THURSDAY, JUNE 3, 1897.

ROCK-WEATHERING.

A Treatise on Rocks, Rock-weathering and Soils. By George P. Merrill, Curator of Geology in the U.S. National Museum. Pp. xx + 411. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1897.)

"THE ruins of an older world are visible in the present structure of our planet; and the strata which now compose our continents have been once beneath the sea, and were formed out of the waste of pre-existing continents. The same forces are still destroying, by chemical decomposition or mechanical violence, even the hardest rocks, and transporting the materials to the sea, where they are spread out, and form strata analogous to those of more ancient date." These memorable words of Hutton, written more than a century ago, have been appropriately selected by the author as the motto for his work, the main object of which is to describe the various processes of rock degeneration and soil formation.

The book is divided into five parts, dealing with the constituents of rocks, the different kinds of rocks, the weathering of rocks, the transportation and re-deposition of rock débris, and the mantle of unconsolidated material which covers the greater portion of the land surface, and for which the author proposes the term "regolith."

The first two parts are not remarkable, either on account of the matter contained or the mode of treatment. The author somewhat disarms the critic, so far as these parts are concerned, by stating in the preface that "the work must be considered in no sense a petrology, as this word is commonly used"; nevertheless, we feel justified in pointing out that much which is inserted might have been omitted without detriment to the work so far as its main object is concerned, and much that is omitted might appropriately have found a place. Thus the first part contains scraps of information about the characters of rock-forming minerals, which are insufficient for the beginner, and are not required by the advanced student. More serious are the omissions. In a work dealing with the disintegration and decomposition of rocks, we naturally look for a somewhat detailed account of the pathological characters of the primary constituents of the crystalline rocks, and of the physical and chemical conditions under which the various secondary products arise. Very little information is, however, given on these points; and this is all the more remarkable, because the works of Roth, and the numerous and important papers by Lemberg, referred to by the author, would have readily supplied him with a large amount of the necessary material.

The classification of rocks adopted by the author is simple, natural, and well suited to his purpose. The igneous rocks are divided into nine groups, depending mainly on chemical composition, and are defined by taking the plutonic and volcanic representatives of the several groups. Thus we have the granite-liparite group, the foyaite-phonolite group, the gabbro-basalt group, and so on. The author does not favour the modern tendency to introduce new names for comparatively unimportant local varieties, and protests against "such monstrosities of nomenclature as ovachichite, monchiquite, yogoite, and absarokite."

The descriptions of the rocks are generally accurate, but we have noted one or two imperfections. Thus the statement that "chert is an impure flint, containing not unfrequently nummulitic remains," appears somewhat strange when one remembers that cherts are of all ages, and that they are largely due to accumulations of sponge spicules and radiolaria.

The unpleasant task of fault-finding ends with the consideration of Part II. In the remaining parts which make up the main body of the work we have an admirable presentation of the various phenomena connected with the disintegration and decomposition of rocks, the transportation of rock-débris, and the formation of soil. Part III. deals with weathering. The action of the atmosphere, the chemical action of water, the mechanical action of water and ice, and the action of plants and animals, including the nitrifying organism, are severally discussed in detail. Then follows a special chapter, based largely on the author's original work, and containing some hitherto unpublished material, in which special cases of decomposition are described. The cases have been carefully selected, chemical analyses of the fresh and decomposed rocks are given, and these are supplemented by mechanical analyses of the latter. In a few instances, chemical analyses of the different parts into which the decomposed rock can be separated by mechanical means are also given. This exhaustive study necessarily brings out a number of points of great interest, only one or two of which can be referred to.

To illustrate the method of treatment, we quote below a table representing the analyses of fresh and decomposed gneiss from Albemarle County, Virginia—that is, from a region outside the area of glaciation, and one in which the rocks have, therefore, been subjected for a long period to atmospheric influences.

—	I. Bulk analysis of fresh gneiss.	II. Bulk analysis of decomposed neiss.	III. Loss.	IV. Percentage of each constituent saved.	V. Percentage of each constituent lost.
Silica	60·69	45·31	31·90	47·55	52·45
Alumina	16·89	26·55	0·00	100·00	0·00
Ferric oxide ...	9·06	12·18	1·30	85·65	14·35
Lime	4·44	trace	4·44	0·00	100·00
Magnesia ...	1·06	0·40	0·80	25·30	74·70
Potash	4·25	1·10	3·55	16·48	83·52
Soda	2·82	·22	2·68	4·97	95·03
Phosphoric acid (P_2O_5) ...	0·25	·47	0·00 [1]	100·00	0·00 [1]
Ignition	0·62	13·75	0·00 [1]	100·00	0·00 [1]
	100·08	99·98	44·67	—	—

A comparison of the bulk analyses of the fresh rock, and the incoherent material resulting from its decomposition, necessarily gives, in many cases, a very imperfect

[1] Gain.

idea of the change which has taken place. Some constituents are readily removed; others, especially the alumina, are comparatively insoluble under ordinary conditions, and therefore remain behind. Thus, Columns III., IV. and V. show the loss or gain of the various constituents estimated on the basis of constant alumina. We may remark, in passing, that alumina may be removed under certain conditions; as, for example, when sulphuric acid is formed by the oxidation of pyrites. This shows the necessity of caution in taking alumina as the basis of comparison, but it does not affect the present case. From Column III. we learn that 31 per cent. of silica, 1·3 of ferric oxide, the whole of the lime, and the greater part of the magnesia and alkalies have been removed. The total loss amounts to 44 per cent. In this case, the breaking down of the rock has been accompanied by decomposition as well as disintegration; in other cases decomposition is not so prominent, and the total loss is consequently much less.

Many rocks are treated in the same way, but one other illustration must suffice, and for the complete data in this case we must refer the reader to the book itself. In certain parts of America, and indeed in all countries where limestones are extensively developed, and where the residual products of decomposition are allowed to accumulate for a considerable length of time, a superficial deposit of red or brown clay is formed. In these cases the author considers that silica may be assumed to be constant, and taken as the basis for calculating the amount of material removed. He thus arrives at the conclusion that in the particular case described by him 97 per cent. of the original limestone has disappeared. In some localities residual clays of this kind attain a thickness of from 20 to 120 feet.

Having considered in detail a number of special cases in the manner above described, the author proceeds to deal with the influence of joints of texture, of mineralogical composition, of climate, and many other factors. All these points are discussed in the light of recent knowledge, and the chapters devoted to them are full of interesting and important information. Illustrative cases are mostly drawn from American sources, and this gives to the book a refreshing novelty, at any rate to English readers, even when well-known principles are treated. Especially interesting are those portions dealing with climate. It is pointed out that in cold and dry climates, subject to extremes of temperature, disintegration is the dominant factor; whereas in moist, warm climates decomposition is very pronounced. Thus the careful study of the petrographical character of sediments may be expected to throw important light on the climatic conditions of those regions which furnished the material. This point is, of course, not new; but its importance has not been fully recognised, and it is therefore satisfactory to see that the author gives it a prominent place.

The concluding part of the book deals with the superficial deposits for which the term regolith is proposed. Under this term is included not only the soil, subsoil and residual products of decomposition, but also the alluvial, æolian, and glacial deposits. We are by no means convinced that the author was well advised in departing from his general and most praiseworthy determination to avoid as much as possible the introduction of new terms; but the point is, after all, of comparatively slight importance. If the term supplies a want, it will come into general use; if not, it will die out.

The petrographical characters and conditions of formation of the various deposits classed as the regolith are described, and we are glad to see that special attention is paid to the æolian formations, as these often receive scant courtesy at the hands of geologists. Loess, however, is discussed under alluvial deposits, although it is ascribed in part to the action of the wind. Surely there can be no doubt that typical loess is of æolian origin; and if, in America or elsewhere, alluvial deposits have been included under this term, this should be recognised as a mistake, and speedily rectified.

The work is admirably illustrated by twenty-five plates and numerous figures in the text, all of which have been produced in the manner so highly appreciated by those who are acquainted with American geological literature.

MECHANISM AND BIOLOGY.

Zeit- und Streitfragen der Biologie. Heft 2. *Mechanik und Biologie.* Von Prof. Dr. Oscar Hertwig. Pp. iv + 211. (Jena: Gustav Fischer, 1897.)

FROM the title of this work one might have expected a critical examination of the validity of the general principles of modern biology, more particularly of modern physiology; and such a criticism, from the pen of Dr. Oscar Hertwig, would have been welcome and instructive. It is with a feeling of disappointment that one finds that his criticism is almost entirely confined to a comparatively limited aspect of the question, and is, in fact, a polemical treatise directed especially against the pretensions and conclusions of Wilhelm Roux and his school. It is, no doubt, a simpler task to refute the theories of Roux; but if Dr. Oscar Hertwig is victorious in this particular argument, it must not be supposed that he has weakened, or that he has even attempted to weaken, the conviction held by the majority of biologists, that the explanation of vital processes is to be sought for on "mechanical" principles. There is, however, a considerable amount of obscurity attached to this word "mechanical" as applied to biological phenomena, and many pages of this book are devoted to pointing out the errors into which we may be led if we use the word in a loose and general sense, or if we confuse its philosophical with its physical meaning. In its widest sense a mechanism is a system of objects, which in place and time stand in a necessary relation to one another. Hence, when we describe the attitude of contemporary science as mechanical, we do but assert that science is convinced that the operations of nature are subject to the control of universal law. Of this the biological are as much convinced as the abiological sciences; yet this conviction does not necessarily lead to the conclusion that the methods of the abiological are in all respects applicable to the biological sciences. To discuss this question is to discuss the philosophical basis not only of biology, but of all the sciences. As a contribution to the discussion, Dr. Hertwig gives us copious quotations from Spinoza, Kant, Lotze and other philosophers, skilfully selecting such passages from these thinkers as best serve his immediate purpose of refuting Roux. His readers would have profited had he taken a more detached view of his subject, and had attempted to define the grounds of our belief in the prevalence of universal law in biological phenomena without special regard to Roux or any other author.

In the second part of this book, Dr. Hertwig deals with the methods of developmental mechanics as put forth by Roux and his school. Roux is one of those who specially represents a modern tendency to magnify the importance of experiment in biological investigation, and to minimise the value of what is called "mere observation." It has been pointed out, over and over again, that there is no sharp distinction between experiment and observation, that some of the most complete, the most "mechanical" of the sciences—as, for example, astronomy—are, from the nature of things, sciences of observation, and that what we call experiment is but a means to an end, the end in every case being observation of the change of state following the disturbance which was the first step introduced by the experiment. Here, says Dr. Hertwig, there is a great difference between the inorganic and the organic world. Inorganic substances are relatively stable; the simple contemplation of them would lead to no result. It is only by disturbing their condition of equilibrium, by causing changes of state in them, that we can observe a succession of phenomena which will enable us to assert relations of cause and effect. With living things the case is different; they are in a constant state of flux, and observation presents us with an unbroken succession of changes whose laws may be traced by the aid of reflection. What is true of biology in general is especially true of the study of the development of organisms, since it is during their development that organisms exhibit the most numerous, the most constant, and the most unbroken succession of changes. In depreciating the results of observation, and in drawing a brilliant picture of the results which are to follow from the use of experiment in biology, Roux, and those who, like Yves Delage, have followed him, have fallen into the error of supposing that observation is necessarily an act of contemplation without reflection, and that reflection added to observation raises the last-named to a level which has neither been attained nor sought after by the majority of workers. Such an error is easily refuted by Dr. Hertwig, who shows that in the domain of embryology the method of observation has been strikingly fruitful of results; that embryologists have been distinguished for the readiness, sometimes by the over-eagerness, with which they have drawn conclusions as to cause and effect from the results of their observations; and, finally, that the much-praised method of experiment, when applied to embryological research, has been comparatively barren of result. We have, indeed, learnt some new and striking facts from the experiments of Driesch, Wilson, Zoja, and of Hertwig and Roux themselves; but the main result of these experiments has been to overthrow the speculations of the school which plumes itself on its insight into the mechanical processes of development.

To most persons the most interesting part of Dr. O. Hertwig's book will be the appendix, which contains critical observations on the mechanical laws of development promulgated by Roux. This author, it will be remembered, as a result of experiments and observations, made by him on the developing ova of the frog, formulated a series of developmental laws, of which the chief were: that the plane of the first segmentation coincides with the sagittal plane of the future embryo; that the four first blastomeres correspond to four definite regions, right and left anterior and right and left posterior of the future embryo; and so forth. From these so-called laws theoretical conclusions of wide applications have been drawn. It has been asserted that the organs and tissues of the adult are represented by equivalent ultra-microscopical particles in the ovum, and that these particles are distributed in the ovum in a manner corresponding to their prospective situation in the adult. The particular manner in which these hypothetical particles give rise, in the course of development, to the tissues and organs of the adult, is set forth in Roux's theories of self-differentiation and mosaic-work. Dr. Oscar Hertwig deals in detail with the developmental laws of Roux and their consequences, and shows that, in the first place, the laws have no validity, and that, therefore, in the second place, the conclusions drawn from them are without foundation. Roux destroyed one of the first two or four blastomeres of the frog's ovum, and stated that the embryo resulting from the development of the remaining blastomere or blastomeres was a half embryo or quarter embryo, deficient in those parts which were contained in the blastomeres which had been destroyed. Hertwig, repeating the same experiments, showed that destruction of any of the earliest blastomeres does not, in fact, lead to the results which were described by Roux, and that the early blastomeres might be, so to speak, shuffled up by means of pressure, and yet a perfectly normal embryo be formed. Hertwig's experiments are confirmed by those of Driesch, Wilson and Zoja, who have shown that if the first four blastomeres of echinoderms, of amphioxus, or of hydromedusæ are separated from one another, each gives rise to an embryo, normal in all respects, except that it is a quarter of the usual size. Such experiments point conclusively to the fact that the material of the egg is not qualitatively, but quantitatively divided in the first stages of segmentation, and that Roux's theories of mosaic-work and self-differentiation are, therefore, without foundation. In the appendix to this book the experiments and conclusions of Roux, and the conflicting observations of Hertwig, Driesch and others, are given in a concise and easily intelligible form; and the reader will hardly fail to be persuaded that the balance of evidence is in favour of Hertwig's opinion. At the same time, it must not be forgotten that there is a considerable mass of evidence in favour of Roux's main proposition, that in *normal* development the first segmentation planes do mark out particular regions of the future embryo. Dr. Hertwig has handled Roux somewhat severely for his definitions of normal and abnormal development; but the truth seems to be this. That the ovum of any animal, if left to itself, will go through a course of development which may be called normal, of which one of the features is that the symmetry of the adult is expressed by the earliest cleavage planes. But this course of development, though normal, is not *necessary*. If the blastomeres be displaced, or even if they be separated, development will complete itself, and the end result is the same, though the first steps have been different. The conclusion is that developing organisms, like adults, are possessed of considerable powers of adaptability. Exposed, for the most part, to very similar conditions, they develop in a very similar way, which we come to recognise as the normal way. But, if the conditions are varied within certain limits, the developing organism adapts itself to those changes, and completes the cycle of its existence. All the evidence, whether from the side of Roux, or from that of Hertwig, Driesch and others of the same opinions, shows that there is a very definite limit to the disturbances to which the developing ovum is capable of adapting itself. Such discussions as are contained in this book only serve to bring forward more prominently the view that the organism is the result of the interaction between its own specific nature and the environmen It would seem that the next essential step in biological inquiry is to determine in special instances what is the nature of the reaction of living substance to external conditions. Much has been attempted in this direction, but the results have hitherto been indefinite, and even contradictory.

THE EXAMINATION OF THE BLOOD IN DISEASE.

A Guide to the Clinical Examination of the Blood for Diagnostic Purposes. By Richard C. Cabot, M.D. With coloured plates and engravings. Pp. xix + 405. (London, New York, and Bombay: Longmans, Green, and Co., 1897.)

SINCE Hughes Bennett's observations on leucocythemia were recorded, great advances have been made in the methods of examining blood, and a certain limited number of physicians, appreciating the importance of the changes that take place in the blood as indicative of changes in the more fixed tissues, have laid considerable stress on the necessity of determining the exact constitution of the blood in certain forms of disease. With all this, however, the use of the various apparatus devised for such estimations have never come into general use. For this there appear to have been two principal reasons: (1) that the medical man has not considered that the information to be derived from such examination is at all commensurate with the time and skill required to obtain such information; (2) the second reason, which, however, is intimately bound up with the first, is that hitherto we, in this country at any rate, have been beholden for any systematic account of the pathology and clinical pathology of the blood to Hayem in France, and to Grawitz, Schmaltz and Rieder in Germany, as up to the present there has been no systematic treatise in the English language on the clinical examination of the blood. Indeed, in recent years, although much valuable work on the blood of animals artificially treated has been published by a number of our younger physiologists and pathologists, and although Gower's work has formed the basis of much of the clinical examination that has been done, it is to the impetus that Metchnikoff and Ehrlich have given to the study of the blood as a histological tissue that these advances have been made. A similar impulse seems to have been given in America, with the result that there has come from the Johns Hopkins Laboratories a work which, whilst based on the researches carried out in France and Germany, has nevertheless a certain individuality and value quite apart from that reflected in it from foreign workers. Dr. Cabot, approaching the subject from the point of view of a man who has made himself thoroughly familiar with the various methods of examining blood, having already examined the blood from nearly a thousand cases, and has at his command the observations on about three thousand more cases examined in the Massachusetts Hospital, gives an account of the structure of the blood, in which, however, it is evident that Ehrlich's observations have been made the basis of the descriptions, as outside Ehrlich's classification the accounts of the structure and appearance of the corpuscles are somewhat meagre, especially from the purely clinical point of view. In the accounts of the systematic work this is, perhaps, not altogether a disadvantage; still we think that those who come to compare this work with the results that they may obtain, either in clinical or in experimental work, will find that full use has not been made of more recent investigations, especially those that have been carried on in this country.

It is impossible, in a short review, to give more than a very meagre outline of this work; but, as it is really the first of its kind that has appeared in the English language, it may be well to indicate the enormous amount of matter that has been collected and arranged in handy form for reference. In the first instance, the methods of clinical examination of the blood are set forth, and from the completeness and accuracy of the descriptions given, and from the fact that the author is so frequently able to indicate the difficulties met with, and the methods of getting over them, it is evident that he has a thorough practical acquaintance with his work. We are glad to see that he insists very strongly upon the examination of the fresh blood—a method of examination which is far too little used in these investigations. The instruments recommended are all of German origin, and the difficulty that has hitherto been found by those working with these instruments are acknowledged. What strikes one very forcibly in this connection is the value of the "Tintometer" system as compared with any of those here mentioned. In describing the myelocytes—the non-motile marrow cells with their large, simple nuclei—Dr. Cabot appears to assign to mere mechanical conditions the regularity of the nucleus, and he says that "the absence of amœboid motion, and of journeys through tissues, leaves the nucleus evenly and moderately stainable throughout, while the amœboid blood leucocyte, through the wear and tear of its migrations, gets its chromatin irregularly distributed, condensed here, pulled out thin there, and hence stains unevenly or is mottled." This point is referred to on several occasions throughout the book. Surely the want of amœboid motion is indicative of the inactivity of the cell, the regularity of the nucleus pointing to the fact that it is in the so-called resting-stage, especially as it is indicated that marked degenerative changes may be observed in these myelocytes. We should feel strongly inclined to reverse Dr. Cabot's cause and effect. After an account of the methods of clinical examination and the physiology of the blood, several chapters are devoted to the general pathology of the blood, after which the bulk of the book is devoted to the special pathology of the blood, primary anæmias, leukæmia and Hodgkin's disease being also very fully treated. Then the blood in acute and chronic infectious diseases, in diseases of special organs, in diseases of the nervous system, constitutional diseases and hæmorrhagic diseases, in malignant diseases in various positions, and, lastly, the blood in which parasites are present. We may take, as an example of the plan of the work, a short description given of the diagnostic value of blood examination in typhoid fever, in which Dr. Cabot notes post-febrile anæmia, sometimes very intense; no leucocytosis; later leucopenia; increased percentage of young leucocytes at the expense of adult forms, especially marked in this late period; most complications cause leucocytosis. Typhoid can be differentiated from local inflammatory processes by the fact that in uncomplicated conditions leucocytosis is never associated with it, whilst all local inflammatory conditions are accompanied by leucocytosis. Typhoid and malaria can, of course, be distinguished by the presence of the malarial organism in one, and its absence in the other. Even in acute tuberculosis, where leucocytosis is not present, the proportion of young leucocytes is, as a rule, larger in typhoid than in tuberculosis. A similar application of this method to other diseases promises excellent results, and we congratulate Dr. Cabot on having placed such a systematic and practical work in the hands of the medical and scientific worker, as we believe that a book of this kind will do more to encourage the study of the pathological conditions of the blood than anything that has appeared in recent years.

OUR BOOK SHELF.

The Forcing-Book: a Manual of the Cultivation of Vegetables in Glass-houses. By L. H. Bailey. Pp. xiii + 266. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1897.)

THIS is a small manual devoted to an explanation of the principles, and to a statement of the practices involved, in "forcing for market." In no department of horticulture do experience and judgment tell more than in forcing operations; but if "practice" be essential, it is certain that to get the best results, it must be directed by trained intelligence. In this country market-gardening under glass has greatly extended of late years, and many agriculturists, finding it no longer remunerative to grow wheat, have turned their attention to the growth of flowers or to market-gardening generally. As a rule these men have been successful because they have known how to adapt themselves to new conditions, and have not been mere slaves to routine. As competition increases it may be expected that market-gardening will become less remunerative, and hence the necessity for increased knowledge and quickened intelligence in order to meet the new circumstances. In the United States, in Germany, in France, in Belgium, in Denmark, this truth has been recognised, and horticultural schools and experiment stations have been established for years. In this country, as is usually the case in such matters, we have lagged behind, and have many arrears to clear off before we can deem ourselves on a level with the countries we have mentioned. And all this time we are importing, to an enormous amount, commodities a large proportion of which might be grown at home.

The experimental station in connection with the Cornell University has taken a very prominent position in teaching the principles of cultivation, and in furnishing the opportunity of putting them into practice. Its bulletins have consequently been read with interest. The present volume is, to a large extent, based on these bulletins, and will be valued accordingly. Within its prescribed limitations the reader will find an epitome of the most advanced views on the culture of plants. Much of the book is taken up with technical details, which need only be referred to here; but we may refer the reader especially to the paragraph on the use of the electric light for forcing-houses, at p. 80. It is very short, but contains a great deal of information which will be serviceable to those who are contemplating further experiment. The results obtained are substantially the same as observed on different plants by the late Sir William Siemens; but, if we remember rightly, the time required to mature the crops and ripen the fruit at Tonbridge Wells was much less than has been ascertained to be necessary in the United States. Probably the discrepancy is easily to be explained by differences of circumstances. "It will be found profitable," says Prof. Bailey, "to use the electric light for plant-growing, if at all, only in the three or four months of midwinter." A general summary of the contents and a good index render the volume easy to consult.

The Birds of Our Country. By H. E. Stewart, B.A. Pp. viii + 397. (London: Digby, Long, and Co., 1897.)

THE Natural History Societies of our public schools should add this book to their libraries. It contains brief illustrated descriptions of all the birds likely to be seen in the British Isles, and will afford young observers a means of obtaining interesting information on bird-life. We hope the book will not add to the number of indiscriminate collectors. The author refers to "many an enjoyable day spent rambling through the [New] Forest in search of something which might be deemed worthy of a place in our collections, and possibly of a paragraph in a natural history paper to be read at one of our social evenings afterwards." The "takes" of such rambles are also mentioned. It would have been well if a word or two of advice had been added on the folly of collecting specimens without studying them. The young collectors into whose hands the book will probably fall, should be told distinctly that their hobby must be exercised with discretion.

The Pamirs and the Source of the Oxus. By the Right Hon. George N. Curzon, M.P. Pp. 83. (London: The Royal Geographical Society.)

WE are glad that this notable contribution to geography has been reprinted from the *Geographical Journal*, and published as a volume handy in size and attractive in *format*. For ages the Pamirs and the Oxus have impressed the imagination of humanity, and though fancy has now to give way to facts, "the mystery and romance of the fabled Roof of the World having been extinguished by the theodolite and the compass, and superseded by the accurate delineation of scientific maps," this celebrated region is full of interest—how full can only be understood by those who read the present monograph, which happily combines historical records with personal experience.

The Journal of the Essex Technical Laboratories. Vol. ii. Edited by David Houston. Pp. 340. (Chelmsford: County Technical Laboratories, 1896.)

A HELPFUL *Bulletin* is published monthly by the Technical Instruction Committee of the Essex County Council. The bulletins issued from October 1895 to September 1896 are here brought together, and published in the form of a handy volume. Notes and articles on most branches of biological knowledge are included in the volume; and also a short course of lessons in elementary chemistry. Many of the articles are well illustrated, and they will all assist in making the agriculturist and horticulturist realise the value of scientific work.

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.*]

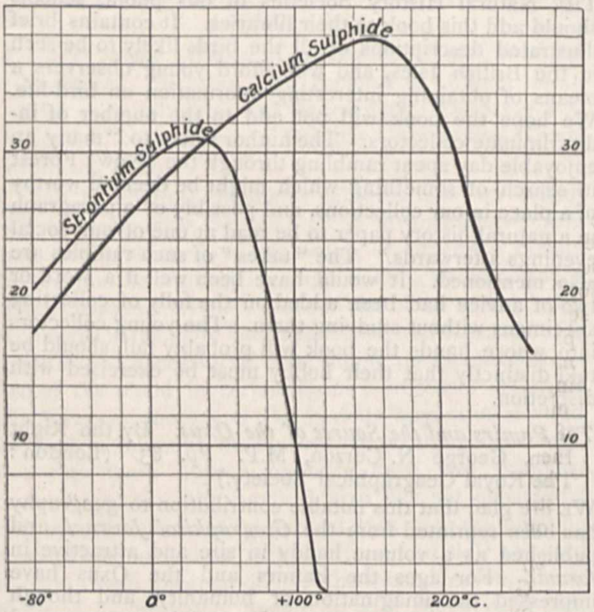
Effect of Change in Temperature on Phosphorescent Substances.

WHEN a substance that possesses phosphorescent properties is exposed to suitable light vibrations, it is found to glow with a certain brightness when the light is shut off.

When such substances are exposed under *similar conditions* for a sufficient length of time the intensity of the phosphorescent light emitted reaches a maximum, which maximum is constant for each substance.

If now the temperature of the substance under observation be altered, the other conditions remaining the same, it is found that the maximum intensity of the light emitted varies with the temperature, and that the maximum for any temperature is constant for that temperature.

The light to which the substances under observation were exposed was that from a spark discharge of a Leyden jar coupled up with the terminals of an induction coil. The instant the spark is stopped, the intensity of the light emitted by the substance is estimated by a photometer devised for the purpose. The principle of the photometer consists in diminishing light



that shines through an aperture of given area, by interposing thin sheets of oil paper. A slip of glass is also interposed, of the same colour as the light emitted by the phosphorescent substance. As yet this photometer has only been used to compare the maximum intensity of the light emitted from the same substance at different temperatures. Now let us suppose, for example, that with a specimen of calcium sulphide at $-40°$ C. ten papers had to be interposed before the light emitted from the sulphide and that from the photometer were of equal intensity; while at 96° C. only seven papers had to be interposed. By taking the reciprocal of the antilog of 10 and the reciprocal of the antilog of 7, we have a rough measure of the relative intensity of the light emitted at $-40°$ and $+96°$ respectively. The antilogs were plotted to scale, and from the curves thus obtained, the accompanying reciprocal curves, showing how the light emitted varies with the temperature, were plotted.

RALPH CUSACK.

Physical Laboratory, Trinity College, Dublin.

Sinistral Screws.

IF mechanical screws "bear" upon natural spirals, as of the *Gasteropoda* (NATURE, May 27, p. 79), it may be worth while to observe that sinistral forms survive in art, as in nature.

The silversmiths of Western India still commonly use a sinistral screw of very primitive form, a pin with a wire twisted round it, especially in the buckles of silver belts; things of very common wear. Europeans, coming into possession of such jewellery, are often sorely puzzled how to open and shut it. Yet these people are as right-handed as we; and write, as we do, "*with* the sun."

W. F. SINCLAIR.

102 Cheyne Walk, Chelsea, S.W., May 28.

Luminous Phenomena observed on Mountains.

THE following account of an occurrence somewhat similar to those recently recorded in NATURE may be of interest. I will give it in the observer's (Rev. W. E. Postlethwaite) own words.

"On March 5, at 9 p.m., I was crossing the Towans, wind north-west; a slight shower came on, which lasted about ten minutes. During that time my hat-brim, ferrule of walking-stick, finger-tips, and the edges of a book I was carrying were phosphorescent, the same colour, and in some places as bright, as the light emitted by a glow-worm. The light was the brightest on the windward side."

The "Towans" referred to in the foregoing account are near Helston, Cornwall, on the sea coast, with an altitude ranging from sea-level to 174 feet above, and with a general downward inclination towards the north-west.

Trewirgie, Redruth, May 29. ARTHUR P. JENKIN.

The Designation of Wave-Clouds.

IN a general article on the "Photographic Observation of Clouds," published in NATURE of February 4 (vol. lv. p. 332), you call attention to the wave-clouds, the origin of which was first explained by Helmholtz, and remark that the name of "Wogen wolken" has been suggested as their designation. May I call your attention to a paper I read before the Linnean Society of New South Wales on August 29, 1894, in which the name *undulus* is suggested for the ripple- or wave-clouds. The name has the advantage of falling easily into line with Howard's nomenclature. And some name is necessary, for out of combinations of the elementary forms *stratus*, *cumulus*, *cirrus*, and *undulus* can be derived most of the diversified and ever-changing cloud-groups, which never cease to delight and astonish the eye and mind of man.

A. H. S. LUCAS.

Newington College, Sydney, April 16.

THE BAKERIAN LECTURE.—ON THE MECHANICAL EQUIVALENT OF HEAT.[1]

THE purpose of this research differs essentially from that of any previous research on the mechanical equivalent of heat. In order to diminish the loss of heat by radiation, as well as to obtain the equivalent for water in the neighbourhood of ordinary temperatures, the ranges of temperature over which the previous dynamical measurements have been made are greatly less than the standard interval between the physically fixed points of temperature to which all thermal measures are referred, and so have of necessity involved the use of scales, the intervals of which depend on the constancy of the relative expansions of such substances as glass, mercury, and air. On the other hand, in this research the object has been to determine the mechanical equivalent of the total heat necessary to raise the temperature of water over the standard interval of temperature, and thus to obtain directly the equivalent of the mean specific heat between the freezing and boiling points.

This undertaking is the result of the occurrence of circumstances which afforded an opportunity such as might not again occur. This consisted in the facilities offered by the appliances which formed the original equipment of the Whitworth Engineering Laboratory, in 1888, the more essential of these being an engine of 100 H.P., working one of Prof. Reynolds' hydraulic brakes. This brake maintains any constant moment of

1 By Prof. Osborne Reynolds, F.R.S., and W. H. Moorby. Read before the Royal Society, May 20. [Abstract.]

resistance on the engine shaft, independent of the speed, all the work done being converted into heat, which appears in the rise of temperature of a steady stream of water flowing through the brake, the magnitude of which stream is independent of the load on the brake or the speed of the engine, and is under independent control.

The existence of the Manchester town's water, of a purity expressed by 3 grains of salts to the gallon, conveniently distributed in the laboratory, as well as auxiliary power, both steam and water.

Although unconsciously, the research was really commenced in 1890, when, without any intention of making a determination of the heat equivalent of the work done on the brake, but solely for the purpose of verifying the mechanical balance of the brake, provision for thermal measurements was added, and a system of trial instituted, in which the object sought was only that of obtaining consistent results over definite portions of the scales of uncorrected thermometers, eliminating the errors resulting from radiation by taking the differences of two trials. In these trials the temperature ranged from 40° to 50° F., and their development was continued over two years. Then it occurred to Prof. Reynolds that by the same method the great facility which this brake was then seen to afford would be available for the independent determination of the mechanical equivalent, if it could be arranged that water should enter the brake at the temperature of melting ice, and leave it at that of water boiling under the standard pressure. Since then all that would be required of the thermometers would be the identification of these temperatures, and with a range of 180° the error in scale over one or two degrees would be comparatively of small importance. At first the difficulties seemed formidable; but on trying by gradually diminishing the supply of water to the brake when it was absorbing 60 H.P., and finding that it ran steadily under control of its automatic gear till the temperature was within three or four degrees of boiling, he further considered the matter, and during the next two years convinced himself of the practicability of the necessary additional appliances by preliminary designs. These consisted of:—

(1) An artificial atmosphere or means of maintaining a steady air pressure of 4/3 atmosphere in the air passages of the brake.

(2) A circulating pump and water cooler, by which the entering water, some 30 lbs. a minute, could be forced through the cooler into the brake at a temperature of 32°, having been cooled by ice from the temperature of the town's main.

(3) A condenser by which the water leaving the brake at 212° might be cooled down to atmospheric temperature before being discharged into the atmosphere and weighed.

(4) Such alteration in the manner of supporting the brake on the shaft as would prevent excess of leakage from the bushes in consequence of the greater pressure of air in the brake, since not only would the leaks be increased, but when the rise of temperature was increased to 180° the quantity for any power would be diminished to one-sixth of that for a rise of 30°, so that any leakage would become six times the relative importance.

(5) Some means by which assurance of the elimination of the radiation and conduction could be obtained, as with a temperature of 140° F. above the laboratory these would probably amount to 2 or 3 per cent. of the total heat.

(6) Scales for greater facility and accuracy in weighing the water with a switch actuated by the counter.

(7) A pressure gauge or barometer by which the standard for the boiling-points might be readily determined at 3° or 4° F. above and below the boiling-point, so as to admit of ready and frequent correction of the thermometers used for identifying the temperature of the effluent water.

(8) Some means of determining the terminal differences of temperature and quantities of water in the brake, which would be relatively six times as large as with 30° rise.

These preliminary designs apparently demonstrated the practicability of the appliances, and also the possibility of their inclusion in the already much occupied space adjacent to the brake. But there remained still much to be done in the way of experimental investigation in order to obtain the data for proportioning the appliances.

In July 1894, Mr. Moorby having undertaken to devote himself to the research, the experiments necessary for the appliances were at once commenced, and these, together with the construction of the appliances and then standardising, and preliminary experiments while this was in progress, occupied till February 1896, when Mr. Moorby commenced the main experiments, which were continued into July 1896.

In these experiments the time of running was 62 minutes; the speed 300 revolutions a minute, on the speed gauges. Observations of speeds, of the temperature of the inflowing and effluent water, and of the temperature of the air were made every two minutes. Observations of the slope of the temperature of the shaft were made every eight minutes.

The temperature of the inflowing water varied from 32·5° to 34°, and that of the effluent from 210° to 214° F. The effluent water was cooled to 8·5° before entering the tank on the scales, in which it was weighed, weighings being taken before and after each trial.

The temperature of the metal surface of the brake being sensibly the same as that of the effluent water (212°), and by taking the difference in the work absorbed in two trials and the differences in the heats developed the errors of radiation and balance in the brake were approximately eliminated, and in order to complete the elimination the coefficient of radiation was approximately determined, so that a correction might be applied for any residual differences of temperature as observed, and in the same way with the slope of temperatures. Further assurance was also obtained by making some trials with the brake naked and others with it covered, so as to reduce the loss of heat to one-fifth; and, in the same way, with every circumstance which could effect the result trials, means were taken to vary the circumstances in different series of trials, so as to obtain an estimate of the limits of error. All the appliances were most carefully standardised; and taking all the limits of error into account the limit of the sum was less than 0·0003.

In all fifty-two trials were included in the final result. Of these—

25	with loads on the brake of	1200 ft.-lbs.	at	70 H.P.	
21	,,	,,	600	,,	35 ,,
6	,,	,,	400	,,	23 ,,

From these, twenty-five separate determinations were made of the equivalent, subject to certain general corrections given below, which gave a mean value 777·91, and from this none of the separate determinations differed by as much as 0·2 per cent., which arranged in eight groups, according to the circumstances under which they were made, the greatest divergence from the mean was 0·05 per cent.

It was found impracticable to eliminate entirely from each determination the losses of heat due to radiation, conduction, leakage of water, &c., and so it was found advisable to determine what these losses were. This information was given by the trials themselves, and the necessary corrections were applied to each separate determination. As illustrating the extent to which the method adopted did eliminate these errors, it is interesting to remark that on the mean value of the equivalent determined, without taking these errors into account, the error was only 0·0192 per cent.

Certain final corrections, which had the same values for all trials, were made to the mean value of J, already given. These were introduced on the following various counts :—

I. Length of the brake lever (0·00042).
II. Salts dissolved in Manchester water (0·00003).
III. Air dissolved in water used in the trials (– 0·00021).
IV. Reduction of weighings to vacuo (– 0·00120).
V. Varying specific heat of water (– 0·00006).
VI. Pressure on thermometer bulbs (– 0·00037).
VII. Work done against gravity (0·00007).
VIII. Engagement of counter (0·00001).

Their total effect was to introduce a correction factor of (1 – 0·00125).

The mean corrected value of the specific heat of water between freezing and boiling points, as measured in mechanical units at Manchester, is found to be 776·94.

THE INTERNATIONAL GEOLOGICAL CONGRESS IN RUSSIA.

THE International Geological Congress may be said to come of age this year, for it was founded at Philadelphia in 1876, at a meeting held under the presidency of the veteran James Hall. The first organised session was held at Paris in 1878, and since then meetings have taken place at Bologna, Berlin, London, Washington, and Zürich. The seventh session is to be held at St. Petersburg, with Prof A. Karpinsky as President.

The ordinary meetings of the Congress will be held in the rooms of the Imperial Academy of Sciences at St. Petersburg. There will be a preliminary assembly of the members on August 28, the formal opening will take place on the following day, and the meeting will terminate on September 4. According to the Russian Calendar these dates will be twelve days earlier, namely, August 16, 17, and 23.

The meetings will extend over eight hours. From 9 till 10 a.m. the Committees of the Congress will deliberate ; from 10 till 2 p.m. there will be discussions on questions proposed in the programme of the Organising Committee. One hour is then set aside for visits to museums and to the exhibition of maps, sections, books, specimens and instruments—possibly some members may then take the opportunity of obtaining lunch. From 3 to 5 o'clock papers of a general character will be read, and these will be so arranged that only one branch of geological science will be discussed each day.

The Organising Committee will reopen the subject of the unification of geological nomenclature. The larger divisions of the earth's history must be based on general palæontological characters, and in defining the several systems attention will be specially given to the study of pelagic life and the evidences of organic evolution. In order that a system be well established it must be capable of subdivision into stages characterised by well-marked pelagic faunas, and these should have a European or equivalent value. It is recognised that sub-stages have only a regional value, while minor divisions have but a local character, and with these the Congress does not deal. The divisions, in short, which the assembly will be called upon to discuss are those of geological time, based on the occurrence of successive groups and zones of fossils ; the purely stratigraphical divisions are essentially regional or local, and they may reasonably be left for each country to fix according to its own necessities ; for they are all important in the interpretation of the structure of a district, in determining its economic resources, and in explaining the origin of its scenery. On the other hand, when we seek to trace out the history of the great changes which the earth at large has undergone, the more comprehensive life-divisions are all important ; and these only can be universally applied, and, we hope, universally adopted. It is true that life-divisions are no more to be rigidly defined than are stratigraphical divisions in the rocks, but fossils are the only guides for correlating the formations in countries far apart. There should be no serious disagreement among geologists, at any rate, with regard to the principles of correlation ; and there is no reason why, after full and friendly discussion, a particular nomenclature should not be generally accepted. It need not interfere with our local divisions, any more than great chronological terms, if applied to human history in general, would interfere with our own time-divisions marked by the reigns of successive monarchs.

The Organising Committee will also deal with the subject of petrographic nomenclature, in the hope of reducing the number of terms now used, and of preventing unnecessary names being introduced. In petrology, as in palæontology, one is nowadays in constant need of a dictionary or glossary, or table of synonyms, to understand the various names of rocks or rock-structures and fossils.

The scheme for Excursions in connection with the Congress is an elaborate one. There will be excursions both before and after the ordinary meeting, and those who have time and money will have grand opportunities of visiting many parts of the Russian empire in Europe.

Prior to the Congress there will be three excursions ; namely, to the Ural regions, to Esthonia, and to Finland. The Ural excursion is timed to take place between July 28 and August 27. There will be a general gathering of the party at Moscow on July 29, and those who join are advised to take thick boots, warm clothing, and waterproof cloaks, for there will be rough walking as well as long journeys in open carriages and on horseback. Messrs. Nikitin, Tschernyschew, Arzruni, Karpinsky, and Stuckenberg will act as leaders. The party will take train to Riazan, and thence journeying to Syzran, on the Volga, they will cross Jurassic, Cretaceous, and Tertiary strata. Thence from Samara to Oufa, Permian and Triassic rocks will be traversed, while onwards to the Ural mountains the party will pass over Carboniferous, Devonian, and Siluro-Cambrian strata, which present evidences of considerable metamorphism, and which, together with various schists, are penetrated by numerous eruptive rocks. The region is famed for its metalliferous deposits, and various mines in rocks bearing gold, copper, and manganese will be visited, as also will be the Imperial stone-cutting works at Ekatherinebourg. The return journey will be made by Perm, Kazan, and Nijni-Novgorod.

The excursion into Esthonia (August 13 to 27) under the direction of M. Schmidt, will be by rail to Reval on the Gulf of Finland, and then a visit will be paid to the Isle of Dago, when attention will be given to the fossiliferous Upper and Lower Silurian rocks.

The excursion to Finland will be made under the guidance of M. W. Ramsáy. The members will assemble at Helsingfors on August 21, and return to St. Petersburg on August 28. Tammerfors and Lavia will be reached, and attention will be directed to the glacial phenomena and the various crystalline rocks.

After the meeting of the Congress is over, the principal excursion will be to the Caucasus, leaving St. Petersburg on September 5, and arriving at Moscow on the following day. The excursion party will then be divided into three sections, A, B, and C. Section A will be conducted by Messrs. Nikitin, Gourow, Tschernyschew, Loutougin, Rouguéwitsch, and Konchin. Leaving Moscow, and travelling by Podolsk, the route will be over Jurassic, Carboniferous and Devonian rocks, and on to the Cretaceous strata of Koursk and Kharkow. Thence the party will proceed to Rostow, at the head of the Sea of Azov, examining a mercury-mine and certain mineral springs, and ultimately reaching Wladikavkaz, on the northern side of the Caucasus mountains. Section B will start, under the guidance of Messrs. Pavlow and Amalitzky, from Moscow to Nijni-Novgorod, across Jurassic and Triassic formations to the Cretaceous rocks of Simbirsk on the Volga. Journeying southwards they will visit asphalt quarries, and by means of steamer and railway they will proceed along the plains of the Volga and the borders of the Kirghiz Steppes to Astrakhan and Wladikavkaz. Section C will be under the direction of M. Sokolow, and will journey to Kiew on the Dnieper, paying especial attention to the Tertiary and Post-Tertiary deposits. Following the river to Alexandrovsk, the party will ultimately join the two other sections at Wladikavkaz by way of Rostow.

Thus united the whole party will proceed across the mountainous country to Tiflis, under the direction of M. Loewinson-Lessing, some few members separating for a while to examine a glacier under the guidance of M. Kolenko. Tertiary, Cretaceous, Jurassic, and metamorphic rocks will be seen. From Tiflis all will proceed to Bakou, on the borders of the Caspian, and thence separating into two portions, they will traverse the mountainous region from east to west, and unite again at Rion. Some may spend a week in the Caucasus, examining the Mamisson glacier; others will have an opportunity of visiting Mount Ararat.

Those who desire to still further continue their field-studies among Cretaceous and Jurassic rocks, may take part in a general excursion into the Crimea. They will proceed by steamer from Batoum to Kertch, and eventually, on October 5, there will be a reunion of all the remaining excursionists at Sébastopol. Thus will terminate the great programme of expeditions planned by the geologists of Russia. H. B. W.

THE NEW LABORATORIES AT GUY'S HOSPITAL.

THE new laboratories which have been erected at Guy's Hospital at the expense of the staff of the medical school, and have entailed an expenditure of about 12,000*l.*, were opened by the Prince of Wales on Wednesday in last week. The buildings occupy about one-third of the whole structure which is contemplated, and a further sum of 35,000*l.* will be required to complete the scheme. The entire building is designed to provide under one roof all the accommodation required by the school in all branches of the medical curriculum. The part of the building now opened contains a well-arranged lecture theatre capable of seating four hundred persons, and beneath it are three dark rooms. The first of these is designed for the reception of the spectrophotometer, polarimeter, and spectroscope, for the use of those engaged in work with them. The other two rooms are intended for galvanometric and photographic work. Other parts of the building are occupied by the laboratories and preparation room for physiological and pathological chemistry, a balance room, a calorimeter room, and a gas room. On the top floor the whole of the front of the building is devoted to the laboratory and preparation room for normal and morbid histology. Large classes can be accommodated, and the claims of investigation have received ample consideration.

An address of welcome was read to the Prince of Wales by Mr. Howse, the senior surgeon, and Dr. Pye-Smith, senior physician, described the objects of the new building in the following words :—

Your Royal Highnesses, my Lords, Ladies, and Gentlemen,—I have been asked by my colleagues, the lecturers, demonstrators, and tutors of this school of medicine to state very shortly the use and object of the building in which we stand.

While in every civilised country, except England and the United States, the training of physicians and surgeons is provided for by the Government as part of its duties, here the profession provides for itself and for the public. The schools of medicine in London have formed themselves around the great hospitals, and have only gradually acquired their present importance and repute.

Apart from practical instruction in the wards of the hospital, some knowledge of natural science has always been included in the preparation for this liberal profession. Physicians have always been botanists and chemists, surgeons have always been anatomists; nor need we look far for proofs that the highest attainments in scholarship and mathematics are admirable training for pathology.

During the last sixty years, great has been the development of these preliminary scientific studies, the indispensable foundation of rational, honourable and helpful medicine. We have now not only able lecturers on physics, on chemistry, and on biology, but well-equipped laboratories for each of these subjects, in which our students become practically familiar with scientific facts. We have twice rebuilt or greatly enlarged our museums and laboratories for *physiology*, for *clinical chemistry*, for *histology*, and for the new science of *bacteriology*. But, again, as our numbers increase and the progress of science goes on, we must pull down our barns and build greater. In medical science, as in a still more important discipline, the Augustinian saying is true, *Qui satis dixerit, perditus est.* We must go on, if we are not to fall back.

Accordingly, after repeatedly considering various plans for enlarging and remodelling the old museum and laboratories, we determined that none of them were satisfactory; and that we must erect a new building for the important department of physiology; one not comparable to the magnificent palaces which are called "Institutes" at Berlin and Strassburg, but such as may rank with the laboratories of our friendly rivals, St. Bartholomew's, St. Thomas's, and the other schools of London, of Cambridge, and of Edinburgh, fitted for the best possible teaching and the most advanced researches.

This part of the future range of museums and class-rooms is now completed. Immense labour has been bestowed upon it. Similar laboratories in this kingdom, and on the continent, have been visited and studied by our lecturers, and the result is what we have every reason to believe will be sufficient for another fifty years. Two names among many to whom we are deeply indebted demand particular mention—those of the architect, Mr. Woodd, and of Dr. Shaw, the Dean of the Medical School.

It is only right to explain how the necessary funds were raised.

We all know the grievous deficiency of rents which have compelled the Governors of Guy's Hospital to close some of their wards.

We know too, and shall never forget, how you, Sir, came to their help, and how, by your generous and practical aid, the prospects of further crippling of the charity were banished, and replaced by a hope that some day its closed wards might be reopened to the public.

The treasurer of the hospital could not give, and the medical school could never ask for, help from the hospital funds. Every pound given to Guy's Hospital is devoted to the direct relief of the patients. The school does not receive from, but gives to the hospital, with which its prosperity and almost its existence are united.

It is needless to say that the Government does not help medical science as it does on the continent, and our rich men are only beginning to learn to devote their wealth to founding colleges and laboratories and observatories, like those which do honour to our kinsmen across the Atlantic.

Only one resource remained open: we determined to appeal—to ourselves. We made a collection; all giving something as he was able, and with the money thus subscribed this physiological institute was built.

Here physiology will be zealously and efficiently taught, and fresh knowledge will be acquired. The old laboratories, where Sir Wm. Gull, Dr. Pavy, Mr. Golding Bird, and the late Dr. Wooldridge worked, will hand over a good tradition of industry, intelligence, and zeal to their successors, and the benefit will not be only for our students, but for the whole community.

Such institutes are too few; for they are not only "light-bringing, but fruit-bearing." They not only form the foundation of scientific and efficient treatment of disease, but are the source whence spring such discoveries as bless the whole world, and crown with the gratitude of nations the names of Jenner, of Simpson, of Pasteur, and of Lister.

One of our kings, sir, zealously helped forward Harvey's immortal work on the movements of the heart and of the blood; another founded the Royal Society, "to search out the secrets of nature by way of experiment."

To you, therefore, as a patron of all that tends to the increase of knowledge and the relief of suffering, we turn and ask your Royal Highness to open this laboratory.

In Harvey's words: *Ad viliorum animalium inspectionem cum Heraclito apud Aristotelem introire si vultis, accedite, nam neque hic Dii desunt immortales.*

The Prince of Wales then declared the building open, and, in the course of a short address, he is reported by the *Times* to have said:—I understand that the building which I have just declared open is to be used in great part for the study of those sciences which have for their object the observation of the natural laws of life. It was in such observations that your distinguished physician, Sir William Gull, first won renown. Nor is it possible to over-estimate the value of such work in the investigation and treatment of disease. One thing I would venture to impress upon our students—namely, that, in endeavouring to follow in the footsteps of the great and good men whom Guy's delights to honour, they should cultivate that gentle and humane spirit which, not confined to any one school, is the best possession of the medical faculty. I have made careful inquiries, and have every reason to believe that whenever experiments upon animals are performed in this school they are undertaken with the object of promoting advances in medicine and surgery which are likely to be of benefit to suffering humanity, and I have satisfied myself that such experiments are conducted under strict supervision, by highly qualified investigators, and that in practice the only operations performed upon animals which are not in a condition of complete anæsthesia are inoculations and hypodermic injections. Looking back upon the history of this school, one cannot but admire the wonderful powers of observation which enabled such men as Astley Cooper, Bright, Addison, Hodgkin, and Gull, with but slender aid from scientific apparatus, to add so largely to the sum of human knowledge. I need hardly remind you that more than one of these great workers in your profession has had his name perpetuated in connection with the discoveries he made in the wards of Guy's Hospital—discoveries which paved the way for the more enlightened treatment of some of the most frequent, and yet most fatal diseases to which man is subject. That harvest has been gathered, and for the present and future generations it remains, with more exact appliances and more delicate apparatus provided by the sister sciences, to seek on other fields to emulate their illustrious predecessors' example. To this end are needed ampler buildings, specially designed rooms, and complicated mechanical contrivances, all of them involving additional expenditure. Your senior physician has made it clear to all how, relying upon themselves, the staff of the medical school have erected this building. I may be permitted to emphasise the fact, to which Dr. Pye-Smith has alluded, that the present building is but an instalment of a more extensive design which is to be completed as soon as funds are forthcoming. I would venture to express a hope that this day may not be long delayed, and that when the building is completed, room will be provided to adequately display the unique collection of wax models which so much interested me when first I visited your museum. The medical staff have expended as much as they safely can, and it is to men of wealth and philanthropic aspirations that we confidently look for further assistance. Let such men once realise that money given for the purposes of medical education directly benefits humanity, and I cannot doubt that that spirit, which has prompted the British people to provide by voluntary effort what in other countries is provided by the State, will prove effective in the present need. On you students of medicine—and a medical man, as Dr. Wilks has said, should be a student till he dies—it devolves so to order your life's work that you make the best use of the improved opportunities thus provided, and to take care that the great profession to which you have aspired to belong shall, when you leave it, stand as high in the service and in the affection of the public as it does at the present time.

NOTES.

THE Select Committee of the House of Commons appointed to inquire into the administration of the museums of the Science and Art Department has presented an interim report calling attention to the peril of destruction by fire to which the collections at the South Kensington Museum are exposed. After describing the general character of the buildings and their inflammable structure, the Committee conclude their report with the following observation:—"This necessity of providing buildings suitable for the exhibition of the objects of art and science collected at South Kensington has been long under the consideration of successive Governments. Your Committee regard it as their immediate duty to lay before the House of Commons by means of an interim report their very strong opinion that permanent buildings for the adequate accommodation of the collections at the South Kensington Museum should be proceeded with without delay. They are of opinion that it will be a source of grave discredit to the country if the settlement of this matter, which has been the subject of consideration by Government for many years, and of endless correspondence between the departments concerned, is any longer delayed."

THE Paris correspondent of the *Times* reports that at Monday's sitting of the Academy of Sciences, M. Moissan communicated the results of his experiments with Prof. Dewar on the liquefaction of fluorine gas. M. Moissan announced that the gas had been liquefied at about 185° C. below zero. When a current of fluorine gas is passed into an apparatus maintained in the midst of liquid oxygen in tranquil ebullition at a temperature of −180° C., liquefaction does not occur. But as soon as that temperature is diminished by exhausting the gas above the liquid oxygen, the liquefaction of the fluorine begins, and a clear yellow and extremely mobile liquid is obtained, which resumes the gaseous state as soon as the temperature rises. This liquid has lost the chemical activity characteristic of fluorine in a state of gas. It no longer attacks glass, silicon, sulphur, or phosphorus. Fluorine at a very low temperature, however, still attacks carburetted hydrogen, and its affinity for hydrogen seems still to exist.

JUST too late for insertion in last week's NATURE we received a cablegram from Prof. A. B. Macallum, Local Secretary for the forthcoming meeting of the British Association at Toronto, asking us to urge members of the Association to apply for Canadian Steamship berths as soon as possible, as the berths still remaining will soon be filled.

SIR ARCHIBALD GEIKIE had a hearty reception from geologists in America during his recent visit. The number of *Science* which has just reached us contains a long article, by Prof. J. F. Kemp, upon the visit of the distinguished director of our geological survey, and it is evident from the account that geologists in America regarded the occasion as one of exceptional interest. Sir Archibald Geikie crossed the Atlantic to open a new course of lectures on geology, founded in connection with the Johns Hopkins University, Baltimore, by Mrs. G. H. Williams. The purpose of the foundation is to support an annual course of lectures in geology, to be given alternately by European and American geologists of distinction; and the fact that Sir Archibald Geikie was chosen to deliver the first course is a high compliment to his learning, as well as a testimony to the breadth of his sympathies. Before he arrived in America, invitations were sent by the Johns Hopkins University to geologists throughout the country, asking them to be present, and to take part in the excursions which had been arranged. In response, fifty or more leading geologists in America accepted. While the lectures were being delivered, short excursions were conducted almost daily to places of geological interest near Baltimore, on one of which Sir Archibald Geikie and his companions were the guests of the Secretary of the Navy at the Naval Academy, Annapolis, and upon one of the United States Government vessels on a trip to view the Cretaceous and Tertiary formations along the Severn River. A longer excursion was made at the close of the lectures, so as to illustrate the geology of the State of Maryland. Through the efforts of Prof. W. B. Clark, who is also State Geologist of Maryland, the interest of the Governor of the State and of the principal railway and mining officials had been secured, so that free transportation was given on the Baltimore and Ohio, the Cumberland and Potomac, and the Western Maryland Railways, as well as on one of the State official steamboats. Before breaking up, the entire company of geologists signed and presented a short address of thanks to the Board of Commissioners of the Maryland Geological Survey and the State Geologist, for the hospitable forethought which had enabled them to spend four days in inspecting a region presenting so many interesting geological aspects. At the close of the Baltimore visit Sir Archibald Geikie went to Washington, where he delivered an address before the Geological Society, and was afterwards given a reception in the rooms of the U.S. Geological Survey. He also gave addresses to the students of Bryn Mawr College, the Philosophical Society in Philadelphia, and the Brooklyn Institute. The different institutions seemed to vie with one another in doing honour to their guest; and it is to be hoped that when an opportunity arises, the cordial feeling thus manifested will be fully reciprocated. Sir Archibald Geikie returned to London a few days ago. His lectures at the John Hopkins University will ultimately be published.

WE regret to hear that Dr. Fritz Müller, the well-known biologist, died at Blumenau on May 21.

A BILL to legalise the use of weights and measures of the metric system was given a first reading in the House of Commons on Thursday last.

AN afternoon meeting of the Anthropological Institute will be held on June 15, at the South Kensington Museum, when Mr. A. P. Maudslay will lecture on "The Maya Monuments and Inscriptions in Central America."

IT is announced that the memorial to Joseph Thomson, the African explorer, will be unveiled by Sir Clements Markham, K.C.B., F.R.S., at Thomson's native town, Thornhill, near Dumfries, on Tuesday next, June 8.

THE great lens for the Yerkes telescope has just been finished by the Clarks, at Cambridgeport, and shipped to the University of Chicago, where it will be immediately mounted, as the tube and connected apparatus are already in position.

IN reply to a question asked in the House of Commons on Friday last, whether any steps had been taken to fix the site of the new magnetic observatory at Greenwich, the First Commissioner of Works replied that a site had been selected, with the concurrence of the Astronomer Royal.

A NEW biological station at Millport, on the Clyde, was opened a few days ago (says the *British Medical Journal*) by Dr. John Murray, F.R.S. The station has been erected at a cost of 1500*l.*, and though in regard to accommodation and equipment it cannot compare with many similar institutions in this country and the continent, as Dr. Murray pointed out, its position makes it a place of very great possibilities. The collection of the late Dr. Robertson, who did so much for the station, has been presented by his wife for the museum of the building.

THE State recognition given to the International Congress of Medicine and Surgery, to be held in Moscow in August next, is referred to in the *Lancet*. The Czar has taken the Congress under his patronage, and has consented to receive deputations from the various nationalities represented at the Congress. It is probable that the reception will take place in St. Petersburg immediately after the close of the meetings in Moscow. The Russian Government has acted most liberally towards the Congress. It has increased its original grant of 50,000 roubles towards the expenses by an additional grant of 25,000. This makes the handsome total of 75,000 roubles, or about 8000*l.* at the present exchange. In addition to this, the State has promised free railway tickets to members of the Congress from the frontier to Moscow and back. To Russian members similar free tickets will be granted from any part of the empire. Just as liberal recognition has been given by the Russian Government to the International Geological Congress to be held at St. Petersburg at the end of August.

IN connection with the recent correspondence in these columns on luminous phenomena observed on mountains, it is interesting to direct attention to a very remarkable series of observations of electrical storms on Pike's Peak, Colorado, contained in vol. xxii. of the Annals of the Astronomical Observatory of Harvard College, and described in NATURE (vol. xlii. p. 595, October 16, 1890). Luminous jets appeared very often along the telegraph wires for the length of an eighth of a mile, and the anemometer cups looked like revolving balls of fire. Upon touching the anemometer under these conditions, an observer found "his hands instantly become aflame. On raising them and spreading his fingers, each of them became tipped with one or more cones of light nearly three inches in length." Many more striking effects of this character are described in detail in the report to which reference has been made.

THE Smithsonian Institution is publishing in their "Miscellaneous Collections" a number of interesting memoirs submitted in the Hodgkins Fund Prize Competition. No. 1077 of this series is a contribution by Mr. A. McAdie, on the equipment and work of an aero-physical observatory, in which he deals especially with the question of future research in connection with our knowledge of atmospheric air and the prevision of weather. After the experience of twenty-five years, the author asks, "Has the synoptic map realised the expectations of meteorologists, and justified the expense of its existence?" The answer is in the affirmative; but if the further question is asked whether the forecaster of to-day is far in advance of the forecaster of 1870, the reply is uncertain, and the experience of recent years would seem to indicate that we have nearly exhausted the capabilities of the weather map in its present form. An aero-physical laboratory would afford opportunity for important research and investigation, and the author draws attention to some profitable lines of study bearing upon the conditions which control the weather. Among such investigations, Oberbeck's papers on the "Motions of the Atmosphere," and von Bezold's "Thermodynamics of the Atmosphere" may be mentioned as examples of the lines indicated. The study of atmospheric electricity also offers possibilities of great extension of our knowledge of atmospheric phenomena. In 1752 a simple experiment demonstrated the nature of the lightning flash, but at the present time the origin of the electricity of thunder-clouds, and similar questions, are as the nature of the lightning was before the time of that experiment. Much useful scientific work in weather forecasting has undoubtedly been done, but it remains none the less true that the present condition of our knowledge is still unsatisfactory.

IN the House of Lords on Friday last, Lord Stanhope moved —"That her Majesty's Government should be invited to take such further steps as are necessary under the Finance Act, 1894-96, to preserve in the country 'such pictures, prints, books, manuscripts, works of art, and scientific collections, not yielding income, as are of national, scientific, or historic interest.'" Speaking upon the subject of the motion, Lord Kelvin pointed out its great importance so far as scientific collections were concerned. It might have an exceedingly injurious effect upon scientific investigation in this country if the heavy death duties were charged upon apparatus for scientific research or upon natural history collections, the property of private owners. Very large sums of money had been spent on private observatories. A large part of the astronomical investigation in the United Kingdom had been performed by amateur astronomers, if he might use the word, who stood at the very head of scientific men in respect of knowledge and skill in scientific investigation. A large amount of money had been spent upon private observatories, on great telescopes, and on other instruments of research, which would be subject to exceedingly heavy death duties, and the heirs of the proprietors might find it impossible to keep them. The result might be that it would be necessary to sell them; foreign purchasers might get them, and those valuable tools for scientific wo.k might be sent out of England and leave this country so much the poorer in respect of scientific work. The same might also be said of natural history collections. Such collections were of unique value. A man might spend his whole life in the work of making such collections and leave something that was of priceless value in reality, and which would be estimated at a very high money figure if the expense involved in creating the collection was to be taken into account. It would be most disastrous that such natural history collections or apparatus for scientific investigation should be subjected to the severe death duties that were charged on those to whom was left property which they could use, and which might be sources of income and revenue to the inheritors, when that which was inherited could only be of use through the inheritor devoting himself, as the creator of the collection had devoted himself, to the public good and for the advancement of science. He thought it would be exceedingly bad, and in every way undesirable that a duty anything more than merely nominal should be charged in such cases.—Lord Cross explained that there was a great desire on the part of the Chancellor of the Exchequer to deal fairly with this matter. Anything that could be done within the terms of the Act of Parliament would be done by him to keep works of art, whether they be pictures, manuscripts, scientific collections, or scientific instruments, in the country. He hoped, therefore, that the motion, with the main object of which the Government fully sympathised, would not be pressed. The motion was afterwards negatived without a division; so the decision whether the objects referred to shall be liable for estate duty or not, remains with the Chancellor of the Exchequer.

A VERY valuable address on the progress of medicine in the Victorian Era, delivered on May 27 by Mrs. Garrett Anderson, M.D., before the East Anglian Branch of the British Medical Association (of which branch she has been elected President), concluded with the following clear statement of the directions in which advances may be gained by research. "It is in medicine proper that more light is specially needed. We want, in medicine, more of the knowledge that can only be gained through research. We want to know the real nature of malignant growths, the complete life-history of the bacillus of diphtheria, of the parasite of malaria, the conditions they require, and how to produce immunity from them and from tuberculosis. It does not need much imagination to realise how the world would be helped, and its sorrows lightened, if cancer, consumption, and diphtheria could be brought under control in at all the same measure as small-pox, thanks to Jenner, has been brought; nor how civilisation would advance by leaps and bounds in many parts of the world if malaria could be effectually combated. Victory in these directions can only come through patient and laborious research, and we should all do our best so to educate public opinion that the true value of this work should be generally recognised, and that the demand for it should no longer be restricted within the narrow limit of the world of science."

PROF. KOCH's final reports upon his rinderpest investigations at Kimberley, appear in the Cape Town *Agricultural Journal* of April 1. The following extracts from the last report, dated March 22, are of interest:—"I consider my researches, respecting the rinderpest, finished in the main, and I believe that I can leave the further working out of them to Dr. Turner, who will for some time still have the assistance of Dr. Kohlstock, and later that of Dr. Kolle, should it be possible to arrange this. This ensures the continuity between my work hitherto and the further investigations at the experimental station. What I had been able so far to find out regarding the microbe of the rinderpest seemed to me too uncertain to mention in my reports. But I have shown Dr. Turner everything I have found in this respect, and he will try to gain further facts about the occurrence and habits of these microbes which, at any rate, do not belong to the class of Bacteria. The discovery that by injection of gall taken from rinderpest animals, sound animals may be protected against rinderpest, and that this discovery is also practically applicable, I consider absolutely proved in view of the results achieved on the farm 'Susanna.' Should my hopes respecting the artificial production of rinderpest-gall by mixture of gall and rinderpest-blood, about which I am not quite certain at present, not realise themselves, it will still be possible to obtain any desired quantity of effective gall by infecting a proportional number of cattle with rinderpest blood and killing them on the sixth or seventh day of the illness. The use of gall for immunisation seems at present to me to be so far superior to immunising with serum, that I would advise the latter procedure to be applied only experimentally."

PROF. J. A. HARPER's paper "On Nuclear Division and Free Cell-formation in the Ascus," reprinted from Pringsheim's *Jahrbücher*, completes a valuable series of observations on the obscure process of nuclear fusion which takes place immediately before the formation of the spores in many of the Ascomycetes. The author does not take the view of several French observers, that this fusion of nuclei is of a sexual character.

THE *Bulletin of Miscellaneous Information*, issued by the Superintendent of the Botanic Garden, Trinidad, mentions the very interesting circumstance that in that island a species of *Bauhinia* (*B. magalandra*, n. sp.), belonging to the Leguminosæ, is pollinated by the agency of bats, the first instance recorded of a "mammalophilous" flower. On visiting a flower the bat alights upon and holds fast to the protruded stamens, and attacks the erect and curved petals. The object of the visit of the bats appears to be not any nectar secreted by the flower, but the insects which are attracted to it by its odour. The flowers open only in the evening.

TOWARDS the end of the notice of vol. ii. of the Cambridge Natural History, in our issue of April 29 (vol. lv. p. 610), reference was made to the admirable illustrations, and regret was expressed that the name of the artist did not appear to be given. We are glad to be able to say that the artist was Mr. Edwin Wilson, of Cambridge, whose illustrative work has taken a high place in science for some years. The volume lately reviewed was written by several different contributors, and, as there was no preface, the editors were unable to say how very much it owed to Mr. Wilson's skill and care.

To the list of cave animals which appears in Dr. A. S. Packard's monograph in the "Cave Fauna of North America" must now be added seven forms which are new to science, and several forms which, while known, have not hitherto been definitely reported from Mammoth Cave, Kentucky. This new material is described by Dr. Ellsworth Call in the *American Naturalist* (May). The specimens described are very minute, and this fact is in itself sufficient to explain their late appearance in lists of the cave fauna. The paper is a noteworthy contribution to a knowledge of the life of the most interesting cave on the American Continent.

A REPRINT from the *Transactions* of the New York Academy of Sciences gives an account of the results obtained by an expedition to Puget Sound, organised by the Department of Zoology of Columbia University in the summer of 1895. The party consisted of six members, under the leadership of Dr. Bashford Dean. Their main object was to obtain materials for the study of the development of the Chimeroid fish *Hydrolagus*, and eggs and young of the Myxinoid form *Bdellostoma*, both known to be abundant there. In both these respects success was achieved, and large collections of other groups of marine animals were secured for future study.

AMONG noteworthy articles which have come under our notice during the past few days are the following:—Dr. R. W. Shulfeldt points out, in the *Photogram* (June), that many of the figures throughout zoological literature are very frequently anything but correct, depicting often the subject in impossible attitudes, badly proportioned, and with erroneous portrayal of characters. To assist in the improvement of this state of things, he describes how photography should be called in with the view to secure pictures of living animals for reproduction by photographic processes.—The *Century Magazine* for May contains three well-illustrated articles on the construction and use of kites for meteorological and photograph purposes. In the June number of the same magazine, Mabel L. Todd describes the establishment and work of the Harvard College Observatory.—An address on "The Problems of Astronomy," delivered by Prof. Simon Newcomb at the dedication of the Flower Observatory, University of Pennsylvania, is printed in *Science* of May 21.

SOME further details, of great interest as to the fermentation of sugar in the absence of yeast-cells (see NATURE, March 11, p. 442), are given in the current number of the *Berichte* by Buchner. The active extract of yeast very rapidly loses its power of producing fermentation, owing probably to the presence of peptic enzymes. The activity of the solution is not affected by the presence of antiseptic substances, and the solid residue left on evaporation at a low temperature is found to yield an active solution, even after having been kept for nearly three weeks. These facts seem to definitely prove that the fermentation in these cases is not brought about by living protoplasm in any form, but is really due to the substance which the author has termed zymase. This is further confirmed by the fact that dried yeast which has been heated at 100° for six hours, and is incapable of further development, still yields an active solution when treated with sterilised 37 per cent. sugar solution.

THE additions to the Zoological Society's Gardens during the past week include a Chimpanzee (young) (*Anthropopithecus troglodytes*, ♀) from West Africa, presented by the Hon. Sir W. Grantham; a West African Sheep (*Ovis aries*, var. ♂) from West Africa, presented by H.E. Colonel F. Cardew, C.M.G.; a Broad-snouted Cayman (*Caiman latirostris*) from South America, presented by Mr. C. L. Hutchings; an Olive-brown Snake (*Phrynonax fasciatus*) from Trinidad, presented by Mr. R. R. Mole; a Pleasant Antelope (*Tragelaphus gratus*, ♂), four Royal Pythons (*Python regius*) from West Africa, thirteen Cunningham's Skinks (*Egernia cunninghami*), two Punctulated Tree Snakes (*Dendrophis punctulatus*) from Australia, deposited; an Alpaca (*Lama pacos*, ♂) from Peru; two Red-topped Amazons (*Chrysotis rhodocorytha*), three White-eared Conures (*Pyrrhura leucotis*) from Brazil, purchased; two Japanese Deer (*Cervus sika*, ♂ ♂), a Red Deer (*Cervus elaphus*, ♀), a Burrhel Sheep (*Ovis burrhel*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE ROTATION PERIOD OF JUPITER'S SATELLITE III.—Mr. Douglass has quite recently determined the period of rotation of Ganymede, Jupiter's third satellite, the period being given as 7 days, 5 hours (Kiel Telegram). This satellite is the brightest and largest of them all, and its sidereal revolution is 7 d. 3 h. 43 m., so that the period of rotation is practically the same as the time of its orbital revolution. This observation partly corroborates what Herschel concluded in 1797, namely, that, like our moon, all the satellites of Jupiter turn the same face towards their primary, thus always presenting to us, when in the same relative situations, the same obscure or brilliant sections of their globes. Engelmann's researches in 1871, and C. E. Burton's, two years later, made this statement of Herschel's almost certain regarding the outer satellite, and since that time it has always seemed probable that it would also apply to the other three. This new observation of Mr. Douglass shows that the deductions of the earlier observers were not very far from the truth.

Referring to this satellite in 1893, Prof. W. H. Pickering (*Astronomy and Astrophysics*, vol. xii. p. 199) said: "On account of its size and brightness, this is much the easiest satellite to observe. Indeed, even the occasionally elliptical shape of its disc has been noted by Lassell, Secchi and Burton. . . . Like our moon, therefore, its period of rotation coincides, at least approximately, with that of its revolution in its orbit. . . . Its surface markings are readily seen, especially during transit, the most conspicuous being a dark belt situated in the northern hemisphere, and inclined about fifteen degrees to its orbit."

AUTOMATIC PHOTOGRAPHY OF THE CORONA.—The idea of connecting several different kinds of instruments with some sort of central automatic arrangement by which one man may work them all during a total eclipse of the sun, is not new; but weather conditions have up to the present prevented any trial being made at the time of an actual eclipse. Mr. David P. Todd, who for the past few years has given considerable attention to this question, describes in the current number of the *Astrophysical Journal* (No. 5, vol. v.) the special automatic shutter and electric commutator which was devised for the Amherst Eclipse Expedition of last year, but which was, unfortunately, not used owing to the bad weather. In all twenty photographic instruments would have been worked by an automatic system, which would have given more than four hundred exposures with several types of reflecting and refracting telescopes, photographic doublets, a pair of spectroscopes, photometers, and a pair of polariscopes.

The system which Mr. Todd advocates is an electric system of control, and he has found that it is perfectly competent to operate any available number of eclipse instruments adapted for photographic purposes; it further makes the time record of every automatic movement in a form which can be identified.

It would be difficult to give the reader a clear idea of this arrangement without the medium of an illustration; so that we refer him to Mr. Todd's article for detailed information.

THE GEGENSCHEIN OR ZODIACAL COUNTERGLOW.—In some former numbers of the *Astronomical Journal* (*A. J.*, vii. 186, xi. 19, and xiii. 169), Prof. Barnard contributed his observations of this phenomenon as seen at the Lick Observatory. His communication to a more recent number (No. 403) of the same journal contains some further observations of considerable interest made at the Yerkes Observatory. He points out that although these naked-eye observations are subject to a more considerable personal error than if they could have been made with any kind of instrument, yet the determination of the position of this phenomenon depends to a great deal on the experience of the observer. The best method he suggests for its location is to estimate the distance of its centre from the nearest fixed star, and then to identify the star by a chart or an equatorial pointing; by this means he can ordinarily determine the centre to within one degree. Any attempt, he says, to locate its position by tracing the outlines among the stars can only lead the observer to very crude results. Prof. Barnard's observations have indicated that the Gegenschein seems subject to periodical changes in the first parts of October and April; but the weather this year did not permit of a corroboration of this statement. The present observations show that this phenomenon has a north latitude as formerly, and that there is still a tendency to lag in longitude; that is, its longitude is not exactly 180° greater than that of the sun. The following summary shows the results for the last fourteen years:—

Dates.	Lat.	Diff. Long. (λ - ⊙)	No. Obs.
1883-1887	+0·4°	179·4°	16
1888-1891	+1·3	179·4	16
1893	+0·5	179·6	22
1894-1897	+0·4	179·9	11

It may be stated that the difference in longitude for the last four years given above is rather high, owing to the fact that the three observations of 1894 made the difference greater than 180°. Those for 1895 and 1897 gave a value considerably less than 180°.

PERIODIC VARIATIONS OF RAINFALL IN INDIA.

THE meteorology of India during the past five years, 1892-96, has been characterised by the largest and most marked periodic variation of rainfall during the past fifty years at least, and probably for a much longer period. The late Mr. Blanford's monograph on the rainfall of India (page 15) gives a brief statement of the method he adopted for ascertaining the average rainfall of India, year by year, and the normal average. According to this method the mean normal annual rainfall of India is, very approximately, 41 inches. The following gives a comparison of the actual mean rainfall of India with the normal mean for each year from 1875 to 1896, determined by Mr. Blanford's method.

Year.	Mean actual Rainfall.	Variation from normal.	Percentage variation.
	Inches.	Inches.	
1875	43·47	+ 2·38	+ 6
1876	36·60	− 4·49	− 11
1877	36·81	− 4·28	− 10
1878	47·43	+ 6·34	+ 15
1879	42·78	+ 1·69	+ 4
1880	39·53	− 1·56	− 4
1881	41·19	+ 0·10	0
1882	43·73	+ 2·64	+ 6
1883	40·97	− 0·12	0
1884	42·82	+ 1·73	+ 4
1885	42·14	+ 1·05	+ 3
1886	44·11	+ 3·02	+ 7
1887	43·51	+ 2·42	+ 6
1888	39·55	− 1·54	− 4
1889	43·50	+ 2·41	+ 6
1890	41·77	+ 0·68	+ 2
1891	37·55	− 3·54	− 9
1892	46·18	+ 5·09	+ 12
1893	50·16	+ 9·07	+ 22
1894	47·56	+ 6·47	+ 16
1895	38·90	− 2·90	− 7
1896	36·26	− 4·83	− 12

The preceding data indicate that from 1876 to 1891 the annual ainfall of India varied somewhat irregularly and by less than 10 per cent. from the normal with one exception, viz. during the period 1876-78. The meteorological features of this period were very remarkable (*vide* NATURE, vol. xxi., page 477, "On the barometric see-saw between Russia and India in the sun-spot cycle," by H. F. Blanford), the most noteworthy being the drought and famine in Madras in 1876, and the scanty rainfall in North-western India in 1877, which gave rise to considerable suffering. Mr. Blanford subsequently traced the cause of the deficient rainfall in North-western India in 1877 to conditions and actions resulting from excessive snowfall in the Himalayan region during the winter of 1876-77.

The causes of the drought in Mysore and the Madras and Bombay Deccan in 1876, have as yet not been fully ascertained. The snowfall of the winter of 1875-6 was unusually scanty in the North-western Himalayas, although there was a heavy local fall in March and April in a part of the Kashmir Himalayas. The Madras drought and famine was probably due to more general actions and conditions than the winter Himalayan snowfall.

The present meteorological period of abnormal conditions and rainfall it will, however, be seen is not only more prolonged, but is accompanied by much larger variations in the amount and distribution of the rainfall than were experienced in the period of 1876-78. It is, moreover, noteworthy that the cycle or period commenced with excessive rain, continued for a period of three years, and culminating in the year 1893 in an average excess of 9·07 inches, or 22 per cent. of the normal fall. This excess rainfall in India in 1893 was equal to the amount of water necessary to supply its largest canal, the Ganges canal, 300 feet wide, 10 feet deep, for a hundred years. This comparison gives a feeble estimate of the surplus water precipitated over India in 1893, in consequence of the special meteorological conditions and actions of the period.

In order to understand the causes of the partial failure of the crops over at least two-thirds of India in the year 1896, it is necessary to bear in mind the more prominent features of its meteorology, that differ very largely from the meteorological conditions in European countries. The following is a brief statement of the chief features of the two monsoon periods in India.

The year in India may be broadly divided into two seasons or monsoons—viz. the north-east monsoon and the south-west monsoon. These names are derived from the direction of the winds prevailing in the Arabian Sea and Bay of Bengal during the two periods. They are inapplicable over the greater part of India, where the winds are from directions nearly opposite to those indicated by the names of the seasons, and are chiefly determined by the axial directions of the local river valleys. Thus the winds in South Bengal are from south-east, and in Bihar from east, during the south-west monsoon, and are from the opposite directions in the north-east monsoon. It would hence be more appropriate to call the two seasons in India the dry monsoon, and the wet monsoon from their most characteristic features.

The dry monsoon or season usually commences in November or December, and continues until May. Winds of land origin prevail more or less steadily in the interior, and hence the period is usually marked by great dryness of the air and little or no rain. The first three months of this period (December to February), characterised by a comparatively low temperature, are known as the cool weather season; and the second three months (March to May), when the temperature increases rapidly, and culminates in a period of excessive heat in May, as the hot weather season. During the cold weather season, shallow depressions of large extent, the majority of which form in Persia, enter India from Baluchistan and traverse Northern India from west to east, distributing light rain in the Indo-Gangetic plains and heavy snow over the Western Himalayas. The severity of the hot weather season is occasionally relieved by the occurrence of series of thunderstorms and duststorms, which cool the air for brief periods. Over nearly the whole of the interior of India the cold weather and hot weather disturbances occupy a very small portion of the period, and the characteristic features of the dry season are persistent dry weather, with clear skies and large diurnal range of temperature.

The chief crops in Northern and Central India during this period are wheat, barley, linseed, &c., and irrigation either from canals, tanks, or wells is essential in almost all districts for their successful cultivation. If the summer rains cease much earlier than usual, it is not possible to plough and sow the higher and drier lands, and the area of cultivation in the dry season under these conditions is hence largely diminished. If the winter rains are light and scanty, the crops are more or less severely affected on all the higher lands where irrigation from wells, &c., is necessarily limited.

The rains of the wet season set in suddenly on the west coast of India in the first week of June, and a little later (in the second or third week of June) on the Bengal coast, and extend more or less rapidly into the interior. The prevailing winds of this period are of oceanic origin, and are, in fact, the northward extension of the winds of the south-east trades.

The extension of these winds northwards across the Equator and up the Indian Seas usually beg ns in the third week of May, and gives a complete and permanent change of weather (lasting for five or six months), more especially over the land area of India. The winds due to the extension of these massive humid air currents usually begin to give daily rain to the Malabar coast in the last week of May, and to the Bombay coast on June 4 or 5. The humid currents advance more slowly into the interior, but are usually established before the end of the month over the whole of India. Cloudy, showery, or rainy weather, with a moderately high temperature and small diurnal range of temperature, prevail during the next three months, which are in a striking contrast to the excessively hot and dry weather that has prevailed during the previous two or three months.

The rainfall of India during this period is of the greatest importance, and is sufficient without the aid of irrigation for the crops, except in a few districts (notably Sind and the West Punjab). The rainfall varies considerably in distribution, and slightly in average amount from year to year. The general volume of the current—and hence of the average seasonal rainfall in India—appears to be primarily dependent upon the strength of the currents in the sea areas to the south of India, and hence also of the south-east trades. Consequently it might be expected that any large and persistent variations in the strength of the south-east trades would be reproduced in the strength of the south-west monsoon currents and in the rainfall of the season in India. The local strength of the current in different parts of India varies, to some extent, from year to year, and it has been found that the distribution of the rainfall is largely dependent upon the pressure and other abnormal conditions prevailing in India at the time of its extension, and hence that these can be utilised to forecast the general character of the distribution of the monsoon rainfall. It has been shown, chiefly by Mr. Blanford, that the amount and distribution of the winter snowfall in the Western Himalayas is an important factor in determining these conditions, and hence in modifying the local distribution of the rainfall during the wet or south-west monsoon. Excessive snowfall during the winter proper (*i.e.* December to March), or heavy and unusual snow in April or May, affect the pressure distribution in such a way as to deflect the monsoon currents in their entry into India from one portion of the area (usually North-western India), and determine it more largely than usual to another portion (as, for example, Burma, Bengal or the Peninsula). Under such conditions, one part of the Indian monsoon area receives unusually scanty rain (leading, perhaps, to drought and famine), whilst another area obtains excessive rain. The last notable example of this was in 1891, when Rajputana suffered severely from drought. The winter of 1890-91, in the Western Himalayas, was very severe, and the snowfall excessive and prolonged until May.

It is of the greatest importance to distinguish between the general conditions in the oceanic area (more especially the strength of the south-east trades) affecting the general strength of the monsoon currents prevailing in the Indian monsoon region and the local conditions determining its relative strength in different portions of the Indian land area. For many years —viz. from 1879 to 1891—the local conditions were undoubtedly the predominant factor determining the variation of the south-west monsoon rainfall in India; but the year 1892 introduced conditions and actions, leading to a very large cyclical variation of rainfall, which cannot be explained by local conditions in India, but which appear to be, in part at least, due to variations in the general strength of the south-west monsoon circulation as depending upon corresponding variations in the south-east trades.

The crops during the south-west or wet monsoon may be locally deficient, either from excessive rain and floods or from scanty rains. Partial failure of the crops from excessive rain is usually local in its extension; but the excessive rainfall of the years 1893-94 undoubtedly affected the crops to a serious extent in many parts of the Central Provinces, Central India, and the North-western Provinces, and impoverished the people of these districts to some extent, and hence diminished their capacity to resist the effects of the deficient rainfall and drought in the succeeding years 1895 and 1896.

Deficient rainfall during the wet monsoon is, undoubtedly, the most potent factor in diminishing the staple food crops of India and leading up to food scarcity and famine. The rainfall may be deficient throughout the whole season, as was the case in many districts of the North-western Provinces in the south-west monsoon of 1896; or the rains may cease suddenly and abruptly some weeks earlier than usual, as in the Central Provinces in 1896. In the latter case, prospects may be excellent from the beginning of the monsoon up to the middle or end of September, and then deteriorate rapidly in consequence of the failure of the rainfall necessary for the full growth of the rice and other food crops. This was the case in 1896 over the greater part of the Central Provinces and Bengal, where the partial failure of the rice crop was solely due to the absence of rain in October and November 1896.

The failure of the crops in India, 1896, was more extensive, and spread over a far wider area than has occurred for probably 100 years at least, and its effects were intensified by the four unsatisfactory seasons which preceded it. It was due in a few districts to excessive rain and floods, in a large number of districts to scanty rainfall throughout the whole monsoon, and in others to the early and abrupt termination of the rains from a month to six weeks before the normal date.

The following gives details and data of the more important abnormal features of the south-west monsoon rains of 1896, which were chiefly instrumental in leading up to the very general and partial failure of the summer or wet crops of that year. The table below gives the average or normal date on which the south-west monsoon rains commence in different provinces of India, and the mean date on which they commenced in the same areas in 1896:—

Province	Normal or average date of commencement of south-west monsoon rains	? Mean date of beginning of south-west monsoon rains, 1896	Variation from normal date
Bombay (West Coast Districts)	June 5	June 14	9 days later than usual
Central Provinces	,, 10	,, 17	7 ,, ,,
Central India ...	,, 15	,, 21	6 ,, ,,
Rajputana... ...	,, 15	,, 21	6 ,, ,,
Bengal	,, 15	,, 18	3 ,, ,,
Bihar	,, 15	,, 19	4 ,, ,,
North-west Provinces and Oudh	,, 25	,, 21	4 days earlier than usual
East Punjab ...	July 1	,, 25	6 ,, ,,

This table shows clearly that the advent of the monsoon was slightly delayed, more especially in the Arabian Sea and on the west coast of India. The monsoon currents advanced, however, so rapidly into the interior that in Upper India the rains began a few days earlier than usual, establishing that the local conditions in India were favourable. (This was anticipated in the Departmental forecast published in the first week of June antecedent to the arrival of the monsoon, in which it was stated "that the monsoon currents would probably set in on the Bombay coast later than usual, but would advance into the interior more rapidly than usual.")

The monsoon currents held without any general break or interruption throughout the remainder of the month of June, and also during the whole of July and the first three weeks of August, but were less steady than usual. A larger number of cyclonic storms than usual formed in the Bay during this period, as is the rule in a weak monsoon. These storms advanced in the same general direction across a broad belt of country at the head of the Peninsula, stretching from Orissa to Gujarat and Kathiawar. The in-draught to these storms affected the distribution of the rainfall in two respects: it diminished the rainfall in Bengal and the Gangetic Plain, and distributed it more largely and copiously in cyclonic downpours over the areas traversed by these storms, viz. Orissa, the southern districts of Chota Nagpur, the Central Provinces, Berar, the south-western districts of Central India and Rajputana, Gujarat, and Kathiawar.

The following comparative statement indicates roughly but clearly the distribution of the rainfall during this period from the commencement of the rains to the end of August :—

	Province	Rainfall of period June 1 to August 31			
		Average actual (1896)	Average normal	Variation from normal	Percent. variation
		Inches	Inches	Inches	Percent.
Areas of deficient rainfall	Bengal	33·69	44·55	− 10·86	− 24
	Assam	43·91	54·53	− 10·62	− 19
	Bihar	25·67	32·88	− 7·21	− 22
	North-west Provinces ...	22·42	26·69	− 4·27	− 16
	Oudh	22·47	26·33	− 3·86	− 15
	Punjab	9·99	12·14	− 2·15	− 18
	Rajputana	13·59	16·03	− 2·44	− 15
	Central India	28·82	33·28	− 4·46	− 13
	Hyderabad, North ...	21·82	22·34	− 0·52	− 2
	Madras Deccan ...	7·62	10·08	− 2·46	− 24
Areas of increased or excess rainfall	Orissa	45·62	32·85	+ 12·77	+ 39
	Chota Nagpur	42·16	36·31	+ 5·85	+ 16
	Central Provinces ...	51·19	35·69	+ 15·50	+ 43
	Berar	24·28	24·05	+ 0·23	+ 1
	Gujarat	45·00	34·00	+ 11·00	+ 32
	Kathiawar	28·51	20·81	+ 7·70	+ 37
	Bombay Deccan ...	31·60	21·34	+ 10·26	+ 48
	Madras East Coast North	20·71	18·71	+ 2·00	+ 11

The data establish that over the broad belt of country between Orissa and the North Bombay coast, including Orissa, the Central Provinces, the Bombay Deccan, Gujarat, and Kathiawar, the rainfall of the monsoon up to the end of August was in large excess, by amounts averaging from 30 to 50 per cent. It was, on the other hand, in defect by nearly equal percentage amounts over the whole of India to the north of that belt, *i.e.*, in Bengal, Bihar, the North-western Provinces, Central India, Rajputana, and the Punjab. It is assumed in the rainfall maps prepared weekly for the Government of India that a seasonal deficiency in a meteorological district or province of 20 per cent. or upwards is large, and that the crops in such an area will be seriously affected unless the rainfall is very favourably distributed throughout the whole season. The data hence show that the rainfall during the period June to August 1896 in Bengal, Bihar, and the Madras Deccan was in serious deficiency, and that it was also in marked defect in the provinces of Assam, the North-western Provinces, the Punjab, Central India (east), and Rajputana, by amounts verging on what may be termed the danger line. It should, however, be noted that, although the rains over the greater part of Northern India were scanty, they had been on the whole favourably distributed (more especially in Bihar and Bengal), and the chief food crops in these districts only required moderate and seasonable rain during the next six or eight weeks in order to give a fair to satisfactory outturn. The rice crop in Bihar, the eastern districts of the North-western Provinces, the Central Provinces, and Bengal especially, requires fair rain in September to complete its growth. Unfortunately, the rains at this critical period, in September 1896, failed almost entirely in Northern and Central India in consequence of the abnormally early retreat of the humid monsoon currents and the prevalence of dry, clear, and much warmer weather than usual in September and October, at a time when occasional rain is essential.

The monsoon currents withdrew from the whole of Northern and Central India from four to seven weeks earlier than usual, in August and September 1896, as shown in the following table. The conditions and features of the withdrawal and retreat of the current were practically normal in all other respects. The table gives data showing the very early termination of the rains.

Province	Normal or average date of termination of south-west monsoon rains	Mean date of termination of south-west monsoon rains, 1896	Monsoon closed earlier than usual by
East Punjab ...	September 15	August 22	24 days
North-Western Provinces and Oudh ...	,, 30	,, 30	31 ,,
Bihar	October 15	September 18	27 ,,
Bengal	,, 31	,, 21	40 ,,
Rajputana ...	September 20	August 18	33 ,,
Central India ...	,, 30	,, 28	33 ,,
Central Provinces	October 15	,, 31	45 ,,
Bombay ...	,, 15	,, 31	45 ,,

The preceding data establish that the monsoon rains ceased from three to six weeks earlier than usual, and also that this acceleration was greatest in the rice-growing districts of Bengal, the Central Provinces and Bombay, where it was most prejudicial in its effect on the staple crops.

The general failure of the rains in September and October 1896, is shown most fully by the data of the following table :—

Province	September 1896		October 1896	
	Variation of rainfall of month from the normal	Percentage variation of rainfall of month from the normal	Variation of rainfall of month from the normal	Percentage variation of rainfall of month from the normal
	Inches		Inches	
Assam	− 0·23	− 2	− 3·16	− 65
Bengal	+ 0·85	+ 8	− 3·94	− 87
Bihar	− 2·38	− 28	− 2·66	− 99
Chota Nagpur	− 3·43	− 41	− 2·92	− 100
North-western Provinces	− 5·82	− 91	− 1·47	− 99
Oudh	− 6·55	− 95	− 1·59	− 99
Punjab	− 2·04	− 78	− 0·22	− 65
Berar	− 5·85	− 94	− 2·29	− 99
Central Provinces ...	− 6·45	− 79	− 1·98	− 100
Central India	− 6·12	− 93	− 1·66	− 100
Rajputana	− 2·17	− 87	− 0·26	− 89
Gujarat	− 6·28	− 78	− 1·36	− 100
Kathiawar	− 4·19	− 89	− 0·69	− 100
Bombay Deccan ...	− 4·33	− 78	− 4·19	− 84
Madras, Central ...	− 2·98	− 56	− 4·85	− 93
,, East Coast North	− 1·97	− 28	− 6·96	− 98
Hyderabad, North ...	− 5·74	− 76	− 2·43	− 89

The preceding data show clearly the very serious deficiency of rain in September and October. Thus in the month of September, the rainfall over the whole of India north of lat. 12°, with the exception of Assam, Bengal, Bihar, Chota Nagpur and North Madras, was only one-seventh or 14 per cent. of the normal amount, and in the month of October the rainfall over the whole of India north of lat. 14° was less than one-twelfth of the normal, and over the greater part of the area, including Bihar, Chota Nagpur, North-western Provinces, Oudh, Berar, the Central Provinces, Central and North Madras, Gujarat and Kathiawar, the rainfall of the month was practically or absolutely *nil*.

It will thus be seen that in the large area including Bengal, Bihar, the North-western Provinces, Punjab, Rajputana, Central India (east), the wet or south-west, monsoon crops (usually called the kharif) failed to a more or less serious extent: (1) from deficient rainfall throughout the season; (2) from the abnormally early and abrupt termination of the monsoon rainfall three to seven weeks earlier than usual. In another large area including Berar, the Central Provinces, and the greater part of the Deccan and North Madras, although the rainfall during the first three months of the monsoon was more abundant than usual, the early termination of the monsoon, about six weeks earlier than usual, affected the crops almost as seriously as in the first area, including the greater part of Northern and Central India.

The preceding discussion has shown the chief features of the south-west monsoon of 1896, which made it so disastrous a season for the staple food crops in India.

It is natural to inquire whether the deficiency of rainfall in India accompanied a greater determination of the monsoon currents towards, and hence heavier rainfall in, the remaining land areas of the monsoon region.

The chief land areas which obtain, in general, moderate to heavy rains from the south-west monsoon winds (the continuation of the south-east trades of the Indian Seas) are: (1) India; (2) Burma, Siam and the Malay Peninsula; (3) the equatorial lake region of Central and East Africa and the Abyssinian highlands.

In nine years out of ten, when the rainfall is in marked defect in Northern India, it is more or less in excess in Burma; and the monsoon of 1896 was no exception to the rule, as is shown by the following:—

Division	Rainfall from May 31 to October 17, 1896			
	Average actual	Average normal	Variation from normal	Percentage variation
	Inches	Inches	Inches	
Tenasserim	183·86	154·58	+29·28	+19
Lower Burma (Deltaic).	106·59	81·57	+25·02	+31
Arakan	161·74	156·86	+ 4·88	+3

The very limited information I have received indicates that the precipitation was also in excess in Siam.

Information of the rainfall in the third region of summer monsoon rainfall has not yet reached India. I am, however, informed that the curve showing the flood level of the Nile at the gauge stations at Assuan and at the Barrage, near Cairo, at the head of the Delta, for the past year was most unusual. Instead of having one maximum in September, as is usually the case, it presented two well-marked maxima, the first being the ordinary and absolute maximum in September, and the second an abnormal and secondary maximum in November, apparently due to heavy rainfall in October in Abyssinia. Heavy rain is reported to have fallen in the Upper or White Nile Basin in November. The defection of the humid current indicated by this fact is confirmed by the unusual and abnormal easting of the winds in October and November at the Seychelles and Zanzibar. This heavy rainfall hence occurred in the African region at the time when the retreating south-west monsoon was giving unusually scanty rain in Southern India and the Deccan.

It is also probable that the rainfall in the sea area passed over by the monsoon currents in their advance towards India may have been greater than usual. Mr. Blanford, in his monograph on the rainfall of India, has laid down the following principle: "that it is not when the monsoon current is blowing steadily that rain is most probable, but when it is defected from its normal direction by some local irregularity of pressure."

It is not possible at the present time to obtain direct evidence on this point. The rainfall of the Seychelles and Zanzibar during the period June to September of the past five years has, on the whole, varied inversely to that of the same period in India, thus slightly in favour of the assumption that the rainfall in the sea area was somewhat larger than usual during the past two years, and more especially in 1895.

So far as can be judged from the limited data available, it is almost certain that the distribution of the rainfall in the whole monsoon land region has not been compensatory, and hence that the precipitation has, from some unknown conditions or actions, been below the normal to a considerable extent, probably more than 5 per cent. of the average of the whole area. It is not possible to infer whether this deficiency has been compensated by a heavier precipitation over the equatorial belt of the Indian Ocean and over the Arabian Sea and Bay of Bengal. The data for the insular stations of Port Blair, Minicoy, Amini Devi and the Seychelles are certainly opposed to this supposition.

It is hence almost certain that the deficient rainfall in India in the past year, 1896, is only a phase of conditions and actions extending over a much larger area.

The variations in the amount and distribution of rainfall in India during the past five years, 1892-6, cannot be explained by the local meteorological conditions, either antecedent to or during the monsoon, and are, in fact, of such a character as to indicate that they are probably mainly due to corresponding variations in the strength of the south-east trades, of which the south-west monsoon circulation is the northward extension from June to October. As the strength of a steady horizontal air movement is directly related to the pressure gradients, the variations of the latter, which are approximately known from the pressure data of the Observatories at Mauritius, Zanzibar, the Seychelles, and Colombo, may be employed to indicate roughly the variations in the strength of the south-east trades from 1892-6.

The following gives the mean differences of pressure between Mauritius and Zanzibar, Seychelles and Colombo (1) for the period June to August, and (2) for the period June to October of each year from 1891 to 1896:—

Year	Mean pressure difference of period June to August		
	Mauritius to		
	Colombo	Zanzibar	Seychelles (observatory opened 1894 April)
	"	"	"
1891	·321	·071	
1892	·339	·087	
1893	·377	·104	
1894	·335	·078	·221
1895	·334	·065	·215
1896	·350	·099	·236
Normal difference...	·335	·080	·230

Year	Mean pressure difference of period June to October		
	Colombo	Zanzibar	Seychelles
	"	"	"
1891	·312	·091	
1892	·324	·102	
1893	·339	·116	
1894	·305	·090	·205
1895	·308	·075	·201
1896	·319	·105	·220
Normal difference...	·310	·095	·210

The preceding data establish conclusively that the mean pressure differences or gradients in the south-east trades region during the south-west monsoon periods of the past five years, 1892-96, exhibit a similar law of variation to that of the rainfall of India. The gradients or pressure differences were above the normal in 1892, 1893, and 1894, reaching their maximum normal in 1893, and considerably below their mean value in 1895. The figures seem to indicate that the maximum and minimum pressure effect precede by some months the maximum and minimum rainfall in India, a very important indication if further experience should show it is a general rule and not a casual coincidence.

The variations of gradient almost certainly indicate corresponding variations in the strength of the south-east trades. That there are variations in the strength of the south-east trades has been suggested by Mr. W. E. Hutchins, Conservator of Forests to the Cape Government, in explanation of the variations of rainfall from year to year in the Cape Colony. In a letter (written in April 1896), which I received from him in June, and sent for publication to several of the Indian newspapers, he says: "The absence of the south-east trades in the Cape throughout the past summer (*i.e.* November 1895 to March or April 1896) has brought abnormal summer rains to the Cape Peninsula, and drought, scarcity and locusts to the bulk of the continent, where the usual summer rains have failed. Are the south-east trades at present deficient in energy? The south-west monsoon in India is held to be an extension of the south-east trades. After what has happened in South Africa it will be interesting to note the character of the coming monsoon in India. There are two indications pointing to the failure of the coming Indian monsoon (in 1896).

"(1) The failure of the south-east rains in South Africa.

"(2) The cyclical variation of weather in South Africa."

Mr. Hutchins' anticipations were unfortunately fully verified, and confirm the probability of the relation between the varying strength of the south-east trades and the monsoon rainfall of India.

I have recently had my attention called, by Captain Froud, Secretary to the Shipmasters' Society, to the presence in large numbers of icebergs in the Antarctic Ocean, much further north than usual, off the Cape Colony coast, to such an extent, in fact, as to be dangerous to steamers following the "safety track" from London to New Zealand, adopted by several English steamer lines. One vessel met with icebergs as far north as lat. 35° N., and numbers, said to be from 400 to 600 feet above water, have been encountered by steamers during the past eighteen months, at least, in lat. 42° to 45° S., to the south, south-east and south-west of the Cape. The following give extracts from the log of the s.s. *Thermopylæ*:—

1896.	Lat. S.	Long. E.	
September 22 ...	45°	... 49°	... Passed iceberg ½ mile long and 640 feet high.
,, 23 ...	—	... —	... Very large icebergs, with perpendicular sides and flat top, ¾ mile long and 400 feet high.
,, 24 ...	—	... —	... Passed two large icebergs and many small pieces.
,, 25 ...	46°	... 70°	... Several large icebergs seen.
,, 26 ...	46½°	... 75°	... Last iceberg seen.

formerly, thereby increasing the risk of the southern passage to Australia."

Mr. Allingham, of the English Meteorological Office, has kindly supplied me with a summary, tabulated below, of the data he has collected, indicating the abnormal number and northward extension of icebergs in the south-east of the Indian Ocean during the past two years.

The following summarises the chief features of the remarkable cyclonic variation of rainfall in India during the past five years, and which culminated in partial failure of the crops and scarcity over so wide an area in 1896:—

Year	Rainfall			
	Mean actual	Mean normal	Variation from normal	Percentage variation
1892	46·18	41·09	+ 5·09	+ 12
1893	50·16	41·09	+ 9·07	+ 22
1894	47·56	41·09	+ 6·47	+ 16
1895	38·90	41·09	− 2·19	− 7
1896	36·26	41·09	− 4·83	− 12

If single stations, in the province most largely affected by the abnormal condition of the period, were selected, the contrast between the excess in the years 1892–94 and the deficiency of the years 1895–96 is very marked. The table at the top of p. 115 gives data of total rainfall of period June to October at one station in the Central Provinces, one in the North-western Provinces, and one in Bihar, in illustration of this.

At Allahabad, the headquarters of the Government of the North-western Provinces, the area most seriously affected, the total rainfall in 1894 was practically double the normal, and in 1896 barely half of the normal.

Ship	Date	Position		Number of icebergs seen	Remarks
s.s. *Thermopylæ* ...	June 24, 1895	45 S.	49 E.	12	Some 400 feet high
Armida	July 9, 1895	42 S.	43 E.	1	400 feet high
s.s. *Zainui*	July 10, 1895, to July 13, 1895	44 S.	45 E. to 45 S. 67 E.	13	100 feet to 200 high
Gainsborough ...	July 15, 1895, to July 17, 1895	42 S.	43 E. to 42 S. 51 E.	5	
s.s. *Port Chalmers* ...	July 27, 1895	45 S.	52 E.		Steamer collided with an iceberg
Queen Mab ...	Aug. 6, 1895	35 30′ S.	20 45′ E.	7	70 feet to 200 feet high
s.s. *Kaikoura*	Nov. 17, 1895	45 S.	52 E.	1	Very large
s.s. *Gulf of Lions* ...	Dec. 23, 1895	47 S.	50 E.	1	130 feet high
s.s. *Buteshire*	Aug. 5, 1896, to Aug. 7, 1896	45 S.	55 E. to 46 S. 66 E.		Several, mud loose in
s.s. *Thermopylæ* ...	Sept. 22, 1896, to Sept. 25, 1896	45 S.	50 E. to 46 S. 71 E.	30	300 feet to 640 feet high (640 feet by sextant)
s.s. *Tongariro*	Oct. 1896	45 S.	50 E. to 47 S. 80 E.	200	Some very large
Loch Fergus ...	Oct. 13, 1896, to Oct. 20, 1896	45 S.	50 E. to 46 S. 78 E.		Numerous icebergs
Firth of Lorn ...	Oct. 27, 1896	43 S.	57 E. to 43 S. 59 E.	3	300 feet high
s.s. *Otarama*	Nov. 3, 1896, to Nov. 7, 1896	46 S.	54 E. to 47 S. 77 E.	336	Mud small
s.s. *Stassfurt*	Nov. 29, 1896, to Dec. 1, 1896	44 S.	68 E. to 45 S. 79 E.	3	50 feet, 70 feet, 250 high
s.s. *Matatua*	Nov. 9, 1896, to Nov. 14, 1896	45 S.	52 E. to 46 S. 81 E.	57	One 420 feet high
s.s. *Pakeha*	Dec. 3, 1896, to Dec. 10, 1896	45 S.	50 E. to 45 S. 80 E.		Very many

The captain adds that measurements were carefully taken by the sextant when the icebergs were suitably situated near the track of the vessel.

The captain of the s.s. *Port Melbourn*, in a letter dated London, February 11, 1897, writes: "On our passage out last voyage to Albany (Western Australia), we encountered a number of large icebergs (about forty-five in all) and a quantity of smaller pieces of ice between lat. 44° S. and 45° S. and long. 49° E. and 70° E. The larger icebergs ranged from ¼ mile to 2 miles in length and from 300 feet to 820 feet in height (as measured by the sextant). It is very evident that ice in the Southern Indian Ocean now appears to work its way further north than

The data hence show that there was a strongly marked cyclical variation of the rainfall of India in this period, the maximum of which was 1893, and the minimum (probably) in 1896. In the year of maximum rainfall (1893), the south-west monsoon commenced early and withdrew much later than usual, and gave excessive rain throughout the whole period of its prevalence, whilst that of 1896, the year of minimum rainfall, commenced late, withdrew early, and gave scanty and very deficient rain throughout the whole period. The marked contrast between the two years was, it may be noted, not restricted to the south-west monsoon. In 1893 and 1894 the rainfall was above the normal in each of the four seasons into

Station	Normal rainfall in use previous to 1894	Normal rainfall in use since 1894	1892		1893		1894		1895		1896	
			Mean actual	Variation from normal	Mean actual	Variation from normal	Mean actual	Variation from normal	Mean actual	Variation from normal	Mean actual	Variation from normal
Suegor	41·03	45·67	47·21	+ 6·18	61·50	+ 20·47	69·96	+ 24·29	42·16	− 3·51	37·13	− 8·54
Allahabad	33·43	37·00	32·92	− 0·51	45·94	+ 12·51	69·60	+ 32·60	25·94	− 11·06	19·93	− 17·07
Motihari	42·52	47·60	65·16	+ 22·64	79·31	+ 36·79	43·12	+ 0·60	57·29	+ 14·77	28·84	− 18·76

which the year is divided in India, whereas from March 1895 to March 1896 it was more or less in defect in each season, as is shown by the data of the following table.

The variations in this table are calculated from the data of over 2000 stations for which normal monthly means have been calculated, and no allowance is made for the area represented by each station. The total annual variation hence varies considerably according to the two methods of calculation, but it will be seen that they agree in the general character of the cyclical variation :—

Year	Rainfall variation of whole of India (excluding Burma)				
	January and February	March to May	June to Sept.	November and December	Of whole year
	Inches	Inches	Inches	Inch	
1892	−0·37	+0·42	+4·39	−0·96	+3·48
1893	+1·42	+3·62	+3·39	+0·49	+8·82
1894	+0·53	−0·10	+7·56	+0·31	+8·30
1895	+0·04	−0·08	−3·27	−0·72	−4·03
1896	−0·45	−1·09	−3·80	+0·33	−5·01

The main features of the rainfall during this period were hence not special to the south-west monsoon, but general and affecting the meteorology of the whole year. This fact indicates that the causes of the periodic variations are not only general, but due to more or less permanent and persistent meteorological conditions or actions affecting the meteorology of the whole period over a considerable portion of the earth's surface.

It has apparently been established in the discussion that the variations of the rainfall in India during the past six years are parallel with and in part, at least, due to variations in the gradients, and the strength of the winds in the south-east trade regions of the Indian Ocean. The discussion has indicated that there are variations from year to year in the strength of the atmospheric circulation obtaining over the large area of Southern Asia and the Indian Ocean, and that these variations are an important and large factor in determining the periodic variations in the rainfall of the whole area dependent on that circulation, and more especially in India. It has also been indicated that these variations which accompany, and are probably the result in part of abnormal temperature (and hence pressure), conditions in the Indian Ocean and Indian monsoon area may be in part due to conditions in the Antarctic Ocean, which also determine the comparative prevalence or absence of icebergs in the northern portions of the Antarctic Ocean.

The economic effects of these very large variations of rainfall during the past five years has been very great, almost disastrous, in India. The variations are so large in amount, and affect so vast an area, as to suggest that meteorological science should have no difficulty in assigning the causes or chain of actions leading up to these effects. Facts have been given in the present paper which suggest an explanation, but it is doubtful whether it can be regarded as satisfactory.

There appear to be only two explanations possible of this periodicity. The first is that it represents large cumulative effects of opposite phases in different parts of the earth. So far as the whole Indian monsoon area is concerned, the variations in different parts have not been compensatory; and the rainfall in 1896 has almost certainly been below the normal, on the mean of the whole area. It would be an interesting study for a Central International Weather Bureau to investigate. So far as can be judged from a brief examination of the weather reports of other countries, there appear to have been no large and marked periodic variation in other parts of the world corresponding to the variation in India—of either the same or opposite phase. It is hence, on the whole, probable that the periodic rainfall variation of the past five years in India has not been compensated by a similar variation of opposite phases elsewhere. If it were the case, it would be purely a question of meteorological investigation.

The second explanation is that this periodic variation of rainfall in the Indian Ocean during the past five years may be one phase of general actions in the earth's atmosphere, due to abnormal variations in the radiation and absorption of solar energy, and hence to some abnormal phase of the sunspot periodicity. Perhaps the observations recorded at Solar Physics Observatories during the past five years may throw light on the question; and if such be the result, it would furnish a powerful argument for India assisting in the work of Solar Observatories to a much larger extent than she has hitherto done.

The question which now affects India most seriously is, whether the rainfall of the present monsoon is likely to be seriously in defect.

An examination of the figures certainly indicates a probability that the mean rainfall of the year will be below the normal. If the causes of the variations were known with certainty, it would probably decide the question. J. E.

THE INSTITUTION OF CIVIL ENGINEERS.

ON Tuesday, Wednesday, and Thursday of last week, May 25, 26, and 27, the Institution of Civil Engineers held a conference. This is a thing unprecedented in the annals of the Institution, it having confined itself hitherto to weekly meetings during the London season. Not only were there daily sittings, many of them proceeding simultaneously, for the reading and discussion of several papers, but there were also excursions to works and "other objects of interest." There was, as well, a conversazione; but this is no novelty for the Institution. A very large number of members attended the meetings, the Westminster Town Hall and the Westminster Guildhall having been retained for the purpose. The general plan of the conference was for one or more members to read a short note by way of initiating a discussion. As there were nearly fifty items in the programme, the congress being divided up into seven sections, it will be evident that in the small space at our disposal we cannot even refer to all the subjects brought forward.

Proceedings commenced at half-past ten on Tuesday, May 25, by the President reading a short address in the Westminster Town Hall, in which the scope of the conference was sketched out. The members then dispersed to the different sections. Section I. was devoted to railways, and the proceedings commenced by Mr. Harold Copperthwaite reading a note on rails and permanent way. He was followed by Mr. F. W. Webb, of Crewe, who read a note on the same subject. The discussion was of an entirely practical and professional nature. Mr. Webb introduced a model of a joint chair; that is to say, a device which combined in itself a rail chair and fishplate. It will be a great boon to railway travellers if this apparatus can be introduced, supposing it will fulfil all the promises made on its behalf by its originator, for there is no doubt that a very great part of the jar and rattle of railway travelling is due to the giving of rails at the joints. This fact was illustrated by means of lead fishplates, which Mr. Webb had used for the purpose of showing what was the amount of deflection at rail connections; it was considerable. The joint chair referred to is of massive construction, and care will have to be taken that too much progress is not made in the direction of rigidity, otherwise there will be repeated the old trouble experienced with stone blocks for sleepers; some flexibility is needful for a good road. In

Section II. there were also two subjects introduced, the first relating to concrete in marine works, and the second in relation to approaches of docks. Sections III. and VII. sat conjointly, the former of these two dealing with machinery, and the second with applications of electricity. Messrs. Preece, Ellington and Dr. Hopkinson contributed the notes which opened the discussion; the combined subject for the day being the transmission of power by electricity, by water, and by other agents. Mr. Ellington naturally claimed that water was superior to electricity, a statement which was equally naturally disputed by the electricians present. It is needless to say nothing definite was settled on this many-sided question. Perhaps the most interesting contribution to the discussion was that supplied by Prof. Forbes, who had come to the conclusion that the distance over which power might be profitably transmitted by electricity was not far short of 1000 miles. He had been consulted as to the transmission of power from the Victoria Falls on the Zambesi to the gold mines in Matabeleland and the Transvaal. At first he considered the suggestion altogether impracticable; but on putting together figures with a view to prove its absurdity, some ideas had occurred to him which led him to believe that the scheme was not so chimerical after all. The electrical world will look forward with interest to the development of Prof. Forbes' plans.

The proceedings in Section IV., which deal with mining and metallurgy, were of a very practical nature. The most interesting of the contributions was that by Mr. Bennett H. Brough, in which he gave some interesting particulars of deep mines in the United Kingdom. At Pendleton Colliery, near Manchester, the workings were 3474 feet below the surface, that being the deepest working in Great Britain. The deepest metal mine in the United Kingdom is the Dolcoath Tin Mine in Cornwall, which is 2582 feet deep. These figures are, of course, exceeded in mines abroad; a shaft in the copper mines of the Lake Superior district, the deepest in the world, going down to 4900 feet.

Section V. was devoted to shipbuilding. The proceedings were opened by a very instructive note by Mr. Archibald Denny, of Dumbarton, in which he dealt with the practical application of model experiments in merchant ship design. As is well known, Mr. Denny's firm have the only experimental tank of a private nature in the world, it being modelled after the design of the late Mr. Froude. Mr. Denny gave a description of the method of procedure in carrying out these model experiments. A very good discussion followed the reading of this paper, in which Mr. R. E. Froude, Sir Edward Reed, Mr. Thornycroft, Prof. Biles, Sir William White, and others took part. Section VI. was devoted to waterworks, sewerage, and gas works. On the first day of the meeting the proceedings were devoted to a consideration of the law of allocation of underground water.

On the second day of the conference, Wednesday, May 26, in Section I. (the railway section), the discussions turned chiefly on the economics of light railways. In Section III. the most interesting paper was that contributed by Mr. Bryan Donkin, on "Important Questions in the Economic Working of Steam Engines and Boilers." The author pointed out that for greater efficiency it was desirable to adopt high pressures up to 250 pounds, efficient steam-jacketing, reduction of clearance volumes in surfaces of cylinders, and a high number of revolutions. He pointed out that moderately superheated steam had long been employed on the continent, but was coming into favour here very slowly. Superheating reduces cylinder condensation, but, of course, is attended by practical difficulties, and requires more highly-skilled attendance. Mr. Donkin also impressed on the meeting the advantage of using entropy diagrams. He stated that multi-cylinder engines, with twenty or thirty expansions, are very economical, but are only admissible where the barrels and covers are thoroughly steam-jacketed, or superheated steam is used. He also advised greater compression than is generally used. He advocated the statement of economy in terms of thermal units per I.H.P. hour, and also in thermal units per break H.P. hour, whether for saturated or superheated steam. In dealing with steam boilers he pointed out the need of analyses of gases to determine the percentage of CO_2, CO, and O. He rightly stated that no boiler experiments are complete without such gas analyses. Reference was also made to the use of coal finely ground, which, it is said, was being used on the continent. The information is interesting, remembering the great efforts made many years ago to use powdered coal, and the difficulties which led to the failure of the scheme. It would be interesting to know how these difficulties had been overcome. This note concluded by an advice that all engine and boiler trials should be tabulated in uniform manner. It is satisfactory to know that the subject is likely to be taken up by the Institution. A speech which the President, Mr. Wolfe Barry, made, gives hope that a Committee will be formed to consider and report on this matter, and it is probable some legislation by the Institution will follow. In order, however, to make the Committee complete it should take a wider range than the Institution of Civil Engineers, which, although our premier engineering society, is not the only representative engineering body, more especially in regard to mechanical engineering. Petroleum as a steam-engine fuel was the subject introduced by Mr. Aspinall, the Locomotive Superintendent of the Lancashire and Yorkshire Railway. An interesting discussion followed the reading of this note, but it took rather a practical than a scientific turn. There is no doubt that liquid fuel can be used with great convenience on locomotives, and would speedily supplant coal if it could be obtained in sufficiently large quantities and at a sufficiently low price. At present it is only now and then that it can be economically used; still the Great Eastern Railway have a number of liquid-fuel-burning locomotives in fairly constant use on their system.

The Electrical Section on this day discussed two subjects—namely, "Should generating plant be mounted on springs?" and "Turbines as applied to dynamos." In regard to the former, it may perhaps be said that the gist of the discussion pointed to the fact that when generating plant has been mounted on springs, the results have not been altogether satisfactory; but, nevertheless, by mechanical improvements and alterations in detail, the system might be sufficiently perfected to enable it to be worked advantageously. The problem of using turbines was introduced by the Hon. C. A. Parsons. The subject is an interesting one, and the author was well able to deal with it had he been allowed further time. As it was, the note was decidedly meagre, and the discussion disappointing. Perhaps the paper of most interest on this day was that read in the Shipbuilding Section, by Mr. Parsons, in which he gave some particulars of the wonderful steam-turbine-driven boat which he has recently designed and built. The *Turbinia*, the boat in question, is 100 feet in length, 9 feet wide, and 3 feet draught amidships, having a displacement of 44½ tons; she is, therefore, only half the length, and of very greatly less displacement, than the torpedo-boat destroyers, which have been, hitherto, our fastest vessels. With this little boat, however, Mr. Parsons has made a speed of 32¾ knots; but he anticipates that when some alterations have been made in the machinery, still higher speeds will be reached: we believe up to 34 knots. There is a water-tube boiler and three steam-turbines working on the compound system in series. Each of these turbines has its own propeller shaft, and on each shaft there are three screws threaded in line. The most remarkable part of the machinery is that the propellers make 2200 revolutions per minute, in order that they may be worked direct from the steam-turbines, which must necessarily revolve at a high speed. The I.H.P. is 2100, and the consumption of feed water per I.H.P. per hour, 14½ lbs. The weight of the main engines is 3 tons 13 cwt., and the total weight of machinery, including water in boiler, &c., 22 tons. Thus nearly 100 H.P. is developed per ton of machinery, and nearly 50 H.P. per ton of displacement of boat; it need hardly be said that the figures are unprecedented.

On the last day of the meeting a large number of papers were read; to these we can only make brief reference. In a discussion on ball and roller bearings, Prof. Goodman gave some interesting details of experiments he had made with a bearing having an 8-inch diameter ball-race of the thrust-block type, which ran at 1600 revolutions. He had tried the system of using four points of contact between the ball and race, which had been advocated by a correspondent to a technical journal, and which was said to give the perfect rolling contact, but had found that the system would not work satisfactorily; and it was only when he fell back on the more ordinary double-contact system, that he met with success. A paper by Prof. Biles, in the Shipbuilding Section, on "Improved Materials of Construction," led to an interesting discussion, in the course of which a good deal was said about nickel steel, which is certainly the coming material for shipbuilding if the question of price can be satisfactorily settled; to effect which further deposits of nickel must be discovered and worked economically. In the Harbour and Docks Section, the Hon. R. C. Parsons described an automatic dredging machine he had devised. There was a good discussion on the decimal system, initiated by a note by Captain Sankey; and to the same section, Mr. Spagnoletti contributed a note on the equilibrium system of feeding electric railways. There were two good papers in the Railway Section: one on "Standardising of working loads and working stresses for railway bridges," and the other on "The use of small scale experiments in some engineering problems." These were contributed by Mr. Moncrieff and Mr. Mallock respectively.

THE POPULATION OF RUSSIA.

THE results of the first one-day census, which was made throughout the width and breadth of the Russian Empire on February 9 last, were expected with great interest. The last census was made in 1851, and a partial one in 1858; and yet it was not a census proper, for the local police authorities on the spot merely made lists of the permanent residents and taxpayers in each locality. After much preparatory work, it was decided to make, this year, a "one-day census"; that is, in the lists which had to be made for each house in each locality, all those persons who spent the night in a given house and in a given locality on February 9 (or about that date in the villages), had to be mentioned, whether they were permanent residents or not. It was quite a novel experiment, which was looked at with little confidence; but the Vice-President of the Russian Geographical Society, who had had already a great deal of experience with such censuses as they were made, since 1870, in separate big towns (in these censuses the illiterate population filled their lists, as a rule, admirably well), insisted upon the new method being accepted. The census was organised under his guidance, and seems, so far as can be judged, to have been quite successful. The items, obtained from all the local committees, partly by telegraph—with the exception of some parts of the province of Yakutsk—are now published; and the population of the empire appears from them as follows:—European Russia, 94,188,750; Kingdom of Poland, 9,442,590; Grand Duchy of Finland (Finnish yearly census), 2,527,801; Caucasia, 9,723,553; Siberia and Sakhalin, 5,731,732; the Kirghiz Steppes, 3,415,174; Turkestan, with the Trancaspian Region and the Pamirs, 4,175,101; Russian subjects in Bukhara and Khiva, 6412; total, 129,211,113. The corresponding figures, in 1851, were: European Russia, 52,797,685; Poland, 4,852,055; Finland, 1,636,915; Caucasia, 4,436,152; Siberia, 2,437,184; Steppes, 1,220,654; total, 67,380,645. It may thus be said that although the percentage of births is very high in Russia, it took nearly fifty years for the population to double.

An English writer about Russia made, some time ago, the remark that Russia suffers from *a polism*, that is, from a want of towns. This want has lately very much disappeared. There are now in the empire no less than 19 towns having a population of more than 100,000 (out of which two in Poland, two in Caucasia, and one, Tashkend, in Turkestan); 35 towns with populations from 50,000 to 100,000; and 69 towns with populations of from 25,000 to 50,000. St. Petersburg has already attained the figure of 1,267,023, and Moscow approaches the million (988,610).

It is worth mentioning that no less than 230,000 persons took part in the census; very many of them were volunteers, who were recruited among the students of the Universities and the High Schools.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. H. A. Miers, F.R.S., and Mr. W. Garstang, have been appointed examiners for the Burdett-Coutts Scholarship.

An examination for one or more Natural Science Demyships and Exhibitions will be held at Magdalen College in October. The value of the Demyships is £80 per annum. Candidates must be under nineteen years of age on the day of election, October 18.

The Right Hon. John Morley delivered the Romanes Lecture in the Sheldonian Theatre on Wednesday last. The subject was Machiavelli.

CAMBRIDGE.—Dr. Alex. Hill, Master of Downing College, and University Lecturer in Anatomy, has been elected Vice-Chancellor for the ensuing academical year.

Dr. R. D. Roberts has been appointed a Governor and Member of Council of the University College of Wales, Aberystwyth.

The first Smith's Prize has been awarded to Mr. E. T. Whittaker (bracketed second wrangler 1895), of Trinity College, for his essay on "Multiform Functions." The second prize is divided between Mr. R. C. Maclaurin (twelfth wrangler 1895), of St. John's College, for his essay on "Solutions of the Equation $(\nabla^2 + \kappa^2)\Psi = 0$ in Elliptic Co-ordinates," and Mr. A. E. Western (seventh wrangler 1895), of Trinity College, for his essay on "Quadratic Complex Numbers." The essays of Mr. C. Godfrey, of Trinity, Mr. T. J. I. Bromwich, of St. John's, and Mr. B. Hopkinson, of Trinity, receive honourable mention.

Mr. A. Sedgwick, F.R.S., has been reappointed a Manager of the Balfour Fund for five years. The University table in the Marine Biological Laboratory at Plymouth is to be occupied by Mr. S. D. Scott, of King's; the corresponding tables at Naples are assigned to Mr. F. B. Stead, of King's, and Mr. K. R. Menon, of Christ's.

Prof. Lewis announces a course of lectures and demonstrations in Crystallography during the long vacation. Dr. Kanthack, Deputy Professor of Pathology, will give courses in Bacteriology, in Morbid Anatomy and Histology, and in Pathology.

The Examiners for the Mathematical Tripos announce that ninety men and twenty women "have acquitted themselves so as to deserve honours."

Honorary degrees will, on June 17, be conferred on the Archbishop of Canterbury, Lord Lansdowne, the Chief Justices of England and South Australia, a number of the colonial premiers—Sir George Goldie, Sir Arthur Arnold, Sir John Kirk, F.R.S., and Sir William H. White, F.R.S.

Dr. Percy Gardner, Lincoln Professor of Archæology at Oxford, Dr. Sydney H. Vines, F.R.S., Sherardian Professor of Botany at Oxford, and Dr. H. Marshall Ward, F.R.S., Professor of Botany at Cambridge, all of whom were formerly Fellows of Christ's, have been elected Honorary Fellows of the College.

THE following are among recent appointments:—Dr. J. L. Prevost to be full Professor of Physiology at Geneva; Dr. E. Kaufmann, Privat-docent in Anatomy at Breslau, to be Professor; Dr. K. Zeisig, Assistant Professor of Physics in the Darmstadt Technical High School, to be full Professor; Dr. Max Wolters, Privat-docent in Anatomy at Bonn, to be Professor; Dr. Ludwig Heim to be Assistant Professor of Hygiene and Bacteriology at Erlangen; Dr. M. Siegfried to be Assistant Professor of Physiological Chemistry at Leipzig; Prof. A. J. Moses to be Professor of Mineralogy, and Mr. H. M. Howe Professor of Metallurgy, in Columbia University; Mr. W. G. McMillan, Lecturer in Chemistry and Metallurgy at Mason College, Birmingham, to be Assistant Secretary of the Institution of Electrical Engineers.

THE name of the Michigan Mining School has just been legally changed to the Michigan College of Mines. It is proposed to make the tuition fees approximately the same as those charged by other advanced technical schools in America. When the school was working out its policy, it was thought wisest not to charge tuition, but to collect as wide a constituency as possible in order that there might be all possible chance to make the methods as broad and thorough as could be done. It was also deemed hardly just to the students to demand tuition until the institution was much better equipped for its work than the public assistance given during the first decade of its existence permitted. Now that success has been attained in educating men for practical work, the institution seems fully warranted in charging hereafter for its instruction. The new regulation comes into effect immediately after August 19.

A ROYAL charter, dated May 11, has, says the *Educational Times*, been granted for the establishment in Sheffield of a University College. The council of Firth College, the executive committee of the Sheffield Technical School, and the council of the Sheffield School of Medicine petitioned that those institutions should be consolidated and included in one college, having for its object the provision of such an education as might enable residents in the city and neighbourhood to qualify for degrees at any of the Universities in the United Kingdom. It was represented that the endowments of the institutions were of the aggregate value of 100,000*l.*, and that there was reason to anticipate further contributions to a large amount after the incorporation of the College. The charter now granted sets forth, amongst other things, that the institution shall be known as

"The University College of Sheffield," and that women may participate in the benefits, emoluments, and government of the College to such an extent and in such a manner as the statutes of the College shall prescribe. There is to be no religious test for students, teachers, or other officers. The first president is the Duke of Norfolk, who is to hold office for five years, and be eligible for re-election. The first vice-presidents are Sir F. T. Mappin, Sir Henry Stephenson, Dr. H. C. Sorby, and Dr. Dyson.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 13.—"On a New Method of Determining the Vapour Pressures of Solutions." By E. B. H. Wade, B.A., Scholar and Coutts Trotter Student of Trinity College, Cambridge. Received April 26.

The statical methods, which have hitherto alone been capable of furnishing results between 60° C. and 100° C., have been attended with serious errors. The apparatus employed in this research was in conception similar to that of Sakurai, except that it was in duplicate, a divided steam supply passing through two U-tubes placed in parallel. It differed, however, from his apparatus in several important particulars, which cannot be adequately described in a brief notice.

Suffice it to say, that the pressure on the contents of the two U-tubes being the *same*, could be adjusted to any convenient value, and that the method of thermometry being the differential platinum one, the *difference* only of the boiling-points of pure water and salt solution, in their respective U-tubes, was recorded. Two series of observations were made at a pressure of 760 mm., in one of which a small external heat supply was used to compensate the condensation in the U-tubes, and a second in which it was found possible to dispense with it.

Neither method gives results differing systematically from the other, though the latter method was greatly preferred.

The substances examined were the chlorides of lithium, calcium, strontium, sodium, and potassium, and bromides of the two last named. A full discussion is here impossible, but we may notice that in all cases the ratio increase of boiling-point to concentration is of the same order as that calculated from Arrhenius' theory, but that the discrepancy always exceeds the experimental error, except in the case of potassium chloride, and is particularly great in the case of calcium chloride. The latter substance gave less well-defined boiling-points than the others which were investigated, for some reason as yet unknown, and the experimental error was here certainly at its greatest, but still not nearly enough to account for the difference.

May 14.—"An Attempt to cause Helium or Argon to pass through Red-hot Palladium, Platinum, or Iron." By William Ramsay, F.R.S., and Morris W. Travers. Received April 9.

A tube of hard, infusible glass was connected at one end with the reservoir of the gas under experiment, helium or argon. Into its other end was corked a tube of platinum, closed with a palladium cap, or, if iron was the metal under experiment, with a tube of thin wrought iron, also closed at the end; the closed end of the interior tube was placed so that it could be raised to a bright red heat by bringing a blow-pipe flame to bear on the hard glass tube. The open end of the metal tube was cemented to a glass tube, attached to a Töpler's pump, and provided with a Plücker's vacuum tube, so that the spectrum of any gas passing through the metal could be observed. This afforded, at the same time, a most delicate test of the presence of the gas under experiment. The metal tube was exhausted, until green phosphorescence appeared in the vacuum tube, and the gas, helium or argon, was admitted into the space between the glass and the metal tube, at atmospheric pressure. The glass tube was then heated to the highest temperature attainable with a blow-pipe—perhaps 900° or 950° C. In no case, whether the metal tube consisted of palladium, platinum, or iron, was there the smallest transpiration of gas, even after half an hour. The phosphorescent vacuum remained in all experiments quite unimpaired.

Physical Society, May 28.—Mr. Shelford Bidwell, President, in the chair.—Mr. Elder read a paper, communicated by Dr. Albert A. Gray, on the perception of the difference of phase by the two ears. The investigation relates to certain acoustical results obtained some years ago by Dr. S. P. Thompson; they may be summarised as follows: (*a*) When two simple tones in opposite phases are conveyed separately, through tubes or otherwise, to the two ears, the sensation of sound appears localised at the back of the head. (*b*) If the respective tones from two forks mistuned to give "beats" are conducted separately to the two ears, they still produce the sensation of "beats"; and, to the observer, this sensation also seems localised at the back of the head. The "beats" are distinct, but there are no true silences, at any rate so long as attention is fixed on the note. (*c*) Although "beats" are heard under these circumstances, no beat-tones are discernible by the binaural method. The author proceeds to explain the phenomena on the assumption that there is a physiological connection between the nerves of both ears. His evidence is derived from the following experiments: (*d*) A vibrating fork is held opposite one ear; the opposite ear is then closed by a finger; the sound of the fork now appears louder to the open ear. (*e*) If the fork is held opposite one ear, and the chain of ossicles of the second ear is then pressed gently inwards by a fine probe, the sound of the fork is heard with increased loudness by the first ear. (*f*) If the chain of ossicles in the second ear is dragged outwards by rarefaction of the air in the meatus, the above changes in loudness are no longer perceptible. The theory put forward by the author in explanation of these results is that they are due to reflex contractions of the tensor tympani or stapius (or more probably both) of the first ear. A further observation, of Pollak, is also brought to bear upon the question, *i.e.* (*g*) stimulation of one cochlea by sound causes contraction of the tensor tympani of both ears, and the contraction is permanent while the sound continues. This is known to be true for the lower animals, and is probably true for man. With regard to (*a*), the author observes that the muscular sense is there being appealed to in a manner quite new to it. The tympani are by nature trained each to relax or expand with the other, and they are thrown out of reckoning if the phases differ. Or, again, the stimuli from the two ears may collide at one of the lower nerve centres, and thus be annulled before any intimation has been received by the brain. The path taken by such stimuli is from the nucleus of one nerve, just after its entrance into the medulla, across to the corresponding nucleus of the opposite side. In these nuclei the stimuli from both ears mix. Some of the nerve-fibres have no nuclear intercommunication at the base of the brain; consequently, stimuli passing by these paths are not subject to interference. This agrees with (*b*), where the silences are not complete. (*h*) It is to be observed that beat-tones are sometimes perceived by the ear under circumstances where they cannot set a resonator into vibration. This indicates that beat-tones may be produced either in the ear or nerve-centres of the listener, and not exteriorly. (*i*) It has been shown by Dr. Thompson that when two simple tones, such as in ordinary hearing produce a differential tone, are led singly to the ears, no differential tone is heard. From this the author concludes that differential tones are not produced in the mind of the listener, nor in any of the cerebral centres. From (*h*) and (*i*) together, the point of production is restricted down to the ear itself; something of the sort was suggested by Helmholtz. Again, from (*g*), it appears that when two notes are sounded so as to give a differential tone, the tensor tympani must be in a state of continual contraction, for the intervals of silence are too short to permit of any relaxation. Meanwhile, there are certain periods during which the tympani membranes are not acted upon by any force external to the ear. The author is of opinion that if the movements of the ossicles upon one another were absolutely frictionless the membranes would come to rest in a position where the force of the contracting muscle was balanced simply by the tension of the membrane and the ligaments of the ossicles; but since the articulations of the ossicles have some friction, the equilibrium is otherwise, and he conjectures that the state of affairs is such that any force acting upon the hammer tending to draw it inwards, produces a slight jerk, and this repeated gives the necessary impulses for the sensation of differential tones. The mechanics of this theory is not fully worked out.—Mr. J. Rose-Innes read a paper on the isothermals of isopentane. The author takes advantage of the recent experimental work of Ramsay and Young, upon the thermal properties of isopentane, to test a formula giving the relation of pressure to temperature for gases generally, over a considerable range of volume. From the linear equation, $p = bT - a$, for the pressure at constant volume, where a and b are functions of the volume, no formula could be found to give close agreement with observed results. More definite results are obtained by examining a quantity depending upon a and b together;

such a quantity is the temperature τ, at which, for each volume, the substance behaves as a perfect gas. It is shown by tables that τ is nearly a constant for volumes from 350 to about 8. Below volume 8 it diminishes very rapidly with volume. A further investigation refers to the $[(av^2)^{-1}; v^{-\frac{1}{3}}]$ curves of Young, for isopentane, and a corresponding formula. At volume 3·4 on this curve there is a decided peak, suggesting discontinuity. Ether gives a similar curve, and the question arises whether such curves would not be better represented by two or more equations. Prof. Young said the diagrams representing the observed and calculated isothermals were probably the best ever obtained. Divergence among the values of τ was explained in part by the smallness of the angle between the theoretical isochor for a perfect gas, and the real isochor. The point of coincidence was difficult to define. Moreover, the values of τ were obtained from "unsmoothed" values of v. The evidence against the linear law consisted in a certain similarity in the shape of the different curves. It was not easy to see where experimental errors could come in. The peak was a very striking feature of the curves, and the agreement between the results with ether and those of isopentane was very remarkable. These two substances had their boiling-points close together, their critical temperatures close together, and their molecular weights nearly alike. The two substances not only agreed in each giving a peaked curve, but the peak corresponded to almost identical volumes. Prof. Young hoped at some future time to examine normal pentane, and to determine whether τ was a constant for this substance also.—The President proposed a vote of thanks to the authors of the papers, and the meeting was adjourned until June 11.

CAMBRIDGE.

Philosophical Society, April 26.—Mr. F. Darwin, President, in the chair.—On the apparent electrification in an electric field at the bounding surface of two dielectrics, by Prof. A. Anderson.—On luminosity attending the compression of certain rarefied gases, by Mr. H. F. Newall. This paper contains a description of the circumstances under which phosphorescence has been observed by the author when certain rarefied gases (initially at a pressure of about 0·01 mm. to 0·05 mm.) are compressed into a volume about one-twentieth of the initial volume. The explanation of the phosphorescence in the case when oxygen is the gas used appears to be in agreement with the explanation given by Sutherland (*Phil. Mag.*, March 1897), of anomalies observed by Bohr and Crookes in the compression and rarefaction of this gas. According to Sutherland, in the rarefaction of oxygen a point is reached (pressure 0·7 mm.) when oxygen begins to be converted into ozone, and below the pressure 0·15 mm. the gas is entirely ozone. Between the pressures 15 mm. and 0·7 mm. the gas obeys Boyle's law as oxygen, and below 0·15 mm. it obeys Boyle's law as ozone. Between the pressures 0·7 mm. and 0·15 mm. the gas is a mixture of oxygen and ozone. Sutherland is led to the view that in the compression of ozone from the lowest pressures, the ozone begins, when the pressure reaches the value 0·15 mm., to be knocked to pieces in virtue of the frequency of collision between ozone molecules being the same as that of some natural vibration in the molecule. It appears that in the phosphorescence observed by the author as arising during compression of the rarefied gas from a pressure of about 0·02 mm. to pressures lying between 0·3 mm. and 0·5 mm., the ozone is converted into oxygen, and the energy evolved is regarded as resulting in phosphorescence. It is not clear, however, what part is played in the phenomena by the impurities, but it seems certain that their presence is of importance, if not essential for the production of the phosphorescence. The spectrum emitted by the phosphorescent gas is very striking, and consists of four bright bands, coinciding with those which Schuster has described as belonging to the spectrum of the negative glow of oxygen. When the same mixture of gas is at a highe ɹpressure, it is possible to produce in it a bright phosphorescence by passing a momentary electrical discharge through it by Prof. J. J. Thomson's method. The phosphorescence is faint at a pressure of 0·6 mm., is at a maximum about 0·4 mm., and is not visible at a pressure below 0·1 mm. (These pressures vary with the impurities present in the mixture.) In the electrical production of phosphorescence in oxygen, it would appear (1) that the gas was initially mainly oxygen, (2) that the momentary discharge supplied it quickly with energy and converted it into ozone, and (3) that the ozone slowly reverted again to oxygen with phosphorescence. In this case, however, the spectrum exhibits no bright lines or bands, but is simply continuous. The author offers no explanation of the difference in the spectra in the two cases of phosphorescence, but calls attention to the probable importance of the observation in connection with astronomical matters and, in particular, with the luminosity of extended nebulæ.

PARIS.

Academy of Sciences, May 24.—M. A. Chatin in the chair.—Tools and weapons of the Copper Age in Egypt: methods and manufacture. New researches, by M. Berthelot. The objects described belong to most ancient Egyptian times, and consist of practically pure copper, no tin being present in any case. A careful examination of some copper needles, found in a tomb at Abydos by M. Amelineau, showed that they had been prepared from a thin lamina of metal, by folding over and subsequent forging. A small chisel obtained from the same place was found to have been made in a very similar manner. A hollow needle was formed from thin copper leaf, in a manner very similar to that employed at the present time in the manufacture of helical tubing for bicycles.—On some liquids contained in antique vases, by M. Berthelot. A liquid found in a flask near Rheims, probably dating from Roman times, showed that the flask originally contained a fat, into which, the flask being open, water filtered in.—Action on light upon gas mixtures, in case where it causes combination, especially on mixtures of hydrogen and chlorine, by MM. Armand Gautier and H. Hélier. No hydrochloric acid is produced from a mixture in equal volumes of hydrogen and chlorine if the latter are prepared and kept in the dark. This is the case even after prolonged exposure, one experiment extending over fifteen months. Similar results were obtained if the mixture was submitted to a very feeble illumination, such as a candle. —New study of tempests and tornadoes, by M. H. Faye. Remarks by the author on the presentation of his work to the Academy.—On the stay of General Poncelet at Saratow, by M. Germain Bapst.—New improvement of the grisometer, by M. N. Gréhant. The instrument is placed in a jacket with parallel glass sides, through which water is kept running.—The surface of cast-iron, kept at a red heat, is able to transform carbonic acid into carbon monoxide, by M. N. Gréhant.—On the elastic vibration and resistance of cannon, by MM. F. Gossot and R. Liouville.—Scientific mixtures, by M. Constant Dubois. —Remarks by M. Mascart on a catalogue of meteorological observations made in France since 1850, taken from the *Annales du Bureau central météorologique.*—On some doubts cast upon the laws of Colonel Goulier relating to the variations of length of levelling sights, by M. Ch. Lallemand. The observations cited, which are mostly produced graphically as curves, all go to confirm the accuracy of the conclusions drawn by Goulier.—On the reflection of light by a long and narrow surface, by M. Gouy. Some remarks on a paper by MM. Nichols and Rubens. —On a phosphorescent anti-anodic system, and the anode rays, by M. C. Maltézos.—On the properties of certain parts of the spectrum, by M. Gustave Le Bon. A reply to the criticisms of M. Becquerel concerning the transparency of ebonite for rays of low refrangibility.—On the precipitation of zinc sulphide in the estimation of this metal, by M. J. Meunier. The difficulties observed in the precipitation of zinc as sulphide are caused by the presence of a large excess of ammonium sulphide; they disappear if only just sufficient hydrogen sulphide is present to cause the complete precipitation of the zinc.—Remarks relating to the heat of formation of the sodium derivatives of acetylene, by M. de Forcrand. Taking into account the latent heat of fusion of acetylene, the latter being deduced from observations by Villard on the heat of formation of the hydrate $C_2H_2 + 6H_2O$, the amounts of heat developed by the successive replacements of the two hydrogen atoms in acetylene by sodium are very nearly equal, the formation of C_2HNa giving out a slightly greater amount (2 Cal.) than that of C_2Na_2.—Some new combinations of pyridine, quinoline, and piperidine with metallic salts, by M. Raoul Varet. — On the preparation of furfurane, by M. P. Freundler. The dry distillation of barium pyromucate gives a poor yield of furfurane, owing to the formation of gaseous products in a secondary reaction; but a quantitative yield is obtained on heating pyromucic acid in small quantities in sealed tubes at 260° to 275°, five grams of the acid giving in this way more furfurane than is obtained by the dry distillation of one hundred grams of the barium salt.—Solubility of ecgonine, by M. Œchsner de Coninck. The solubility of ecgonine is given for twenty-five organic solvents.—Comparative study of the changes in the respiratory quotients of fruits during ripening, by M. C. Gerber.—On the denaturation of alcohol, by M. Ernest Barillot. It is shown that the method of Dr. Lang employed in Switzerland for the denaturation of alcohol is of little use, since a simple treatment with a bisulphite, followed by a fractional distillation, is sufficient to recover 70 per cent. of the alcohol in a pure state.—On the embryonic shell of the Lamellibranchs, by M. Félix Bernard.—Disease of the branches of the mulberry in Turkey, by MM. Prillieux and Delacroix. The disease is caused by the attack of a parasite, *Sclerotinia libertiana*.—The subterranean hydrography of the Devoluy, by M. E. A. Martel.—Trophic troubles following the section of the posterior medullary roots, by M. J. P. Morat.—Influence of the stretching weight upon the heat disengaged by muscle during contraction, by Mlle. M. Pompilian.—On the antiquity of tatooing as a mode of treatment, by M. Fouquet.—Medico-legal appreciation of traumatic lesions and determination of individual identity by the X-rays, by M. Foveau de Courmelles.—On the three French balloon ascents and the third international experiment, by MM. Hermite and Besançon.—On the formation of acetic acid in a gas battery, by M. Gaudet.—On a means of stopping a leak from the outside of a ship, by M. Burgal.

DIARY OF SOCIETIES.

THURSDAY, JUNE 3.

ROYAL SOCIETY, at 4.—Election of Fellows.——At 4.30.—The Sensitiveness of the Retina to Light and Colour: Captain Abney, F.R.S.—On the Mechanism by which the First Sound of the Heart is produced: Sir R. Quain, F.R.S.—Mathematical Contributions to the Theory of Evolution. On the Relative Variation and Correlation in Civilised and Uncivilised Races: Miss Alice Lee and Prof. K. Pearson, F.R.S.—An Investigation on the Variability of the Human Skeleton, with especial reference to the Naquada Race, discovered by Prof. Flinders Petrie in his Explorations in Egypt: E. Warren.—On the Brains of Two Sub-Fossil Malagasy Lemuroids: C. I. Forsyth Major.—(1) On the Dielectric Constants of certain Frozen Electrolytes, at and above the Temperature of Liquid Air; (2) On the Dielectric Constants of Pure Ice, Glycerine, Nitrobenzol, and Ethylene Dibromide, at and above the Temperature of Liquid Air: Prof. Fleming, F.R.S., and Prof. Dewar, F.R.S.—Preliminary Communication on the Nature of the Contagium of Rinderpest: A. Edington.

LINNEAN SOCIETY, at 8.—Observations on Termites: Dr. G. D. Haviland.—On the Genus Ramulina: Prof. T. Rupert Jones, F.R.S., and F. Chapman.

CHEMICAL SOCIETY, at 8.—On the Thermo-chemistry of Carbohydrate Hydrolysis; On the Thermal Phenomena attending the Change in Rotatory Power of Freshly-prepared Solution of certain Carbohydrates, with some Remarks on the Cause of Multirotation: Horace J. Brown, F.R.S., and Spencer Pickering, F.R.S.—Optical Inversion of Camphor; Derivatives of Camphoric Acid. Part II. Optically Inactive Derivatives; Racemism and Pseudo-racemism: Dr. F. S. Kipping and W. J. Pope.—On some New Gold Salts of the Solanaceous Alkaloids: Dr. H. A. D. Jowett.

FRIDAY, JUNE 4.

ROYAL INSTITUTION, at 9.—Signalling through Space without Wires: W. H. Preece, C.B., F.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—The Origin of the High-Level Gravel with Triassic Débris adjoining the Valley of the Upper Thames: H. J. Osborne White.

SATURDAY, JUNE 5.

GEOLOGISTS' ASSOCIATION—Excursion to Cheltenham and Stroud. Leave Paddington at 10.32 a.m.

TUESDAY, JUNE 8.

ROYAL INSTITUTION, at 3.—The Heart and its Work: Dr. E. H. Starling.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Newly-discovered Stone Implements from Somaliland, and from the Lost Flint Mines of Egypt: H. W. Seton-Karr.—Anthropology in Brittany: Dr. Topinard.—Physical Anthropology of the Isle of Man: A. W. Moore and Dr. John Beddoe, F.R.S. ——*Probable* Papers: The Walloongurra Ceremony: R. H. Mathews.—Prehistoric Diamond Fields: W. H. Penning.—The Capping Ceremony in Korea: Dr. E. B. Landis.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Photographic Surveys: C. J. Fowler.

WEDNESDAY, JUNE 9.

GEOLOGICAL SOCIETY, at 8.

THURSDAY, JUNE 10.

MATHEMATICAL SOCIETY, at 8.—Models of the Regular Convex and Star Solids: W. W. Taylor.—The Calculus of Equivalent Statements (Sixth Paper): H. MacColl.

FRIDAY, JUNE 11.

ROYAL INSTITUTION, at 9.—Diamonds: W. Crookes, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.

PHYSICAL SOCIETY, at 5.—The Effect of Sea-water on Induction Telegraphy: C. S. Whitehead.—A New Definition of Focal Length, and an Instrument for its Determination: Thomas H. Blakesley.—On the Decomposition of Silver Salts under Pressure: Dr. J. E. Myers and Dr. F. Braun.—On a New Way of determining Hysteresis in Straight Strips: Dr. Fleming, F.R.S.

MALACOLOGICAL SOCIETY, at 8.

SATURDAY, JUNE 12.

ROYAL BOTANIC SOCIETY, at 4.

LONDON GEOLOGICAL FIELD CLASS.—Excursion—Coulsdon to Merstham. Lower Chalk. Leave Cannon Street, 2.17; arrive Coulsdon, 2.59.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—The Induction Coil in Practical Work: Lewis Wright (Macmillan).—Report on the Working and Results of the Woburn Experimental Fruit Farm since its Establishment: the Duke of Bedford and S. U. Pickering (Eyre).—An Essay on the Foundations of Geometry: B. A. W. Russell (Cambridge University Press).—Hypnotism and its Application to Practical Medicine: Dr. O. G. Wetterstrand, translated by Dr. H. G. Petersen (Putnam).—Abel's Theorem and the Allied Theory, including the Theory of the Theta Functions: H. F. Baker (Cambridge University Press).—A Manual of Botany: Prof. J. R. Green, Vol. 1, new edition (Churchill).—Illustrative Cloud Forms: Captain C. D. Sigsbee (Washington).—Among British Birds in their Nesting Haunts: O. A. J. Lee, Part 4 (Edinburgh, Douglas).—Lessons in Elementary Practical Physics. Vol. 3, Part 1. Practical Acoustics: C. L. Barnes (Macmillan).—Einführung in der Theorie der Analytischen Functionen einer Complexen Veränderlichen: Prof. H Burkhardt (Leipzig, Veit).—Africa, Antropologia della Stirpe Camitica: G. Sergi (Torino, F. Bocca).—Twelve Charts of the Tidal Streams near the Channel Islands and neighbouring French Coast: F. H. Collins (Potter).—Cours Supérieur de Manipulations de Physique: Prof A. Witz, deux édition (Paris, Gauthier-Villars).—Guide to the Genera and Classification of the North American Orthoptera found North of Mexico: S. H. Scudder (Cambridge, Mass., Wheeler).—Telepathy and the Sublimal Self: Dr. R. O. Mason (K. Paul).—Electric Movement in Air and Water, with Theoretical Inferences: Lord Armstrong (Smith, Elder).—The Outlines of Physics: Prof. E. L. Nichols (Macmillan).—Formation de la Nation Française: Prof. G. de Mortillet (Paris, Alcan).

PAMPHLETS.—Längenänderung und Magnetisirung von Eisen und Stahl: G. Klingenberg (Berlin, Simion).—Ueber den Gebrauch der von Prof. E. v. Federow, herausgegeben Stereographischen Netze (Leipzig, Engelmann).—Homogene Structuren: Barlow (Leipzig, Engelmann).

SERIALS.—Botanische Jahrbücher, &c., Vierundzwanzigster Band, 1 Heft (Leipzig, Engelmann).—Proceedings of the Royal Society, Edinburgh, Session 1896-97, Vol. xxi. No. 4, pp. 249-312 (Edinburgh).—Humanitarian, June (Hutchinson).—Natural Science, June (Page).—Chambers's Journal, June (Chambers).—Contemporary Review, June (Isbister).—National Review, June (Arnold).—Century Magazine, June (Macmillan).—Astrophysical Journal, May (Chicago).—Notes from the Leyden Museum, Vol. xviii. Nos. 2, 3, 4 (Leiden).—Scribner's Magazine, June (S. Low).

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