stretched under a load approaching the limits of elasticity, and that when the wire was heated by ordinary methods no peculiarity in the change of Young's modulus was found to exist.—The theory of general determinants in the historical order of development up to 1860: Dr. Thomas **Muir**.

July 20.—Dr. R. H. Traquair, vice-president, in the chair.—A sensitive state induced in magnetic substances and materials by thermal treatment, part ii.: J. G. **Gray** and A. D. **Ross**. The sensitive state induced by annealing the material from moderately high temperatures was reduced by jarring, but could not be completely obliterated by this means. A strong sensitive state was induced when the material was cooled from room temperature to that of liquid air, or when it was heated from the temperature of liquid air to that of the room; but when the material was cooled to the temperature of liquid air and then heated again, only a small increase was observed in the susceptibility. The effect was associated with temperature change, and was not apparently influenced by the length of time the material was kept at the high or low temperature.—The structure of *Turrilepas peachi* and its allies: F. R. Cowper **Reed**. An examination of type-specimens from Whitehouse Bay and of further material shows that the organism is bilaterally symmetrical. There are four series of plates, a double median longitudinal row of small triangular plates in close contact overlying the larger and more elongated lateral kite-shaped plates. The latter are arranged in pairs on each side, extending (in the middle part of the body) nearly at right angles to the axial line, but becoming inclined more acutely forwards towards the anterior end. The lateral plates also overlap each other for about half their width, and bear on their outer surface a median longitudinal impressed narrow groove which appears as a fold on the reverse side of the plates. The characters of *Turrilepas scotica* were discussed in the light of the newly discovered structure of *T. peachi*, and of fresh material from the Balcletchie beds, and the Scottish species were compared with the undescribed forms from the Ordovician beds of England and Wales, and with the American genera Strobilepis and Lepidocoleus.—The recalescence of nickel: T. A. **Lindsay**. Two cylinders, one of nickel and one of copper, were allowed to cool simultaneously from a high temperature, the difference of temperature at each instant of time being measured by a thermoelectric couple with the two junctions in the heart of their respective cylinders. The difference curve of cooling so obtained indicated recalescence phenomena at temperatures of 650° C., 515° C., and within the range 370° C. to 285° C.—Note on the study of polarisation by means of the Dolezalek electrometer: A. F. **Ewan**. The method afforded a very delicate test of the independence of polarisation on the potential of the electrode, and it was also found possible to extend the time curve of polarisation through a much greater range than had been possible with any one of the other methods. Interesting corroboration was obtained of Bouty's and Wiedeburg's

formulæ.—Preliminary note on the action of nitric anhydride on mucic acid: Prof. Crum **Brown** and G. E. **Gibson.**—The meteorology of the Weddell quadrant and adjacent areas: R. C. **Mossman.** This was a general discussion, restricted to the more prominent elements of climate, of the meteorological conditions of Antarctic and sub-Antarctic latitudes, with the aim of correlating the weather changes of these adjacent regions.

PARIS.

**Academy of Sciences,** August 10.—M. Maurice Levy in the chair.—A problem relating to the theory of orthogonal systems and to the method of the mobile trihedron: Gaston **Darboux.**—Complement to an earlier note on the manner in which the changes in magnitude of the two right lines joining the sun and a planet to the earth are related to their changes in direction when the planet moves in the plane of the ecliptic: J. **Boussinesq.**—The registration of the upper layer of calcium in the solar atmosphere: H. **Deslandres** and L. **d'Azambuja.** A special study has been made of the calcium line $K_3$. The dark calcium filaments appear in all latitudes, and are clearest at the edges. They are the seat of considerable radial movements. The filaments, which form the principal character of the upper layer of the solar atmosphere, are evidently related to the general circulation of the vapours, to the accidental variations of their velocity of rotation, and possibly also to the formation and dissipation of faculæ.—The rotation of the sun: A. **Perot.** An application of the method of interference spectroscopy devised by the author and M. Fabry to the lines of wave-lengths (Rowland) 5202·4, 5349·6 (Ca), 6065·7 (Fe), and 6122·4 (Ca), the angular velocities and times of revolution of which are given. The equatorial acceleration is very marked for the two calcium lines studied, whilst the two others are normal in this respect.—Equations all of whose roots are real: A. **Pellet.**—Some remarkable movements: M. **Haag.**—The action of the radium emanation on solutions of copper salts: Mme. **Curie** and Mlle. **Gleditsch** (see p. 372).—A new application of superposition without confusion of small electric oscillations in the same circuit: E. **Mercadier.** The signals are produced by alternating currents controlled by electro-diapasons, and are received on vibrating plates tuned to exact unison. It has been found possible to superpose in the same circuit simultaneously and in both directions the signals arising from twelve electrodiapasons on lines from 5 to 700 kilometres in length. Messages on this system have been successfully exchanged between Paris and Marseilles.—The physicochemical analysis of wines; Paul **Dutoit** and Marcel **Duboux.** An application of D. Berthelot's method of electrical conductivities to the titration of acids and bases in wines.—Researches on the cause of the odour acquired by air submitted to the ultra-violet radiations emitted by a mercury vapour lamp: H. **Bordier** and T. **Nogier.** It is definitely proved that this odour is not due either to the production of ozone or nitrous fumes. The circulation of gases free from oxygen, such as nitrogen or carbon dioxide, causes the same odour.—The intradermo-reaction of tuberculin: Ch. **Mantoux.** Details are given of the method of applying this test, which has been compared in fifty-two cases with the cuti-reaction. The test failed in only two cases, and has the advantages of simplicity of execution and greater sensibility.—The culture of the virus of fowl plague *in vitro*: E. **Marchoux.** This disease is one in which no organism has been detected, probably on account of its extreme minuteness. It has been reproduced in ten successive stab cultures, retaining its virulence.—Contribution to the study of the Continental *facies*: Palæozoic landslips: Stanislas **Meunier.**—The kaolin-bearing rocks of the basin of Lake Nepigon, Canada: F. Romanet **du Caillaud.**

GÖTTINGEN.

**Royal Society of Sciences.**—The *Nachrichten* (physico-mathematical section), part ii. for 1908, contains the following memoirs communicated to the society:—

July 27, 1907.—Records of the specific conductivity of atmospheric air: H. **Schering.**

February 21, 1908.—Determination of the vertex and apex (of the stellar system), on the ellipsoidal hypothesis, from a small number of observed proper motions: K. **Schwarzschild.**

March 7.—Seismic records in Göttingen for 1906: K. **Zoeppritz.**

March 21.—The generation of linear ternary substitutions from a minimal number of fundamental substitutions: W. Fr. **Meyer.**

The business communications of the society, part i. for 1908, include a report on the Samoa Observatory for 1907, the address presented to the University of Upsala at the Linnæus celebration, and a memorial notice of Lord Kelvin by W. **Voigt.**

CAPE TOWN.

**Royal Society of South Africa,** July 15.—Mr. S. S. Hough, F.R.S., president, in the chair.—Preliminary note on the diurnal variation of level at Kimberley: J. R. **Sutton.** This paper gives the preliminary results of observations made during the course of three years upon the variation of the level of the ground as recorded by a large horizontal pendulum of a special design made for the author by the Cambridge Scientific Instrument Co. It appears from the results that the movements in the surface of the ground which set up corresponding movements on the pendulum at Kimberley are very great. The maximum westerly elongation of the extremity of the pendulum occurs about 5½ a.m., the maximum easterly about 4½ p.m., the median positions a little before 11 a.m. and 9½ p.m. Geometrically these movements may be represented on the hypothesis that the hemisphere facing the sun bulges out, forming a sort of meniscus to the geosphere. The enormous rise and fall of the surface of the land that such a supposition would postulate are, however, mechanically difficult. The range of the pendulum's excursion from west to east during the day is twice as great in winter as it is in summer.

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