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A GREAT NATURAL PHILOSOPHER.

Life and Scientific Work of Peter Guthrie Tait. By Cargill Gilston Knott. Pp. x+379. (Cambridge: University Press, 1911.) Price 10*s.* 6*d.* net.

TWO large quarto volumes of Prof. Tait's collected papers were published some time ago by the Cambridge University Press, and these have now been supplemented by an exceedingly interesting account of Tait's life and work, from the pen of his pupil and friend, Dr. C. G. Knott. Every Edinburgh student must recognise the fidelity of the picture which Dr. Knott has drawn, and feel that his book is in all respects a worthy memorial of the great Edinburgh professor. The book will appeal very directly to many of the readers of NATURE, who remember the searching and trenchant reviews of books on physical mathematics, and the articles on such subjects as the physics of golf, and on questions connected with physical mathematics, which appeared in these columns from time to time, and were signed with the initials "P. G. T." Many of these less formal papers were of much scientific interest, which was not lessened by the eminently human personality of the writer, which appeared in every sentence, and the humour, a little grim at times, with which he illustrated or drove home his conclusions.

In a review of Tait's "Thermodynamics" in NATURE (January 31 and February 7, 1878, vol. xvii.) Clerk Maxwell said, "Science has enough to do to restrain the strong human nature of the author, who is at no pains to conceal his own idiosyncrasies, or to smooth down the obtrusive antinomies of a vigorous mind into the featureless consistency of a conventional philosopher." These words are a true description of Tait, the outspoken and uncompromising controversialist, the critic unsparing of error, but not without regard for the feelings of the advocates of views which he combated or denounced, the philosopher who said hard things regarding professed metaphysicians, but who thought of the foundations of dynamics and did not disdain to adduce metaphysical considerations for the justification of a fundamental principle of quaternions. Such men are rare at the present time. Everybody is superficially and laboriously polite; the old broadsword play of word and phrase is too often replaced by suggestion and innuendo. But a good knockdown blow or cut is better than a sting that empoisons the blood and festers.

Tait was a native of Dalkeith, near Edinburgh, and studied his rudiments in the grammar school of that town. At the age of ten, on the death of his father, he was brought with the family to the city in which his life-work was to be done, and became a pupil of the Edinburgh Academy, a day school which from its foundation in 1824 has always been famous for the soundness of its classical and mathematical instruction. There he had as schoolfellows Clerk Maxwell, Lewis Campbell, Fleeming Jenkin, and several others who achieved eminence or fame in after life. Maxwell was his senior by a year. It is foolish to attach very great importance to school examinations—some minds begin to mature sooner than others—but it is interesting to note that Tait, Campbell, and Maxwell seem to have been nearly equally distinguished in mathematics. All were soundly drilled in classics; the rector of the academy was an eminent classical scholar—the Ven. John Williams (curiously enough at the same time Archdeacon of Cardigan), who was chosen first rector in 1824, mainly at the instance of Sir Walter Scott. Tait had an excellent verbal memory, and used in after life to repeat much Greek and Latin poetry learned in the forms of the academy.

It is rather remarkable that at the University of Edinburgh neither Maxwell nor Tait excelled the best of their fellow-students in natural philosophy. Perhaps in music alone does early precocity precede the highest excellence in maturity; but then musical genius is much less dependent on the ripening of the logical powers. For original work in mathematics and physics a natural gift or instinct is, of course, essential.

Tait's career at Cambridge, and his initiation in the following years into experimental work in the laboratory of Dr. Andrews at Belfast, were incidents in the scheme of things which led to his return to Edinburgh in 1860 as the successor of Forbes. Tait entered at Peterhouse in 1848, Maxwell in 1850, but afterwards migrated to Trinity, and both, like Thomson (afterwards Lord Kelvin) before them, had William Hopkins as their private tutor. Each had his own strong personality, but the influence of that great teacher seems to have been of the best possible kind for the minds of all. Tait was Senior Wrangler and First Smith's Prizeman in 1852, and his first act when the Tripos result was declared was to telegraph home and ask that the news should be told to Gloag, his old mathematical master at the academy.

While professor of pure mathematics in Queen's College, Belfast, and working in the laboratory of Dr. Andrews, he was introduced by Andrews to Rowan Hamilton, at that time in the full tide of his quaternion work, and busy with the preparation of the "Elements" for publication. Then began an interchange of letters on quaternions, of which Dr. Knott, *con amore* as himself an ardent and accomplished quaternionist, has given a most interesting account. Apparently Tait's first letters, which were chiefly on difficulties raised by his perusal of the "Lectures on Quaternions," attracted Hamilton's attention to the writer as one likely to cultivate the new calculus and extend it to fields of physical research. Hamilton's own applications were mainly geometrical; Tait saw in quaternions a powerful instrument for the dynamical study of various branches of physics, which, in fact, placed at once in a new light all that analysis, applicable to so many different problems, in which Green's analytical theorem plays a prominent part. The result was his paper on Green's theorem, and, later, many of those physical investigations which form the latter part of his "Treatise on Quaternions."

Hamilton was a willing and voluminous correspondent, and his letters (the first was forty-five pages long, divided into thirty-two paragraphs), here printed, so far as they are quoted, with all the italics, small capitals, &c., which he used, even in his books, to mark different degrees of emphasis, abound in acute and suggestive remarks, which were no doubt due to the inspiration of the moment. The humour which he displays here and there, as in his "mortal leap from Chaucer to Moigno," and his description of the Abbé, is of a truly Irish flavour, and has the merit of unexpectedness.

The absence of quaternions from Thomson and Tait's "Natural Philosophy" has been the subject of some remark. It is now well known that the senior author could not be convinced that the quaternion calculus, or indeed any form of vector analysis, was of advantage in physical work. To this conservative view he adhered to the end of his life, and in a private letter of his later years, written, as he described it, politely and mildly as to a stranger, he states his adverse opinion with remarkable vigour. And there is the letter to Chrystal, quoted by Dr. Knott on p. 185, on the thirty-eight year war over quaternions.

It is somewhat remarkable that vectors should have led to so much correspondence of an animated sort. The respective merits of quaternions and the systems of Grassmann and others seem not merely to have kindled the intellects, but to have stirred the emotions of the various advocates to a surprising extent. The playful paraphrase by a physicist of the famous saying of Tertullian into "Behold, how these vector-analysts love one another!" suggests with a touch of irony that after all the differences may not be so fundamental as they appear, that perhaps each sees the truth, and may safely be left to fight its battle in his own way. Let each go on using the armour and weapons he has proved; no man can tell to whom the victory may be; perhaps after all to someone whose equipment seems lamentably inadequate. But nobody can help admiring the steadfast fidelity of Tait to the notation of the master, and his chivalrous defence of quaternions against all comers. He had a right to speak with authority: no man with the exception of Hamilton himself did more for quaternions or with them. And if the linear vector function ever yields its whole secret to the student of vector analysis, it will be because Tait has made the disclosure possible. Often light suddenly comes to a man who has turned a subject over in his mind for weeks or months or years. It is surely also possible that one explorer may enter into the labours of another, and quickly behold the promised land which the instinct and faith of the first pioneers told them lay beyond the mountains.

Cambridge had no more systematic student than Tait, and no university had a more faithful and duty-doing professor. The work to hand, the daily task, the common round of teaching, it was his joy to perform. In the opinion of some it is waste to keep such a man lecturing to elementary students; but Tait inspired his students, and that was surely a very great thing. As a lecturer on experimental physics he was well-nigh unapproachable; and he was well aided by his mechanical assistants, who understood his methods and knew that he could be depended on to take everything in the carefully thought-out and prearranged order. Without such order and close adherence to it, no man, however eminent, however great his genius even, can teach a university class effectively.

In his introductory and other occasional addresses, Tait often dealt with more or less controversial subjects. The tract which he wrote on "Thermodynamics" contains a sketch of the theory of energy, in which questions of priority of complete logical proof, for example, Joule's establishment of the equivalence of heat and work, are discussed with great force and cogency of argument, albeit with a dash of patriotism. Such things he also discussed in his popular lectures and lighter papers. His book on "Recent Advances in Physical Science," was a course of such lectures, taken down by a shorthand writer, and carefully revised. Its title is out of date now, but as a clear statement of the true foundations of the science of heat, and of the work done by Joule, Kelvin, Balfour Stewart, and others in that field, it cannot be excelled.

In thermodynamics he insisted always on the importance of Kelvin's idea of absolute temperature. Kelvin was undoubtedly behind Clausius in accepting the consequences of the equivalence of heat and work; but when his first scruples had been overcome, and Carnot's function had disappeared in the idea of absolute temperature, the scheme of relations of heat and work stood forth in a logical clearness, which no other mode of treatment has ever approached. The imperfectly specified thing called a "perfect gas," by means of which temperature is defined in many continental treatises, he cordially disliked, and he lost no opportunity of denouncing the treatment founded upon it. In the cause of accuracy Tait was zealous almost to slaying. No one who heard his lecture on "Force," to the British Association at Glasgow in 1876, will ever forget his dramatic denunciation of slipshod popular science and its professors.

Tait's association with Kelvin in the composition of the "Natural Philosophy" has been referred to. Not the least interesting chapter in Dr. Knott's book is the account of this collaboration. The two men had much in common, they were both pupils of Hopkins, their great mathematical power and sure physical instinct well fitted them to work together, but in other respects the combination was not so successful. Tait was orderly and methodical—that can be seen in his neat penmanship and clear and precise composition, which was fit, with scarcely an erasure or substituted word, to be sent to the printer. On the other hand, the perusal of matter in clear print on a proof-sheet, showed Kelvin so many opportunities of extension and amendment, that he immediately overflowed in new sections on the margins, to the dismay of the printers, and the augmentation of the bill of costs. Then Kelvin had so many irons in the fire; his thoughts were being carried away continually from the "Natural Philosophy," and that, of course, stood

still, for there come times when one partner in such an enterprise cannot advance without the other. No wonder the book stopped at the end of the first volume.

For many years Tait was the general secretary of the Royal Society of Edinburgh, and of the 365 papers, the titles of which are enumerated in Dr. Knott's bibliography, by far the greater number were communications to the society's Proceedings or Transactions. Unlike most secretaries of learned societies, he was himself the most prolific contributor.

He never joined the Royal Society of London, though he was a royal medallist in 1886, and was often asked to allow his name to be submitted. Indeed, his heart was in Edinburgh and his work there. For the last twenty-five years of his life he never crossed the Tweed; the only occasions on which he left the city were his visits to St. Andrews, ten days in spring and six weeks in autumn, with one exception, when he went to Glasgow to deliver a lecture on thunderstorms.

Though not himself a great golfer, he was the recognised authority on the physics of the game. His explanations of the "carry" of a golf ball, of the action of toeing, heeling and slicing, all examples of his theory of the effect of spin, stood the severe test of his own experiments, and are beyond cavil. His papers on this subject—in NATURE and elsewhere—would form an interesting book on the dynamics of a spherical projectile in air, if they were collected.

Failing health, and the death of his son, Lieut. F. G. Tait, the great amateur golfer, at Koodoosberg in 1900, brought the toil of his strenuous life to a close. But at the last, only two days before his death, he was busy with his beloved quaternions, and wrote a sheet of notes of investigations on the linear vector function.

This notice is already too long, and yet nothing has been said of Tait's work on thermoelectricity, on mirage, or of "The Unseen Universe," and the "Paradoxical Philosophy." The two last-mentioned works, written in conjunction with Balfour Stewart, are interesting as an attempt to apply the principle of continuity to infer, and to some extent explain, the existence of an unseen system of things to which in some sort we stand in physical relation. Incidentally they show the strong yet unobtrusive religious faith of their authors. A. G.

AUSTRALIAN PLANTS.

Australian Plants Suitable for Gardens, Parks, Timber Reserves, &c. By W. R. Guilfoyle. Pp. 478. (Melbourne and London: Whitcombe and Tombs, Ltd., n.d.) Price 15*s.* net.

THIS work, prepared, as we learn, at the request of a special committee, embodies the practical experience of its author during the past thirty-six years. Except for some five-and-twenty pages of preliminary matter, the book is not one that admits of being read. But this fact in no way detracts from its merits as a work of reference, or lessens the debt to Mr. Guilfoyle of Australians who care either for gardening or for Australian plants. The feeling, its author explains, which has inspired its publication, is a desire to arouse increased enthusiasm in regard to the native species. The introduction should at any rate have the effect of directing the attention of his compatriots to the fact that Australia is richly endowed with what is wonderful and beautiful in the vegetable kingdom. If it does have this effect, it will have well served its purpose, since all that can be needed to evoke the enthusiasm which is desired is some intelligent attention to the plants themselves.

Granted the existence of such enthusiasm the work before us must prove invaluable in guiding and controlling it. That some control will be needed an examination of Mr. Guilfoyle's lists abundantly shows. The value of the lists for this purpose is enhanced by the self-restraint which has enabled the author to confine to a couple of lines references to individual plants which those who are not themselves Australians would gladly have seen expanded to as many pages.

It is scarcely strange that the inhabitants of an autonomous State like the Australian Commonwealth should be less enthusiastic over their native plants than the inhabitants of Britain. The wattles and gums, the myrtles and honeysuckle trees, the Boronias, Brachycomes, and Epacrids of Australia do not yet arouse feelings and memories so keen as those aroused by the oak and thorn and gorse, the primrose or the daisy or the heather of Britain. There is, however, more than the mere absence of literary allusion or historical association to account for the fact. In Australia the number of forms capable of awakening interest or provoking admiration is so immeasurably greater than in Britain that the observer's attention is distracted. Even where, in spite of greater or less botanical differences, the plant-forms of the two countries are sufficiently alike to be comparable from an æsthetic point of view, as, for example, in the case of the Epacrids or Australian heaths and our familiar ling, the manifest superiority of the Australian plants scarcely suffices to produce the expected effect. Perhaps the fact that the enthusiasm of the Australian has to be extended to a dozen different forms, while we can concentrate ours on one or two, may be some explanation. Should Mr. Guilfoyle's own enthusiasm enable his fellow-countrymen to overcome this difficulty, he may truly be said to have deserved well of the Commonwealth.

The attempt made in a special list to bring some order out of the chaos which prevails in respect of the common names applied to Australian Eucalypts in different parts of the country, deserves especial attention. How great the prevailing confusion is will be readily appreciated if the Eucalyptus names recorded in Mr. Gerth van Wijks's "Dictionary" be examined. Mr. Guilfoyle's courage in endeavouring to deal with this troublesome question compels our admiration. It is perhaps too much to expect that everyone all over Australia will be willing to abandon the use of names to which they personally have become accustomed, and to be guided by what, after all, must at best be a somewhat eclectic set of substitutes. But if in this particular matter it can scarcely be hoped that Mr. Guilfoyle's action will receive the universal approval

of his own generation, there is no doubt that some such action, if only on grounds of public convenience, is necessary, and it is more than probable that Australians of another generation will be grateful for the prescription of a stereotyped list of names.

THE CHEMISTRY OF CALCAREOUS CEMENTS.

The Chemistry of Testing of Cement. By Dr. C. H. Desch. Pp. xi+267. (London: E. Arnold, 1911.) Price 10*s.* 6*d.* net.

THE "cement" treated of in this volume is the group of calcareous cements—that is, the plastic materials employed to produce adhesion between stones and bricks in the construction of buildings and engineering works. The book deals, shortly but clearly, with the manufacture of the various kinds of calcareous cements, with their components, constitution, and properties, and with the mechanical and chemical methods of testing them.

Owing to the extending employment of concrete the production of cement is becoming more and more important, and the demands upon its qualities increasingly stringent. These more exacting requirements have so far been met with a remarkable degree of success, partly by improvements in mechanical processes, but also to no small extent through the co-operation of the chemist. For two reasons the services of the latter are likely to become of yet greater value in the industry. On one hand a still higher standard of quality may be demanded in the finished product, and, on the other, a larger variety of raw materials may be found to be utilisable in the production.

The complex character of the substances entering into the composition of calcareous cements, and the obstacles in the way of ready experiment with the products, have in the past greatly limited our knowledge of the chemical reactions which occur in the making and "setting" of these bodies. In modern practice, however, two things are helping to shed light upon the dark places. One is the introduction of "etching" methods, similar to those employed in metallography, for studying the structure of cements in their various phases; the other is the conception of cements as, essentially, colloids. Both these matters are fully explained and their importance emphasised in the volume before us.

The view adopted by the author as to what takes place during the setting of Portland cement is substantially that of Dr. Michaëlis. Assuming for the purpose of discussion that the cement materials consist of lime, alumina, and silica only, then the essential hydraulic constituent, alite, is formed from these by the action of heat during the process of manufacture. It is regarded as a solid solution of calcium silicates and aluminates. When water is added to the cement, it partly decomposes the alite, hydrolysing the aluminates in the first instance. The solution thus produced is a supersaturated one, and it presently deposits tricalcium aluminate. According to the quantity of water in the mixture, the deposit is either mainly colloidal or mainly crystalline; if the proportion of water is small it favours the production of a colloidal "gel." The excess of lime above that required for tricalcium aluminate remains in solution, or a part may be deposited as crystals of calcium hydroxide. This process is regarded as probably corresponding with the "initial set" of the cement.

As regards the subsequent gradual hardening, the argument is that water acts much more slowly on the calcium silicate contained in alite than on the aluminates, but when hydrolysis does occur the calcium silicate separates out in the colloidal form. The gel thus produced forms a coating round the cement particles, protecting them from further direct action of the water. But as the latter slowly diffuses through the colloidal coating, more and more of the alite is slowly hydrolysed, and the lime set free is absorbed by the gel, which thereby increases gradually in density and hardness, and loses its plastic qualities. To this gradual desiccation of the gel, which takes place even when the cement is immersed in water, is due the eventual hardening of the mass.

Evidence for the actual existence of colloid products in hardened cements is found in the fact that some of the components can be stained with eosin. Etching with acids shows the structure of the unchanged cement in the interior of the particles, around and between which lies the dyed colloidal gel.

The volume embodies the chief results of modern inquiries into what is admittedly a difficult subject. It is written in a true scientific spirit, and would be an excellent book to place in the hands of a chemist with progressive ideas, who wishes to study carefully the chemistry of calcareous cements. C. S.

GEOPHYSICS.

Physik der Erde. By Prof. M. P. Rudzki. Pp. viii+584. (Leipzig: Chr. Herm. Tauchnitz, 1911.) Price 14 marks.

THE course of lectures at the University of Cracow published by Dr. Rudzki in the book under review covers a wide range. The subject-matter lies on the border-line of astronomy, mathematics, geography, and geology, and the lectures have coordinated these different sciences very successfully. By readers in this country, where specialised studies so largely cramp workers into one narrow domain, the book should be greatly appreciated. It is much to be desired that more opportunity could be found for similar work in British educational methods; for those who agree with this view Dr. Rudzki's work will prove a useful stimulus.

In saying that the lectures have successfully coordinated the different subjects represented, the reviewer does not wish to suggest that the treatment is necessarily the happiest from the point of view of a student in this country. For instance, while the mathematical reader will find much to interest him and very little that he cannot follow in the subjects outside his own domain, he will find the mathematical part of the work occasionally incomplete or sketchy. At the same time the reader who is not a professed mathematician must frequently find the mathematics

beyond his reach. Rather more or rather less mathematics would probably suit a larger class of students. A second weakness of the book, and one which robs it of some value as a systematic treatise, lies in the somewhat arbitrary way in which certain branches of geophysics have been neglected, while others have been accorded very full treatment.

In general, however, the ground has been very thoroughly covered. Many valuable references are given throughout, and save for the last few years they seem very fairly complete. In his preface the author refers with regret to several interesting investigations which have appeared too late to be made use of in the text of the book. The reviewer has found few instances of work overlooked. Taking the work of this country alone—work which has in general received a full and generous treatment—the only important omissions that he has noted have been some of the investigations on wave problems of Prof. Lamb and the scientific results of Sir Ernest Shackleton's last Antarctic voyage. But all students reading the book must find many references which will be new to them, and the book has been made more serviceable by a useful index of authors and subjects.

Throughout the whole range of subjects considered—and there are included geodesy (practical and theoretical), seismology, isostasy, and the theories of tides, ocean currents, waves, seiches, rivers and glaciers—the treatment is fresh and full. As a type of the questions discussed in a most interesting manner the winding form of a river-bed may be selected for mention, also the problem of glacial epochs and the differing views as to the nature of the earth's interior. The general answer which Dr. Rudzki gives to the solutions so far offered for most of the problems he discusses is "Not proven," and no fault can be found with him for adopting so cautious a position. The book is replete with suggestions of unsolved problems, and would supply fruitful reading to many a student on the look out for a piece of research off the ordinary lines.

F. STRATTON.

THE EVOLUTION OF MAN.

(1) *Anthropogenie oder Entwickelungsgeschichte des Menschen, Keimes- und Stammesgeschichte.* By Prof. E. Haeckel. Sechste Auflage. Erster Teil, Keimesgeschichte des Menschen. Pp. xxviii+432+xvi plates. Zweiter Teil, Stammesgeschichte des Menschen. Pp. x+(433–992)+(xvii–xxx) plates. (Leipzig: W. Engelmann, 1910.)

(2) *Der Mensch: sein Ursprung und seine Entwicklung.* By Prof. W. Leche. (Nach der zweiten schwedischen Auflage.) Pp. viii+375. (Jena: Gustav Fischer, 1911.) Price 7.50 marks.

(1) BOTH these books are popular treatises discussing "man's place in nature" (to use the title of their English prototype), his origin, and development. They cover practically the same ground, and both aim at presenting the results of highly technical biological investigations in a form that will be intelligible to the educated layman. Nevertheless there is a marked contrast between them, one that in a measure reflects the influence of the difference in the attitude of the educated public towards the problems of evolution and the descent of man thirty-seven years ago and now. One of them is a weapon, forged in times of struggle, for the purpose of carrying offensive operations into the camp of those who were using every influence that casuistry and sentimentality could arouse to discredit Darwin and all his works. The other was written in more peaceful circumstances, long after such foolish animosities were buried, as one of the innumerable series of tributes which every country and class united in paying to Darwin's memory, on the occasion of the fiftieth anniversary of the publication of "The Origin of Species," two years ago.

This is the sixth edition of Haeckel's famous book. It first saw the light in 1874, in the days when the mere suggestion of the idea of evolution, in reference to man, was still regarded as "insulting" by many people. Its author was the most ardent and combative upholder of evolutionary ideas on the Continent, and he made no attempt to soothe the susceptibilities of his readers, preferring rather to set forth unpalatable views in the frankest and certainly not the least distasteful way. The book was originally flung as a challenge to the opponents of Darwinism, who replied by describing it as "a fleck of shame on the escutcheon of Germany."

Since then a vast change has taken place in the attitude of educated men towards the problem of evolution; but Haeckel has made surprisingly few changes in his book. From time to time, in the various successive editions, he has added liberally to the supply of illustrations, and tacked on a variety of tit-bits of new information, such as references to Pithecanthropus, the recent work on "the demonstration of the blood-relationship" of apes and man, and the results of investigations on the fate of the tail in man; but these are mere scraps of corroborative detail—embellishments to the edifice built in 1874, without altering the plan of the building or enlarging its dimensions. The great modern movements of biological thought in reference to heredity and evolution, and the results of recent morphological research, have made little or no impression upon Haeckel's book; its scope has not been enlarged to include the new learning; in spite of its veneer of modernity it is still a typical product of thirty years ago. But it is a wonderful tribute to its excellence that a book which does not claim to represent the present state of knowledge should maintain its position in competition with more recent works; it has, in fact, now attained the venerable rank of a classic.

The present edition is little more than a reprint of the fifth edition, which has appeared in an English translation. Slight additions have been made to the accounts of Amphioxus and the embryology of the chick, and a few more illustrations have been inserted; but these are mostly taken from old sources.

The author does not even provide a new preface; but in his introduction to the previous edition (1903) he frankly admitted that the literature relating to the problems discussed in his treatise had become so

extensive and intensive that he made no pretence of keeping pace with it.

(2) Prof. Leche's book made its first appearance in Swedish at the time of the Darwin celebrations in 1909, and when the time came for the preparation of a second edition he made his interesting work available to a wider circle of readers by issuing this German edition.

The book is a simple and lucid description of the growth of evolutionary ideas, with an account of the men to whom we are indebted for this new learning.

Unlike Haeckel's treatise, which takes the form of lectures addressed to students of biology, but in virtue of its lucidity has become, nevertheless, a popular treatise, Leche's book is obviously written for the educated public in general, and therefore omits certain topics discussed by Haeckel, which are properly included in a treatise on biology, but not in works for wider circulation.

It is somewhat disappointing to the biologist familiar with the author's important contributions to comparative anatomy that Prof. Leche should have chosen to cast his book in so popular a mould. It would have been instructive to have had more information concerning the higher primates from one who is so great an authority on the other end of the mammalian phylum. But Prof. Leche has chosen the *rôle* of expositor, mainly of other people's work, and we are duly grateful for his clear statement of generally accepted views regarding man's origin and developmental history.

The book opens with an exposition of the growth of the theory of evolution, with an account of the work of Charles Darwin, his predecessors, co-workers, and followers, and it discusses the modern conflict between the teaching of Weismann and "Neo-Lamarkismus," expressing the opinion, for which he claims the support of Darwin himself, that the origin of species can be explained only by admitting the potency of the essential factors emphasised by both schools.

The second chapter is a simple exposition of man's place in the vertebrate series, explained by reference to the facts of comparative anatomy and embryology. Chapter iii. gives an account of the nature of the palæontological record, and deals at some length with the histories of the various vertebrate groups that have been recovered by this means, most of the space devoted to mammals being filled by the familiar story of the horse. The next three chapters deal respectively with man's structure as illuminated by comparison with that of other vertebrates; the light thrown on man's development by comparative embryology; and the nature and significance of rudimentary organs in the human body, the pineal body, the third eyelid, the palatal ridges, the coccyx, superfluous hair and teeth, and the vermiform appendix being the vestigial structures selected for discussion. There is a brief chapter on the brain, which can scarcely be considered adequate when it is remembered that it is the organ which has played the chief part in making man what he is.

The closing chapters are perhaps most useful to the zoological reader. They deal with man's nearest relatives, the primates, fossil-man and Pithecanthropus.

It is gratifying to find that Prof. Leche lends the weight of his support to the view, first set forth in NATURE in the year 1907, that Tarsius is the slightly specialised living representative of a very primitive group of primates, from which the lemurs and the apes were derived by specialisation along divergent lines; that in this sense Tarsius is the connecting link between these two suborders, because it is the least modified descendant of the common parents of all three suborders of primates.

There is a very useful summary of the circumstances of the discovery of the remains of Palæolithic man and Pithecanthropus, with an unbiassed account of the nature and significance of these much-discussed relics of fossil-man. In the chapters dealing with this subject he follows Schwalbe in most matters, and describes the recent trend of opinion on the Continent in reference to Palæolithic man, without committing himself, however, to any of the extreme views that are so much in evidence at the present time.

The volume closes with a brief statement in reference to certain points in the anatomy of modern man that have some wider significance of racial or sociological importance.

Prof. Leche's book can be heartily recommended as a calm and dispassionate summary of the present state of our knowledge of the structure of man, as it is interpreted by comparative anatomy. G. E. S.

GEOLOGY AND BUILDING STONES.

(1) *The Geology of Building Stones.* By J. Allen Howe. Pp. viii+455. (London: E. Arnold, 1910.) Price 7*s.* 6*d.* net.

(2) *British and Foreign Building Stones: a Descriptive Catalogue of the Specimens in the Sedgwick Museum, Cambridge.* By John Watson. Pp. viii+484. (Cambridge: University Press, 1911.) Price 3*s.* net.

(1) THERE has long been a demand for a book such as that now produced by Mr. Howe. It would be well for all architects, and also engineers, to go through some short course of geological training, leading up to the understanding of a geological map. Mr. Howe has to meet those cases where no preliminary work has been possible, and he describes in a clear manner the essential characters of rock-forming minerals. Quaintly, but properly enough, he includes ice, the mineral most utilised by the Eskimo. Knowing as he does the utility of the microscope, he introduces extinction angles in the table of the felspars on p. 20, but these are left unexplained, and the variation in the angle between the cleavages would surely be more interesting to the beginner. Thin sections of typical rocks are well illustrated in the later pages. The work of Dr. Flett, Mr. Lovegrove, and the author, has probably introduced the microscope to many "practical" men with good effect.

The classification of rocks employed is commendably simple. Trachyte seems to have slipped out of the table on p. 43, as a parallel with rhyolite and andesite, though it is described on p. 103. Mr. Howe

does very well in avoiding local and specialised rock-names, though we suppose "kentallenite" (p. 89), the incorrect but accepted use of "granophyre" (p. 92), and "keratophyre" could scarcely be kept out. A large part of the book is naturally devoted to sedimentary rocks, and no reader will fail to appreciate their structure, and the interesting way in which structure records their modes of origin. The treatment of slate is an excellent example; we note that chemical composition is here so dominated by the compactness and by the fissile structure of the rock as to have no effect on relative durability (p. 287). Limestones are also adequately dealt with, the important oolitic stones of England being described in considerable detail. Among sandstones, we may direct attention to the interesting account of the Surrey "firestone" on p. 166. There is much in this book which will enable the professional geologist to give a "practical" touch to his teaching, and thus in turn to attract the technical student towards the broader aspects of geology. One of the chief rewards of the instructor in a modern college is to note the pleasure aroused when some familiar feature is explained. The "practical man" may know a good deal already about a stone, but he now sees it taking its place in the history of a world of stones.

Mr. Howe's chapter on the decay of building stone is especially to the point. He uses chemical symbols at times in his text in place of words, which is scarcely literary; but he shows well how sodium chloride and other salts increase the attack of rain-water on a stone, and how the acids liberated in towns also play their destructive part. A special section is devoted to the decay of limestones. The deleterious formation of gypsum in parts of buildings sheltered from the rain, or even beneath rain-washed surfaces, is impressively pointed out. Crystalline dolomites (p. 353) decay in the country through the more rapid solution of any calcite granules that are present, while in towns a worse evil befalls them, from the fact that magnesium sulphate is even more soluble than gypsum. The sulphuric acid in towns, of course, arises from the iron pyrites contained in coal. Mr. Howe's remarks as to our love for limestone (p. 9) should be taken to heart by architects.

There is a useful chapter on the testing of stones; but we question if the appendices which follow, containing lists of quarries, were worth compiling in view of the far more complete lists issued by the Home Office, and referred to on p. 435. A liberal description, however, not merely an enumeration, is given of the sandstones of Ireland (the heading accidentally calls them limestones). The reason for this treatment is not apparent, since a reference to the source of information, Kinahan's "Economic Geology of Ireland," would show that a similarly detailed essay might be written on any class of Irish stone.

It is one of the curses of curators that manuscript labels lead to cumulative errors in the names of places. Mr. Howe has succeeded far better than any copyist would have done. We do not know if his variations from Kinahan are accidents or corrections, for Kinahan was indifferent to proof-reading; but such words as Dundale, Geradmer, Blekinje, Thuringewald, Böhm-Brod, and Maenturog require emendation. Why write "the Tyrol," and also "Steiermark" and "Mähren"? But at such a book—the metaphor is obvious—we would not willingly cast a stone. We are additionally grateful for an index of twenty pages.

(2) Mr. John Watson's work represents an immense amount of patient application, behind which lies real enthusiasm. He has brought together a collection of building stones for the Sedgwick Museum in Cambridge, in which he aims at representing the whole world. He has presented a large number of the specimens, and furnishes a catalogue of rocks used in construction, leaving those used for decoration, road-making, and roofing for future work. On p. 8 he approves "a suggestion" that the University of Cambridge might be a fit place for "a national bureau, where building stone could be examined, tested, and reported on." The existence of the Geological Survey of Great Britain, as a public body of the first standing, would no doubt occur to our legislators, and the difference of outlook adopted in an economic and in a university museum is at once seen by Mr. Watson's choice of a classification. His stratified building stones are arranged according to their geological age, and are then grouped under their countries of origin. It is a question if this appeals even to the university student of petrology, and it certainly conveys no useful information to the seeker after building stones. The admirable index of fifty pages, surpassing that of the diligent Mr. Howe, does not set matters straight. There are thus twenty-six references to oolites, even though the Caen stone of p. 184 is omitted; but the seeker after sandstone will have to turn the pages of the volume. Granites, however, are copiously indexed as a group. The universities, having adopted law and medicine, have proceeded to engineering, mining, and distilling. It may now be too late to leave building construction and building stones to great technical colleges, of the type of the Royal School of Mines. Mr. Watson's book, issued at so very moderate a price, is a treasury of information for the inquirer. It is not the author's fault if it seems to emphasise that overlapping of functions which threatens to impoverish British centres of education. G. A. J. C.

SUPERNORMAL PSYCHOLOGY.

(1) *New Evidences in Psychical Research. A Record of Investigations, with Selected Examples of Recent S.P.R. Results.* By J. Arthur Hill. With an introduction by Sir Oliver Lodge, F.R.S. Pp. xii+218. (London: Wm. Rider and Son., Ltd., 1911.) Price 3*s.* 6*d.* net.

(2) *Personality and Telepathy.* By F. C. Constable. Pp. xv+330. (London: Kegan Paul and Co., Ltd., 1911.) Price 7*s.* 6*d.* net.

IT was in the early 'seventies of last century that men of scientific training began to take an interest in certain mental and physical phenomena which appeared to transcend the ordinary laws of psychology and biology. It has taken a generation to acclimatise some of these phenomena in the realm of serious and orthodox scientific pursuit, and the two present

volumes represent further attempts, along two different lines, to win recognition for apparently supernormal facts, and to frame theories capable of bringing them into line with general knowledge.

Mr. Hill's book (1) is an eminently temperate and dispassionate statement and analysis of selected cases of clairvoyance and automatism, the former including the sayings of a professional clairvoyant, and the latter dealing with the "cross-correspondences," now fairly well known, between the automatic writings of Mesdames Thompson, Forbes, Holland, Verrall, and Piper. It is not difficult to perceive that the author inclines to the agency of disembodied human intelligences as the simplest explanation of many of the phenomena dealt with. When, in circumstances which exclude collusion as a reasonable hypothesis, phrases and allusions are simultaneously written out automatically by two or more persons in different continents, different phrases which only become intelligible on being pieced together, the case for assuming the operation of some intelligence different from that of the writers becomes strong. When, in addition, these phrases are characteristic of a Gurney, Myers, Sidgwick, or Hodgson, the temptation to attribute them to those deceased personalities is obvious. On the other hand, if telepathy and clairvoyance are real faculties, the proof of identity is faced with apparently insurmountable difficulties. Nevertheless, Mr. Hill's book is a valuable contribution to our knowledge of this difficult subject, and it is rendered particularly acceptable by the author's "careful and responsible truthfulness" and "unemotional habit of mind," to which Sir Oliver Lodge testifies in his introduction.

(2) Mr. Constable's book is an ambitious attempt to colligate the same range of facts by a new theory of personality. Experimental telepathy is assumed to be fully established, and is accounted for by the existence of an "intuitive self," which is in "timeless and spaceless" communion with all other intuitive selves. A large part of the book is taken up with a criticism of Kant and his transcendental dialectic, and the new departure claimed is the proof of the existence of the intuitive self from facts of ordinary human experience, chiefly relating to telepathy, or the reception of impressions otherwise than through the normal organs of sense.

The book as it stands can scarcely be said to succeed even in its main object, for even if telepathy were fully established, the possibility of some form of physical vehicle is becoming, if anything, increasingly obvious in these days of wireless transmission; and the whole conception of the "intuitive self" tends to remove these matters from all scientific procedure. An author who confesses his inability "to distinguish between time and space" (p. 34) is scarcely likely to convert physiologists or even psychologists to his views on crystal-gazing, or "psychometry," or communion with the disembodied. Any theory of survival likely to appeal to the scientific mind must be based upon physiological rather than metaphysical reasoning, and must, above all, remain in touch with the facts of racial and individual development. A physical scheme of immortality cannot be ruled out as an *a priori* impossibility while so many unknown forms of matter and energy remain to be discovered. Meanwhile, a transcendental self, independent of space and time, makes too great a demand on our powers of conception to be of any living scientific interest.

E. E. F.

OUR BOOK SHELF.

A Star Atlas and Telescopic Handbook (Epoch 1920). For Students and Amateurs. By Arthur P. Norton. Pp. 19+16 star and 2 index maps. (London and Edinburgh: Gall and Inglis, 1910.) Price 5*s.* net.

FOR the general use of amateur astronomers this is the best atlas and handbook we have yet seen. The sixteen maps are printed exceptionally clearly, and, while not overcrowded, show more than 7,000 objects. Each map is about 10 in. by 8 in., and is part of a lune, covering, exclusive of overlap, four hours of R.A., and 60° N. or S. of declination. The atlas opens out flat, and shows two maps joined together at the equator, so that about one-fifth of the whole sky is seen at once. Meridians and parallels mark every hour of R.A., and every tenth degree of declination, while marginal divisions enable a position to be fixed to the nearest 5m. or 1°. The polar regions are shown on two pairs of maps.

In addition to these excellent maps there are a large number of tables and a quantity of letterpress giving practically all the information the amateur is likely to require for ordinary work. The list of star catalogues, astronomical abbreviations and symbols, and the notes on astronomical terms are to be confidently recommended for their lucidity and trustworthiness. Then there is a number of notes on the planets, comets, meteors, eclipses, &c., which are very interesting, concise, and informative. The sun and moon are awarded rather fuller treatment, and a useful sketch-map of the latter forms the frontispiece.

All this is good, but what will probably appeal more strongly to the average amateur possessing a telescope is the section devoted to hints. These are eminently practical, and the observer is told how to take care of and to use his instrument, how to get to know its constants and capabilities. Should he wish to determine the focal length of his objective or mirror, or of his eyepiece, or the diameter of the field, or should he wish to clean the different delicate parts or undertake special work, he is advised tersely how to do it.

Then preceding each pair of regions there are a few notes directing attention to any special telescopic objects found therein; double stars, variables, nebulæ, and star clusters are located, and their special characteristics briefly described.

The whole work suggests that the author undertook a congenial task; the result shows he did it well.

W. E. ROLSTON.

Triumphs and Wonders of Modern Chemistry. A Popular Treatise on Modern Chemistry and its Marvels, Written in Non-Technical Language for General Readers and Students. By Dr. G. Martin. Pp. xx+358. (London: Sampson Low, Marston, and Co., Ltd., 1911.) Price 7*s.* 6*d.* net.

THE author of this book has sought to make chemistry attractive to readers untrained in the methods of science, by offering them an account of some of the most surprising achievements of modern practical chemistry, and of the most startling deductions from recent chemical and physical speculations. These two subjects alternate throughout the book, but their treatment is of unequal value. Such practical matters as the liquefaction of air, the preparation of oxygen, and

the artificial production of nitrogen compounds, are described in an interesting manner, and in an easy and popular style. The wisdom of the plan adopted in dealing with theoretical points is more questionable. The reader is presented, almost on every other page, with numbers intended to impress by their vastness. Such statements as that "in such an inconceivably short interval of time as the millionth part of the millionth part of a second there occur no less than 2,800,000,000,000,000,000 collisions between the little atomic worlds which make up a [candle] flame!" abound in every chapter, and the latest hypotheses concerning electrons and the æther are utilised freely to supply similar data. The exclamatory style of these portions, and the excessive attention given to the sensational and the marvellous, render much of the book fatiguing to the reader, and injure its value as a means of instruction, especially as no clear distinction is made between those wonders which are facts of experience and the most hazardous guesses as to the structure of the universe.

Some of the most interesting sections deal with natural marvels, such as the caverns of limestone districts, the diamond mines of Kimberley, and the sulphur deposits of Sicily and Japan, and the author's reading has enabled him to bring together a mass of curious information in which most readers will find something new or unfamiliar.

In spite of the defects on the scientific side, to which attention has been directed, it is evident that the author has a real enthusiasm for his subject, much poetic feeling, and considerable facility of expression, and that his book represents a genuine effort to communicate his enthusiasm to others.

Plant-Life on Land, considered in Some of its Biological Aspects. By Prof. F. O. Bower, F.R.S. Pp. ii+172. (Cambridge: University Press, 1911.) 1*s.* net.

THE first part of this book deals with the problem which the author has expounded more fully in his large work on the origin of a land flora. The life-histories of Ulothrix and Pteris, the flower of Cycadeoidea, and the motile sperms of Zamia are the central points in the earlier chapters. Then after discussing the limitations imposed upon plants by fixity of position, the author turns towards the golf links, noting by the way the incidents connected with plant increase and the biological features of sand-dunes. The golf links are introduced to serve as an object-lesson in plant colonisation. Finally, it is explained in the concluding chapter how the various themes treated as separate essays converge upon the all-important problem of descent. The facts and opinions set forth can scarcely fail to interest the general reader, who desires to become acquainted with modern views regarding the origin and development of the plant world, but he is likely to find the information somewhat disjointed and sketchy; thus he would certainly desire to learn more, if only hypothetical, of the transition from the fern to the flowering plant, and also of the evolution of the flower. Botanists are, of course, familiar with the subjects discussed, but to some the tale of the Culbin sands may be new, and all will appreciate Prof. Bower's "dicta" on golf links.

Butterflies and How to Identify them. By the Rev. S. N. Sedgwick. Pp. 63. (London: Charles H. Kelly, n.d.). Price 1*s.* net.

THIS is an excellent little book for the beginner, and contains a quantity of useful information, for which we might often seek in vain in more pretentious works. There is a coloured frontispiece, representing three butterflies and two moths, and thirty-five photographic illustrations (some of them including a whole page of figures), representing scales, eggs, larvæ, and pupæ, besides perfect insects. Some of these are natural size, and others reduced or (occasionally) enlarged, and those of perfect insects are generally good, but the figures in some of the plates representing the butterflies of each month are rather too small, and have scarcely come out very recognisably.

The first chapter deals with metamorphoses, collecting, &c., and the second includes a complete list of British butterflies, with Latin and English names, and a sketch of the contents of the five families. In chapter iii. we find a table giving the month of appearance, food-plant, name, and locality, &c., of each butterfly, then a series of plates, to which we have already referred, showing the butterflies of each month from April to September, then notes on typical larvæ and pupæ, of which a representative series is figured, and, lastly, another table, giving name, brief descriptions of image, larvæ and pupæ, food plants, and locality; and a few pages of ruled paper for notes.

A few doubtful species are included, such as *Argynnis dia* and *Erebia ligea*, but if this is an error, it is an error on the right side. Altogether the book should be specially useful to schoolboy entomologists.

The Open Book of Nature: an Introduction to Nature-Study. By the Rev. Chas. A. Hall. Pp. xi+268. (London: A. and C. Black, 1911.) Price 3*s.* 6*d.* net.

VARIOUS allusions and the general tenor of the book indicate that the author's early proclivities towards natural history were developed at a time when there were few inducements, either in the shape of popular books or general appreciation, to take up the study of the natural sciences. Having derived so much pleasure from his studies he desires to arouse in others the spirit of observation and a similar enthusiasm for a knowledge of nature.

The earlier geological chapters are devoted mainly to dissertations on rocks and fossils; identification of flowers is the chief botanical feature, and zoology is introduced with botany in the description of a ramble which occupies a third part of the book. The final chapter containing practical hints is by no means the least useful, although the manipulation of microscope and camera are better postponed to a more advanced stage. The purpose of the author is best served in those passages where he describes his own observations and experiences. There is overmuch introduction of information which, referring to natural objects not easily obtained, cannot be practically confirmed, and it is certainly inexpedient to give a string of morphological definitions (as on pp. 120 to 130), some of which are admittedly incorrect; it would be wiser in every respect to refer the student to a text-book for such details. Undoubtedly the author would be a delightful companion in the field, but conversations that are instructive on a ramble appear fragmentary when offered as a set piece.

The Oxford Geographies. Edited by A. J. Herbertson. Junior Geography. Questions. Pp. 28. By F. M. Kirk. Statistical Appendix. Pp. 36. By E. G. R. Taylor. (Oxford: Clarendon Press, 1911.) Price 1*s.*

IF these questions and summaries—prepared to accompany Prof. Herbertson's "Junior Geography"—lead teachers to make boys and girls themselves take an active part in their geography lessons, and not merely listen to what the teacher has to say, they will serve a very useful purpose. The resourceful master should find no difficulty in basing practical work upon the material here provided.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Deformation of Rocks under Tidal Load.

THAT a shore-line should be depressed by the weight of a high tide and rise again when the tide retreats is an idea that has occurred to many. Sir George Darwin has on certain assumptions calculated the form and amount of deformation to be expected under given tidal conditions. In the British Association Report for 1910, p. 49, I showed what had actually been recorded by Mr. W. E. Plummer at the Bidston Observatory, which lies two miles inland from high-water mark. At that place a 10-foot tide resulted in an angular deflection of approximately 0·2″. Had the instrument been nearer to the sea a greater change in inclination might have been expected.

This year, between March 4 and May 24, an instrument similar to that at Bidston was, by the kind permission of the committee of the Royal Victoria Yacht Club, installed in the base of their premises at Ryde. The distance between this installation and high-water mark was 138 feet. The displacements due to a 10-foot tide were approximately 0·9″. This is more than I should expect to find at Bidston if that observatory were near to the high-water mark. If it would be really greater, then the soft Tertiaries beneath the Solent yield more than the hard sandstones which run seawards from Bidston. This may perhaps be a point of interest to geologists. The astronomer with his observatory near a seashore will realise the extent to which he is handicapped, due to tidal tilting, in relation to the man who makes similar observations twenty miles inland.

Considering the magnitude of the deflections due to tidal load, the geophysicists may wonder whether we could or could not in a country like Britain obtain satisfactory measurements of a terrain tide due to lunar influences. The definite measurements of the amount of bending which a tide produces on a floor of a shallow dish-like sea bed puts the hydrographer in a position to calculate the difference between what he observes in the rise and fall of the tide and what it would be if the bed had been absolutely rigid.

Lastly, as to the seismologist who has tried to find the relationship between earthquake frequency and tidal load. So far as I know, this has not yet been shown. The reason for this is perhaps because we have not confined our attention to earthquake regions where the effect of tidal load was marked.

The diagram (Fig. 1) is a half-sized reproduction of a "graph" at Ryde. The flat crests and sinuses of the waves indicate that the tide lingers for a considerable time at "high" and "low." The reason for this is apparently connected with the fact that Ryde is approached by tides from two directions. One enters the Solent from the east and the other from the west, but at somewhat different times.

Shide, Isle of Wight, July 5. JOHN MILNE.

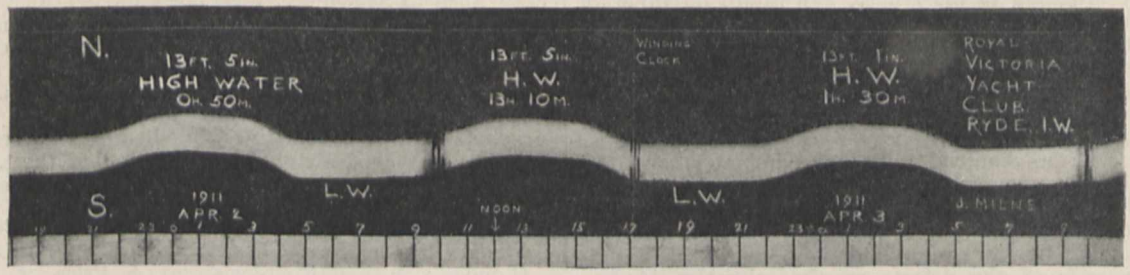
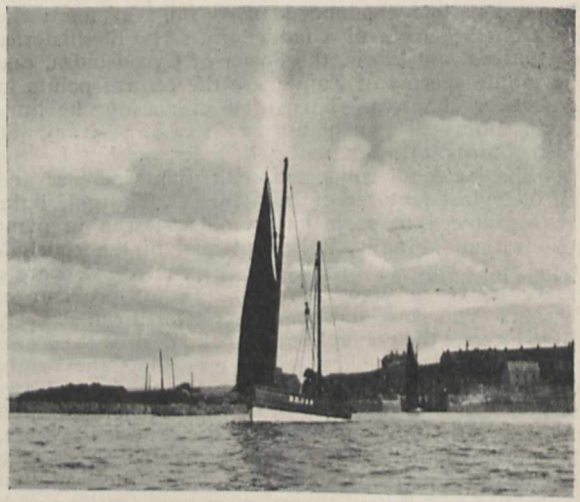


FIG. 1.—Record of Deformation of Ground by Tidal Load.

Electrical Discharge—Possible Cause of Flare Spots in Photographs.

DURING a recent yachting cruise on the north-east coast, I sailed from Holy Island to St. Abbs, arriving off the harbour before the fishing fleet came out, and therefore dropped anchor off the entrance. About 5.30 p.m. some of the Scotch herring boats sailed out, and I photographed one shortly after leaving the entrance, and another when she was well outside. On having the two negatives developed and printed, I was disappointed to notice that both pictures were considerably marred by a white flare extending from the mast and yard of the sail skywards. At first I put down the flare spot to light leaking into the camera, or some sort of optical halation. On considering the matter more carefully, I was struck with the coincidence of both photographs showing the defect starting from the yard and the mast, and not at all visible on the lower dark sail. I talked the matter over with several friends, and eventually Mr. C. Faraday Proctor jokingly suggested it was evidently caused by electrical discharge. We both took the idea in a sarcastic spirit; but very soon we realised that the suggestion was not so ridiculous, and was well worthy of serious consideration, particularly as I remembered that the weather conditions had been thundery during the two previous days whilst sailing up from Blyth to Holy Island. I then carefully examined other photographs taken on the following day of boats in the harbour, and several of these showed evidence of the same effect.



Photograph of Flare Streak, possibly due to Electric Discharge.

I enclose herewith three photographs.

No. 1 (here reproduced) shows the keel boat just sailing out of the harbour, taken Tuesday, June 20, 5.30 p.m., looking south.

No. 2 shows boat taken a few minutes later looking east.

No. 3 shows boats in the harbour looking north, taken about 1 p.m. on Wednesday, June 21. In the sky above

all the masts are distinctly visible, pronounced white flares extending skywards. The photographs were taken on a Kodak film, exposure about one twenty-fifth of a second.

On the Tuesday the wind was blowing fresh from the north-west, and on the Wednesday the wind was still fresher from the south-west.

This note and photographs are being sent with the object of directing attention to the phenomenon, and with the hope of learning whether it has been noticed by others.

ARNOLD SPILLER.

Northumberland Yacht Club, Blyth, July 5.

Anhydrous Volcanoes.

THE cumulative evidence in Dr. Albert Brun's "Recherches sur l'exhalaison volcanique" leaves very little doubt but that the explosive action in volcanoes is due to decomposition of compounds of C, N, Cl, F, &c., held dissolved in the glass of the lava. All the theories about volcanic activity must be revised, as pointed out by that author; but along with the disappearance of the theory attributing the explosive action to water, there must be a disappearance also of the theory of a hot interior of the globe, as a corollary following on Dr. Brun's researches, if on no other grounds. For if a magma containing carbides, nitrides, &c., will explode with great violence if heated, then, supposing the earth's centre were hot, a single volcanic vent would allow the whole of the volcanic magma contained in the earth to swell and boil over on to the surface of the earth.

Accepting, then, Dr. Brun's conclusions, the volcanic magma below the crust must be cold, and only when heat is applied to it, through movements in the earth's crust, will the expansion take place and the volcano be formed. The gases given off from volcanoes, or expelled by heating obsidians to their melting points, are strongly reducing, and were, therefore, forced into the magma at a stage in the earth's growth (on the planetismal hypothesis) when the surface was incandescent from the infalling of meteorites, and when the atmosphere consisted of gases carried to the earth in these meteorites, principally CO, CO_2, H, N, and CH_4. The rock-silicates absorbing these gases gradually cooled down and were buried, and thus a supply of material was laid by from which the volcanoes of future ages could be formed. The absorption is more than mere occlusion, for an obsidian can be thoroughly weathered and absorb water throughout its mass, yet, when dried and then raised to fusion point, free chlorine can be given off, showing that the water cannot have had access to the storage chamber of the chlorine. Again, a granite powder may be sprayed with paraffin and heated to 1100° C. The excess of paraffin burns instantly, but a certain portion is fixed by the silicates and remains as paraffin within the rock-magma up to the explosion point, when it is expelled with explosive violence. Actual paraffin can be distilled from the pitchstone of Arran. If paraffin can be retained in a magma heated to above 1000° C., it means that it has practically entered into chemical composition with the silicates.

An obsidian retains some of the gases originally held in the magma, because it has cooled quickly; a certain time is necessary, even at fusion point, for the gases to be expelled; hence a lava will continue to give off gases as it flows down the side of the volcano, although a large proportion has escaped in the chimney, and will still be found to contain gas when it has cooled completely. The solidified lava, if left long enough, will slowly give off gases, N, Cl, CO, CO_2, CH_4, &c., but the life of a lava, before it becomes what Brun calls a "dead rock," is probably thousands of years.

There is certainly an analogy, if nothing more, between these results of Dr. Brun's researches, and the properties of radio-active substances. Helium must have existed in the earth's atmosphere when the surface was incandescent, for the same reason that it exists in the sun's atmosphere to-day, and it is possible that certain substances had the power of causing it to enter into a sort of chemical combination with them, like the paraffin in the rock silicates. Existing in the lower layers of the earth's crust near the centre, which I have given reasons to suppose is very little, if at all, above the temperature of outer space, these substances would retain the helium frozen in them, as the chlorine, paraffin, &c., are frozen in the rock silicates, and they could retain the helium for indefinite periods. When some of these substances, however, are brought by the ordinary processes of ore-formation into the warmer regions of the outer crust, they would give off their helium. The difference between the way in which the helium is held in radio-active substances, and that in which the gases are held in rock-silicates, is shown by the fact that the rate of expulsion of helium is unaffected by temperatures available in the laboratory, whereas the gases can be all driven off from a rock-silicate at one time. There may be nothing in this, but it may reassure some who are alarmed at the rate of decay of radium and see no possible sources of replenishment.

ERNEST H. L. SCHWARZ.

Rhodes University College, Grahamstown, June 12.

The End of the *Beagle*.

WITH reference to the letter in NATURE of June 1, the following particulars of what I know upon the subject may be of interest.

In the year 1863, at Hong Kong, a friend of mine purchased from the Government the dispatch gun vessel *Beagle*, which was at that time laid up, after being some years on the China Station. We had her thoroughly overhauled and repaired, and renamed her *The Stork* (a sacred bird of the Japanese). I then took her over to Japan, to the ports of Nagasaki and Yokohama, for sale. She was visited and examined by the Japanese; but no sale was effected at the time, and I took her back to Shanghai. However, she was eventually purchased by the Japanese Government, and after that I have no further knowledge of her movements.

The other *Beagle* mentioned in NATURE was an old 10-gun sailing brig, and I think there can be no doubt that she was the vessel in which Darwin made his scientific explorations. I see in the "Encyclopædia Britannica" that Darwin made his voyage in the *Beagle* in the years 1832 to 1836, several years before the *Beagle* that I commanded was built, so I presume that settles the matter.

H. C. SHOOSMITH.

54 Billing Road, Northampton, June 23.

[THE second line of the "Voyage of a Naturalist" describes the *Beagle* as a 10-gun brig. The vessel was barque-rigged, and is believed to have been about 280 tons. —ED. NATURE.]

The Osmotic Pressure of Colloidal Salts.

IN reference to the interesting letter of Dr. Hardy, published in NATURE of June 29, I should like to state that work on similar lines has been proceeding in this laboratory during the last year and a half. We have been investigating the general subject of "membrane-equilibria" and "membrane-potentials" in the case of non-dialysing electrolytes. An informal note on the principles involved in these investigations was read by me before the Physiological Society in December, 1910. Some time ago a paper dealing with the theory of these equilibria and potential-differences was sent to the *Zeitschrift für Elektrochemie*. In this paper, which is already in type, Dr. Hardy will find that I have arrived at equations expressing the membrane-potentials which are practically identical with the equation given in his letter. We propose, therefore, to continue our investigations on the subject.

F. G. DONNAN.

Muspratt Laboratory of Physical and Electro-Chemistry, University of Liverpool, July 1.

The Date of the Discovery of the Capillaries.

DR. FRASER HARRIS is quite correct in stating that Malpighi (working with Charles Fracassati) demonstrated the existence of blood capillaries with the microscope in the year 1660. The two letters to Joh. Alph. Borelli announcing the discovery were published in folio at Bononia (Bologna) in 1661. This is now a rare tract, and not usually quoted. It is, however, doubtful whether

Malpighi first saw capillaries in the frog's lung or in the frog's bladder—probably it was the latter. Although, of course, he was not the first to practise injection methods, we may note that Malpighi traced the course of the vessels by (*a*) inflating them; (*b*) injecting mercury; (*c*) injecting coloured fluids. Both Sir Michael Foster and your correspondent appear to have overlooked the fact that the expression "Magnum certum opus oculis video" is not Malpighi's, but a translation from Homer, and is intended, I imagine, to be translated after the Malpighian manner as: "I see with my eyes a truly great work."

F. J. COLE.

University College, Reading, July 4.

ARISING out of the letter on the above subject in NATURE of June 29, by Dr. D. Fraser Harris, is the true date of the momentous discovery of what is the oxygen carrier of the blood. This discovery is put down to Sir G. G. Stokes, and the date some years later than 1862.

I wish to direct attention to a fact hitherto overlooked, namely, that Dr. John Roberts, of Plas Eryr, Clwtybont, Carnarvonshire, was the first to say (and to publish it) that the colouring matter of the blood (hæmoglobin) was the oxygen carrier. This can be verified by perusal of his thesis (for M.D. Edin., published in 1860, and now lying in the archives of Edinburgh University) on "Pigment."

Dr. Roberts is still alive and well.

R. CADWALADR ROBERTS.

Heathfield, Cardigan.

THE FUR-SEAL QUESTION.

FOR some time past a conference has been sitting in Washington, in which representatives from Great Britain, or rather Canada, Russia, Japan, and the United States, have taken part, for the purpose of drawing up new regulations for the conduct of the Bering Sea seal fishery, and for the protection and restoration of the herd. *The Times* of June 28 contained an account of the findings of the conference, and in the issue of July 8 its correspondent at Washington reports that the new convention was signed on July 7. The full text of the agreement has not yet come to hand, but its main provisions, which are of great international importance, and of great interest to all naturalists, are said to be as follows. Pelagic sealing will be totally prohibited to all subjects of the participating countries for fifteen years, and measures will be taken to induce other countries to prevent its being carried on under cover of their flag; the United States and Russia, which own practically all that remain of the seal herds of the North Pacific, will pledge 30 per cent. of their catches for the purpose of paying a specified yearly dole to Canada and Japan to compensate them for abstention from the fishery, and the United States (it is said) will advance 40,000*l.* to each of the latter countries for the immediate compensation of persons engaged in the industry; the contracting Powers will admit no skins to their ports the origin of which is not properly certified; and, lastly, regulations are laid down as to the method of killing seals on land, and as to the establishment of guards upon the rookeries. These resolutions are, we suppose, still subject to ratification by the several Governments, but nevertheless we have good reason to believe, and every reason to hope, that the wise and liberal proposals thus stated may soon be adopted and carried into effect. The Washington correspondent of *The Times* reports that, so far as can be gathered, the convention will be accepted by the Senate. It will come into force on December 15.

The Bering Sea Arbitration of 1893 was an affair of such international magnitude that it is far from being forgotten. It is unnecessary and impossible to enter here into a review of that great debate, of all the causes that led to it, or of the minor questions that arose for a few years after its close. We may simply remind our readers that its chief result was the delimitation of a zone of sixty miles around the Pribylov Islands, within which zone pelagic sealing was prohibited during the season when the herd were living and breeding upon the islands, while at the same time the use of firearms was entirely prohibited to the pelagic sealers. A few years later pelagic sealing was entirely prohibited, both by America and Russia, in the case of their own subjects. But while it is impossible to enter here into either diplomatic or commercial history, a few words upon the general aspect of the case, and especially upon the natural history of the fur seals, may be of interest at the present moment.

The true fur seals, forming the old genus Otaria (now broken up into subgenera), belong to the more extensive family of the Otariidæ, or eared seals, the various members of which differ considerably in their habits. For example, Steller's sea-lion (Eumetopias), a large, ungainly animal, is sparsely distributed on a multitude of coasts and islands around the North Pacific; while, on the other hand, it is characteristic of the fur seals, throughout the whole area of their distribution in the Pacific and Southern Oceans, to resort to but few local breeding-places, where, in prosperous times, they congregate in great multitudes. Naturalists are not quite agreed as to the number of species of these fur seals, but the best-known breeding-places are, or have been (besides those in the Bering Sea), Robben Island at the Cape of Good Hope, the Auckland Islands, the Falklands, South Georgia and many other islands in the Southern Ocean, Lobos Island, at the mouth of the River Plate, Guadalupe, off southern California, and the Galapagos. In the Northern Pacific by far the greatest of the rookeries are those of the Pribylov Islands, St. Paul and St. George; next in order come those of the Russian Commander Islands, Bering and Copper Islands; while in the Sea of Okhotsk there is still a small rookery on Robben Island (now ceded to Japan), and on the Kuriles a number of rookeries were formerly known but are now either extinct or very nearly so. Dr. Jordan and his American colleagues ascribe specific differences even to the seals of these comparatively neighbouring breeding-grounds, and it is highly probable, if not certain, that the Pribylov seals from the eastern part of the Bering Sea, and the Commander Island seals from its western part, form absolutely separate communities, the long southward migrations of which in winter time follow different routes, the one towards the shores of British Columbia and the other towards those of northern Japan. For an unknown period, but probably for centuries, they have been exposed to attack by expert native fishermen, spearing them at sea in the course of these winter wanderings.

During the greater part of last century the history of the seal herds, of all species and in all their various haunts, is a long record of pillage and extermination; and nowadays the extent to which they have been reduced may be measured by the simple fact that a sealskin coat is a thing we very seldom see. In a comparatively few cases, especially on the American and Russian Islands and the Uruguayan Lobos Island, the herds have long been placed under proper control while on their breeding-grounds; and, so far as we are aware, the Lobos rookery, though small (for the island is less than a mile long), and though right in the track of commerce and close to a considerable town, is still maintained in comparative prosperity. But though on the Pribylov and Commander Islands the remains of the once immense herds are still considerable, yet they represent but a

small fraction of the numbers that were massed there during living and even recent memory.

The life-history of the fur seals is, very briefly, as follows. The males grow to a great age and size, wholly disproportionate to that of the small and slender females; and this difference is, as usual, accompanied by the habit of polygamy. The old males arrive upon the breeding-grounds in May, some weeks earlier than the females, and take up their quarters on the rough beaches, generally on some prominent slab of rock; here they doze and sleep until the arrival of the females, who, heavy with young, slip quietly into their places in the harems. The birth of the young follows almost immediately, and soon afterwards the comparative quiet of the rookery is exchanged for a babel of noise and incessant quarrelling. The old bulls in possession of neighbouring harems contend with one another for the females, and the younger bulls, as yet wifeless, strive continually to carry off a straying cow, or dash into a harem when its owner has wandered a few yards away. Moreover, the old bulls are now in perpetual activity, rounding up their harems, hastening after errant cows, quarrelling with their neighbours, or engaging in fierce combat with the "idle" and predatory bulls. So all day long the noise of battle rolls along the *beaches* by the wintry sea, and the growling and the snarling, the confusion and the din, are for some weeks together indescribable.

The harems vary very much in numbers, fifty cows being not uncommon, while a hundred, or even more, have been occasionally recorded; but their numbers depend upon the prosperity of the herd, and fifteen years ago the average number seemed to be rather under twenty. The young males, or bachelors, from one to three or four years old, arrive about the same time as the females, but herd apart on grounds remote from those occupied by the breeding herd. The females and these young males go down to the sea to feed, but the old males starve rather than leave their posts; they come fat and vigorous in springtime, and are gaunt, emaciated, and scarred with the scars of many battles before they leave again in autumn. This family life, and the type of rocky coast resorted to by the herds, seems to vary little in the different species, and a photograph of the herd upon Lobos Island, for instance, is scarcely, if at all, distinguishable from one taken on the Pribylovs. At Guadalupe, however, by reason of the tropical heat, the seals resort to the dark volcanic caves that surround its coast-line, and to the same cause perhaps is due the thinner and very inferior quality of the fur, as compared with that of the northern species.

The old bulls display surprising agility, in spite of their bulk and clumsy form, climbing over the rough rocks and boulders in a wonderful way; and, in general, as is well known, these eared seals can waddle on their long, flapping flippers with greater activity and over much longer distances than might be expected. It was formerly the custom on the Commander Islands to drive the bachelor seals from the "hauling grounds" to the place of slaughter, a distance of at least three miles up and down a rough mountain path. But Dr. L. Stejneger was once witness of a more remarkable case. Climbing to the top of a rocky mountain on Copper Island, certainly not less, if I recollect rightly, than 2000 feet high, he heard, as he reached up to the last rocky summit, an angry growl, and there, to his amazement, was a great old bull seal, and the beast was blind!

On the polygamous habits of the species, on the segregation of the young males, and on the superfluity of the latter (for both sexes being born in approximately equal numbers, a very large proportion of the males are destined to perish in the struggle for existence)—on these characters are based the practical methods for the conservation of the herd. The Government lessees kill the young bachelors only, by preference those of three years old, leaving what they consider a reasonable proportion to replenish the stock. It is generally agreed that on the American Islands this operation has always been conducted with reasonable care and moderation, and with no more cruelty than is implied in the rapid and skilful slaughter of a large number of defenceless creatures. But the other dangers to which the herds are exposed are neither selective nor in any way conservative. The pelagic sealer when at work around the islands kills not only the young males, but in still greater numbers the females of all ages, and it is certain that many pups on shore must in consequence perish of starvation; while the raider who lands upon the rookeries kills all and sundry, young and old, in one spell of merciless destruction. Nor is the seal altogether immune from natural causes of mortality, apart from old age and from the attacks of man; but though the grampus, for instance, now and then devours him at sea, there is only one known cause of mortality that is apparently serious. In warm countries a very considerable number of puppies die owing to the attacks of a species of Ankylostoma, a tiny nematode worm, the eggs of which lie among the earth and sand, and in one way or another are swallowed by the pup; and a species of the same dangerous parasite is found abundantly in the bodies of the many dead seal-pups that towards the end of the season are found lying upon the rookeries, and apparently in greater numbers on the more sandy and less rocky of these.

But whatever part this parasite or other accidents may play as causes of mortality, it is certain that

A Rookery Courtship on the Pribylovs. (From Nature, by Bristow Adams, in the American Commission's Report, 1896–7.)

they are not such as to prevent the permanent and healthy upkeep of the herds when under proper management and control, nor even to prevent the rapid recuperation of their numbers during periods of release from persecution. On the Galapagos every seal that could be found had been killed by 1887, and the fur trade was surprised when ten years later a vessel came into San Francisco with somewhat above 200 seals from that abandoned rookery. In like manner, the seals on Robben Island were practically exterminated about the time of the Crimean war, when for a year or two 15,000 or 20,000 skins were taken in single voyages, after which the catches dwindled to trifling amounts, and, finally, the place was abandoned, and its existence as a hunting ground all but forgotten; but after fourteen or fifteen years of quiet, the rock was again covered with seals, just as it had been in the old days when first discovered.

Of the present state of the Pribylov herds we have no precise information at hand, but it is at least known that the seals are greatly diminished since the time, some fourteen or fifteen years ago, when they were last visited by British agents; while even then, some years after the arbitration, they were, of course, immensely less than in the palmy days of the fishery. We hope all the more, accordingly, that the agreement which is now said to have been arrived at will in due course be ratified, in the hope and confident belief that in a few years' time this great source of wealth, and this wonderful spectacle of crowded, teeming animal life, will be again as it was in former times. But it remains to be mentioned that the decrease of the Bering Sea herds in recent years is not to be laid at the door of the Canadian sealers, or at least not to nearly so great an extent as of their opposite neighbours, the Japanese. The once large fleet of Canadian sealing schooners has dwindled, we believe, to some four or five, while ever since the Japanese war the Japanese have taken more and more to this pelagic industry. It is said that they were first led so to do when the Russian guards were removed from the Commander Islands during the war, and when accordingly the rookeries lay at the mercy of the first comer. In recent years they have been charged with actually raiding the American rookeries, and, in any case, as Japan was no party to the Bering Sea Treaty, the Japanese captains have up to the present been free to use firearms, and to pursue their trade up to the three-mile limit of the territorial waters. In 1908, the Japanese had a fleet of thirty schooners, some with as many as sixteen boats, which formed a cordon round the Pribylov Islands. There can be no doubt at all that this has told very heavily upon the herds. Lastly, it is right to say that the terms of the new agreement, and the compensation which it is proposed to pay to Canada and Japan for the loss of their pelagic interests, appear to be both liberal and enlightened, and indicate a sincere desire on the part of the United States and of Russia to do all that lies in their power for the attainment of a great national and general benefit, and for the preservation of one of the great phenomena of the living world. D. W. T.

THE EDUCATION AND TRAINING OF ENGINEERS.

THE Conference on the Education and Training of Engineers, held at the Institution of Civil Engineers, at the end of June, of which a report appeared in our issue of last week, marks a further advance in the development of a scheme which has engaged the attention of the council during the last fifteen years, and cannot fail to have considerable influence on the future of the engineering profession. The first step was taken under the presidency of Sir John Wolfe Barry, when a system of qualifying examinations was established. Candidates who were desirous of entering the institution as students had to give proof of a sound general education developed upon lines suited to subsequent scientific study. Every candidate for associate membership was required to give proof of a competent knowledge of those branches of science which form the basis of engineering, and to have received an adequate practical training under actual engineering conditions. The council found it necessary, from the first, to organise special examinations; these are still continued, and largely availed of by candidates for admission in both the classes mentioned. On the other hand, the council was desirous of minimising the number of examinations to which candidates were subjected, and was prepared to recognise degrees or diplomas granted by universities, university colleges, and engineering colleges, but only on condition that the standard of attainment represented by these degrees and diplomas was not inferior to that imposed by the council's own examinations.

Subsequent experience has shown that the advantages which were anticipated at the outset have been more than fulfilled. The imposition of more stringent conditions put a temporary check upon the numbers of those who entered the institution, particularly in the student class, but this check was only of short duration, and the rate of admission speedily began to grow. It may now be confidently asserted that every associate member admitted to the institution has satisfied the council that he does possess a competent knowledge of both the science and practice of his profession. In fact, British civil engineering, through the action described, has fully established its claim to rank as a learned profession, while the stringency and standard of the conditions which must be fulfilled by all successful candidates are certainly in no respect inferior to those imposed by the medical and legal professions. Another important advantage resulting from the action of the council has been the establishment, throughout the British Empire, of a practically uniform standard of attainment for engineering graduates of universities and university colleges. This excellent result has come about chiefly because the authorities of these institutions have appreciated fully the advantages attaching to the recognition of their degrees by the council of the Institution of Civil Engineers as a substitute for success in examinations held by the institution itself; and, as before stated, the policy of the council has always been to minimise examinations so far as may be possible.

On the side of practical training the council has never delegated, and probably never will delegate, to any other body the duty of deciding whether or not the training of individual candidates is satisfactory. Not merely does the council insist on the production by candidates of articles, indentures, or certificates given by trustworthy persons who have personal knowledge of the training which each candidate has undergone, but it has instituted special and stringent forms in which the details of that practical training must be recorded, and these statements have to be supplemented and verified by the testimony of members of the institution who have personal knowledge of each candidate's career and work. In other words, while recognising the value of scientific education for engineers, the claims of practical training are in no way subordinated thereto: both are essential.

In 1903 the council decided to invite the cooperation

of the leading engineering institutions in the United Kingdom in setting up a special committee which should consider and report to the council on the broad principles of engineering education and training likely to yield the best results. Sir William White, who was then president of the institution, was appointed chairman of the committee; its membership embraced a considerable number of men occupying eminent positions in the practice of all branches of engineering. The inquiries of the committee included general preparatory education, as well as the scientific and practical training of those who were proposing to enter the engineering profession. The work to be done, therefore, was very extensive in its range, and occupied the committee more than two years. The report was unanimous, and was approved by the council of the Institution of Civil Engineers and by the councils of the other engineering institutions which had been represented on the committee. That report has exercised great influence since its appearance, and as the council of the institution arranged for its publication at a low price (by Messrs. Clowes and Sons) it has obtained a wide circulation, both at home and abroad. One of the most valuable features in this report was an appendix containing the analysis of replies made by a large number of eminent practising civil engineers to a series of questions framed and circulated by the committee. From this analysis it became evident that the suggestions made in the report not merely represented the views of the members of the committee, but that the recommendations of the committee were endorsed by the great majority of engineers consulted. In the main the report undoubtedly represented, and still represents, the views of the leading men in the civil engineering profession. Five years have passed since the report was issued, and the council of the institution this year reached the conclusion that many questions of detail and of method which were involved in the realisation of the principles laid down in the report might with advantage receive further consideration. It was mainly for the purpose of affording an opportunity of discussing important questions of that kind that the recent conference was held.

The broad conclusions of the members of the conference in regard to preparatory education of boys who may be intended to become engineers were confirmatory of opinions expressed in the education committee's report of 1906: a good general education, including modern languages, was considered to be essential, and early specialisation was deprecated. The advantages obtained by engineering students who are attached to a university were generally admitted, but one most interesting feature of the discussions was an outspoken declaration by professors of engineering in favour of the practical workshop training being chiefly obtained in manufacturing establishments rather than in college workshops. As to practical training, anyone who has studied the subject cannot fail to have been impressed with the enormous importance attaching to friendly relations between engineering employers and college students.

The question of the period at which practical training should be undertaken by those who intended to receive a college training has been much discussed. The report of the education committee of 1906 recommended that boys after leaving a secondary school (say, at the age of seventeen or eighteen) should serve for about a year in mechanical engineering workshops, so as to gain some knowledge of practical conditions and work. It was also recommended that at the age of about nineteen they should proceed to college and complete their scientific training, taking courses of three or four years, and availing themselves of any opportunities for practical training during the vacations. After graduation, their practical training in such branches of engineering as they might desire to follow would be completed. This clear statement of the committee's report was not grasped by some of the speakers at the recent conference, some of whom argued that the whole of the practical training should be taken between the secondary school and the college, while others maintained that all the practical training should be taken after the college course was completed, in order that there should be no break between the secondary school and the college. The balance of opinion, however, was much in favour of the committee's suggestion, and that also represents the established practice in Germany. Formerly all practical training in that country was put after the technical university or high-school education; but experience led the Germans to adopt the system which the education committee recommended. After twelve years' trial of the new arrangement, the German authorities are more than ever in favour of its beneficial effects.

No doubt whatever was expressed as to the absolute necessity of thorough scientific training for all engineers. There was equally universal acceptance of the view that no man can be considered fit to take part in the design, as well as in the control and direction, of engineering works, unless there is added to a competent scientific knowledge a thorough practical training under actual engineering conditions.

In announcing their decision to summon the conference, the council expressed the hope that it would be widely supported by those interested in solving the difficulties and uncertainties which are experienced by aspirants to membership of the engineering profession. The result of the conference has shown that this hope was well founded. No one who took part in the conference will entertain the least doubt as to the value and interest of its proceedings or of the certain and considerable benefits which will result therefrom to the engineering profession. W. H. W.

THE PROBLEM OF PITHECANTHROPUS.[1]

NEARLY twenty years have gone since Eugene Dubois, then a young surgeon attached to the Dutch forces in Java, and now professor of geology in the University of Amsterdam, discovered that remarkable individual to which he gave the name of *Pithecanthropus erectus*. The actual discovery, it will be remembered, consisted of the roof of a skull, a thigh bone, and two teeth; they were found in a fossil-bearing stratum on the left bank of the Solo or Bengawan, a stream which, after flowing through the province of Mediun—"the hell of Java"—in the centre of the island, turns in a north-easterly direction to reach the sea. Experts agree that the bones found were parts of the same individual or at least of individuals of the same race or species. As to the nature of the individual, there has been a wide divergence of opinion; the discoverer regarded it as more anthropoid than human, hence the name, while others, looking on it as altogether human, simply name it the "fossil man of Java."

The position of Pithecanthropus amongst the higher primates is still debated; while one school of experts places it in the direct line of human evolution, another regards it as part of a side stem which ended in extinction. The age of the formation in which it was found is also still under discussion; Dubois assigned the fossil-bearing layer to late in the Pliocene period;

[1] "Die Pithecanthropus-Schichten auf Java." Geologische und Paläontologische Ergebnisse der Trinil Expedition (1907-1908). Herausgegeben von M. Lenore Selenka und Prof. Max Blanckenhorn. Pp. xlii+268+32 (Leipzig: W. Engelmann, 1911.) Price 50 marks.

the evidence and expert opinion to be found in the well-illustrated and excellent scientific memoir now under review indicate a more recent age for Pithecanthropus. It belongs, not to the Pliocene, but at the utmost to an early Pleistocene formation.

The late Prof. Emil Selenka, who did more than any man of his time to advance our knowledge of the higher primates, saw very clearly that the right way to solve the Pithecanthropoid problems was not discussion, but exploration. After his death in 1902, his widow took up the aim he had in view, and the manner in which she has carried it out commands our unstinted praise. Only those who have organised a scientific expedition know the care, labour, and expense entailed. Financial assistance was obtained from learned institutions in Berlin and Munich, but the major part of the expenditure had to be met from Fräu Selenka's private purse. Scientific investigators and overseers had to be selected and sent out; coolies had to be engaged—as many as seventy-five were employed at one time—and barracks built for them; Fräu Selenka accompanied the expedition into this remote and unhealthy part of Java. Extensive mining and digging operations were necessary for the fossil-bearing layer lies under 35 feet of a sedimentary deposit of volcanic origin. In the seasons 1907-8 10,000 cubic metres of material were removed, and forty-three large boxes filled with the fossil remains found. The contents of these boxes were sent to Europe and distributed amongst seventeen specialists. Their reports, with an introduction by Fräu Selenka and a summary of results by Prof. Max Blanckenhorn, make up the present memoir.

So far as Pithecanthropus itself is concerned, the expedition was a failure; the stone which Dubois erected to mark the spot of his discovery was found, but no further trace was seen of the much-discussed fossil primate. In the dry bed of a tributary of the Bengawan—about two miles from the scene of Dubois's discovery—the crown of a human tooth was picked up; it is a human lower molar of rather remarkable dimensions, but otherwise showing no special feature beyond its state of preservation. Dr. Walkhoff found that the dentine within the enamel cap was replaced by a fossilised organic matrix. From its condition he infers that it may be older in point of time than the remains found of Pithecanthropus, and is inclined to regard it as the earliest known trace of man.

Dr. E. Carthaus has prepared even a greater surprise for the readers of this memoir. In the same stratum as contained Pithecanthropus he has found traces of man's existence. These traces are:—(1) Certain splinters of bones and tusks; (2) hearth foundations and wood charcoal. He is quite aware of the fact that jungle fires by ignition from volcanic outbursts still occur in Java, but believes the appearances he has seen cannot be explained by any accidental conflagration.

On the slender evidence thus brought forward by Drs. Walkhoff and Carthaus, Fräu Selenka supports the theory that man was a contemporary of Pithecanthropus, and that therefore the latter is an aberrant form, taking no place in the line of human evolution. The evidence, in our opinion, is rather of the nature of suspicion than of fact; the Selenka expedition leaves the problem of Pithecanthropus—so far as concerns its structure and position, unchanged, but it may be otherwise as concerns its geological age. Dr. E. Carthaus regards the Pithecanthropus stratum as belonging to a comparatively recent Pleistocene formation; Fräu H. Martin-Icke finds that 87 per cent. of the gasteropods found in it are modern forms, and concludes that the formation must be well within the Pleistocene period; the evidence and opinion of the botanist, Dr. J. Schuster, tend to the same conclusion.

The problems relating to the estimation of the age of a fauna of a tropical and distant country are many and difficult; most palæontologists will follow the example of Dubois and look to the mammalian fauna as the means of fixing, if not the age, at least the degree of evolutionary change undergone by higher vertebrates in this part of the earth since the period of Pithecanthropus. It is the mammalian fauna which is best known; Dubois found remains of nineteen genera and twenty-seven species; Dr. H. Stremme and Dr. W. Janensch, who describe the mammalian remains of the Selenka expedition, found fourteen genera and seventeen species, many of which are new. The whole of the mammalian fauna contemporaneous with Pithecanthropus has been extinguished or modified, and hence those authorities lean towards Dubois's estimate that Pithecanthropus belongs to the Pliocene period. It is at least not on a point of geological age that Pithecanthropus can be excluded from the genealogy of modern human races.

Prof. Blanckenhorn's general summary of the results of the expedition constitutes one of the best chapters of this memoir. He recognises the difficulty of drawing a line between Pliocene and Pleistocene in the formations of Europe and the even greater complexity in correlating the geological data of Europe and Java. As a tentative hypothesis he places the age of Pithecanthropus in the first interglacial period, corresponding to the formation of the Norfolk beds; the Heidelberg man—whose lower jaw only is known from the Mauer strata—he places in the second interglacial period, while the Neanderthal race he assigns to the third period. From an anatomist's point of view this provisional dating will answer very well, for these three forms are certainly progressive steps towards the modern human type. A. KEITH.

DR. G. JOHNSTONE STONEY, F.R.S.

DR. JOHNSTONE STONEY has passed away, one of the last of those who, during the latter half of the nineteenth century, contributed to the development of the modern ideas of the constitution of the atoms, which have borne such a rich harvest during the last two decades.

It is often difficult to get back to the point of view from which to estimate correctly the pioneer work of those who took the first steps; often the new ideas introduced by them have become the commonplace, so to speak, of science, but it is just these first steps breaking away from the older positions which mark the far-seeing intellect.

So early as 1871 we find Stoney endeavouring to formulate a relation for spectral lines depending upon possible simple harmonic modes of vibration in the atom, and he succeeded in finding a numerical relationship of a simple character in the case of the hydrogen spectrum, which has proved to be the forerunner of much subsequent work. Twenty years later he returned to the subject in a paper in which he considered the question more systematically, viewing the internal movements of the atom as those of a planetary system. Much work had been done by others in the meantime in following up the clue which Stoney had found in the numerical relationships of the spectral lines of hydrogen, and he was able himself to show further that double and triple lines would be produced by perturbations of elliptic orbits described under controlling forces in the atom, double lines being attributed to apsidal motions, triple lines to precessional motions. These conceptions of the constitution of the atom afterwards found satisfactory

support in Preston's observations on the Zeeman effect.

He took a keen interest in the development of the kinetic theory of gases, to which he made notable contributions. In 1867 he arrived at his estimate of the size of molecular dimensions, which is substantially that made by Kelvin a year or so later, and by Loschmidt two years previously.

By utilising his value of the mass of the atom Stoney was able to give, at the Belfast meeting of the British Association in 1874, the first calculation of the atomic charge in electrolysis. To this quantity he gave the name *electron*, which is now very generally adopted, and has proved a most suitable term. It was to the orbital movements of the electrons in the atoms, to which, as we have seen, Stoney attributed in 1891 the spectral lines and their various singularities.

Stoney invariably invented a nomenclature for the quantities he was dealing with, where none already existed. Such new terms are continually to be met with in his writings. Many of them have been found by others to be most convenient, and have consequently taken root in science, as, for example, his term *wavelet*, employed advantageously in his papers on microscopic vision, in connection with his method of resolution into plane wave fronts. This facility in suggesting suitable terms proved most useful when serving on the now famous committee of the British Association which devised our present system of electrical units, and of which he was one of the early members.

Stoney was the first to see that the movements in Crooke's radiometer were not due to radiation directly, but arose from unsymmetrical gaseous impacts resulting from unequal heating of the surfaces of the rotating vanes. His original explanation, however, required modification, afterwards supplied by Maxwell and Osborne Reynolds.

He introduced into cosmical physics considerations of a limit to each planet's power of retaining a gaseous envelope, which are of the highest interest in connection with the moon and with Martian questions. He showed that helium, as well as hydrogen, must eventually escape from the earth's atmosphere, a fact with important bearings on the past history of the radio-activity of the materials of the earth's crust.

Stoney's ideas were sometimes rather ahead of the recognised requirements of the day, and consequently paid the penalty of neglect which unfortunately sometimes happens in such cases; indeed, one of his papers on a periodic scheme of the elements, predicting, among other points, the atomic weights of the "inert" group, remained unpublished on the mistaken advice of one of the greatest of his contemporaries. This very scheme is now thought by many to be the most satisfactory of any yet devised.

He was essentially of a philosophic turn of mind, and wrote several papers on ontology and kindred subjects, but at the same time he took delight in all new developments of both industry and science, rejoicing that his span of life had coincided with what he considered would probably prove in the world's history to have been the period of most rapid advance, flowing from the first systematic application of scientific method on an extended scale to industrial progress. He would describe how as a child he had witnessed the first use of illuminating gas in the streets of Paris, and would with evident pleasure recount the many achievements of man in his time.

Stoney was born in King's Co., Ireland, in 1826. His mother was a Blood of County Clare. His ancestry belongs to the Protestant settlers in Ireland of the sixteenth and seventeenth centuries, a class from which has sprung so many of our great men of science, including Hamilton, Stokes, and Kelvin, but which, through economic and political causes, is now fast disappearing. He came from strong stocks on both sides, which have provided an unusually large number who have made their mark, including four Fellows of the Royal Society.

He was educated at Trinity College, Dublin, taking high place in his examinations. He was anxious to devote his life to collegiate work, and sat for the fellowship examination, the entrance in Trinity College to this, but, as in many other cases, his brilliant intellect was lost to his university through the unfortunate working of an examination system, now happily to be abolished.

For many years he held the post of secretary to the Queen's University of Ireland, a position affording him small leisure for pursuing his scientific researches. To his official duties he gave a wholehearted service. This involved much organisation of the scattered colleges which constituted that university, and it was with unfeigned regret he saw the work of these years abandoned on its dissolution.

All who came in contact with Johnstone Stoney were impressed with his sincerity and devotion to all which makes for truth and righteousness. He was veritably a prophet as of olden time. Younger scientific men who have had the privilege of knowing him will not easily forget his kindliness and encouragement.

He died on July 1, after a prolonged illness, in his eighty-sixth year, at his residence at Notting Hill Gate, where he had lived for some years.

F. T. T.

NOTES.

A NEW attempt is being made to work the alluvial goldfield in Helmsdale, in eastern Sutherland. The existence of gold there has long been known, and some of the gold of the ancient ornaments found in north-eastern Scotland may have come from that district. The first modern attempt to work the field was in 1869, when gold was obtained in the Kildonan and Suisgill Burns, two tributaries of the Ullie, the main stream of Helmsdale. Royalty was paid on about 3000*l.* of gold, but the amount obtained is said to have been considerably higher. The largest nugget was found in the Kildonan Burn, and weighed two ounces. The richest alluvial deposits were in the Suisgill Burn, a higher tributary of the Ullie. This burn flows over mica schists belonging to the Moine system, which have been invaded by granite dykes. The existence of gold in this granite was recorded by Bryce in 1870. The workings were stopped at the end of 1869 owing to damage done to the fishing and the farmers. A serious effort to reopen the field is now being made by the Duke of Sutherland. Gold is being obtained, but whether it occurs in paying quantities has still to be proved.

DR. H. N. DICKSON, president of the Royal Meteorological Society, in a letter to *The Times* of Thursday, July 6, raises the question of increasing the utility of the daily forecasts of weather issued by the Meteorological Office by more effective distribution. His letter suggests the general restoration of the afternoon service of weather forecasts, which is now only operative in the summer months. "Presumably these could be issued all the year round, and they could easily reach the general public before the arrangements for the next day's work were finally completed, provided proper facilities for distribution were given." The history of the public announcement of weather forecasts in this country includes some interesting

chapters, and the last of them carries the story to the present day from the re-establishment of the issue of forecasts in 1879 by the Meteorological Council, which at that time was composed of Prof. Henry Smith, Warren de la Rue, Captain Evans, Francis Galton, Prof. G. G. Stokes, and Sir R. Strachey. After the experience of thirty-two years, it is time that a new chapter was begun in which the question of the distribution of forecasts should receive its share of attention.

WITH an extraordinary regularity, all the aviators in the European Circuit—with the exception of Valentine, who came to earth at Brooklands—recrossed the Channel in the last stage but one from Hendon to Calais on July 6. The following day Paris was reached by six of the competitors, the remaining three, Tabuteau, Védrines, and Barra, coming in at intervals during July 8, owing to various minor mishaps *en route*. The winner was Naval-Lieutenant André Conneau (who flew under the pseudonym of "Beaumont"), who completed the circuit in 58h. 36m. on a Blériot monoplane fitted with a 50 horse-power "Gnome" motor and a "Normale" propeller. His time works out at an average of more than 17 miles an hour. Those who obtained the next six places were Garros (Blériot), 62h. 18m.; Vidart (Déperdussin), 73h. 32m.; Védrines (Morane), 86h. 34m.; Gibert (R.E.P.), 89h. 42m.; Kimmerling (Sommer), 93h. 10m.; and Renaux (Farman biplane), 110h. 44m. Barra (M. Farman biplane) and Tabuteau (Bristol biplane) also finished. Renaux deserves a special word of praise, as he carried a passenger, M. Senoncques, throughout the race.

A SPELL of ideal summer weather has occurred recently over England, where in places the thermometer in the shade has risen to between 85° and 90°. For the country generally it is unfortunate that the high temperature was preceded by dry weather, and rains are now greatly needed. At Greenwich the thermometer in the shade exceeded 80° on the four days from July 5 to July 8, and on July 6, 7, and 8 it exceeded 86°, the highest temperature being 88°, on July 8. In the sun's rays the thermometer was 144° both on July 7 and 9. The shade temperature has not risen so high at Greenwich since the summer of 1906, when, it will be remembered, a reading of 94·3° was recorded on August 31, and on the three following days the readings were respectively 91·9°, 93·5°, and 91·0°, the last three observations being a record for September. The temperatures recently experienced are not excessive for July; in 1900, on July 16, the reading was 94·0° at Greenwich; in 1896, on July 14, 91·1°; in 1887, on July 4, 92·2°; in 1885, on July 26, 90·2°; and in 1881, on July 15, 97·1°, the latter being the highest temperature recorded at Greenwich since 1841. In the recent hot spell the thermometer registered 90° in London at Camden Square, at Epsom, and at Cullompton. A decided change of temperature set in during the evening of July 8, and the weather became much cooler, although the conditions continued dry. On July 11 the shade reading again touched 80° in parts of London, and a return of the hot weather seemed probable. The temperature experienced in England falls considerably short of that in the United States, where in many parts the sheltered thermometer has exceeded 100°. The official records of the U.S. Weather Bureau, which are not available in this country yet for a later date than July 2, show a temperature of 104° on that day at Marquette, Mich.; 104° at Valentine and North Platte, Nebr., on June 29; and 108° at Tuma, Ariz., on June 28 and 26. The hot spell in England can in no way be associated with the excessive heat in the United States. It is not conceivable that the heated air could traverse the whole extent of the North Atlantic. The atmospheric conditions were at the time similar in England and America, the type of weather being in both cases anticyclonic and the movement of the air very sluggish.

SIR HENRY MORRIS, Bt., has been elected president of the Royal Society of Medicine for the session 1911–12.

PROF. A. E. METTAM, principal of the Royal Veterinary College, Dublin, has been elected president of the Royal College of Veterinary Surgeons for the ensuing year.

Science announces that Dr. Leonhard Stejneger has been appointed head curator of the department of biology in the U.S. National Museum to succeed Dr. F. W. True.

THE council of the Royal Society of Arts has elected Lord Sanderson, G.C.B., chairman for the year 1911–12. Lord Sanderson has been a member of the society for more than thirty years.

DR. W. J. S. LOCKYER, whose recent articles upon the British solar eclipse expedition have interested many readers of NATURE, has just returned home by the *Mauretania*, quite recovered from the attack of fever which he had in Fiji.

THE death is reported, in his fifty-third year, of Dr. Julian W. Baird, since 1886 professor of analytic and organic chemistry at the Massachusetts College of Pharmacy, and dean of that institution since 1895. He had previously been on the scientific staff of the University of Michigan and Lehigh University successively.

MR. R. H. CHANDLER, of Kearsbrook, Belvedere, Kent, desires to direct attention to an exceptionally good section of the plateau drift of the chalk downs, exposed in a pit which has been recently opened by Mr. Benjamin Harrison, of Ightham. The section is in a field behind Two Chimney House, about half a mile from Terry's Lodge, near Wrotham, and is described as showing between 2 and 3 feet of plateau flints in a sandy clay, resting in pockets in the clay-with-flints.

THE Paris correspondent of *The Morning Post* states that the inauguration of the Aërotechnic Institute, near Versailles, founded by M. Deutsch de la Meurthe, who has endowed it with a capital of 20,000*l.* and a yearly income of 600*l.*, took place on July 6. The institute has been provided with all the apparatus necessary for experiments in aëronautics and aviation. Speeches were made by M. Steeg, the Minister of Public Instruction, M. Liard, Vice-Rector of the Paris Academy, and Prof. Appel, Dean of the Faculty of Sciences in the University of Paris.

WE are informed by the Royal Society that the Mackinnon studentships for the ensuing year have been awarded to Mr. T. F. Winmill, of Magdalen College, Oxford, for research in structural chemistry, and to Mr. T. Goodey, of Rothamsted Experimental Station, for research on protozoa in relation to the fertility of soil. The Joule studentship for the ensuing period of two years has been awarded to Mr. Albert Eagle, Imperial College of Science, for research on the thermal relations of spectra of gases and on cognate subjects.

AT the meeting of the Royal Society of Edinburgh on Monday, July 3, the Makdougall-Brisbane prize for the biennial period 1908–9, 1909–10, was awarded to Mr. E. M. Wedderburn for his series of papers bearing upon the temperature distribution in fresh-water lochs, and upon seiche phenomena which occur at the interface of two layers of different density, whether that difference be due

to difference of temperature or difference of salinity, published in the Proceedings of the society within the prescribed period, and also in the Transactions and Proceedings before and after that period.

A STRONG earthquake was felt at San Francisco and throughout a large part of central California and Nevada on the afternoon of July 2, and was evidently the most severe of all the successors of the great shock of 1906. The total damage was comparatively slight, but many buildings were cracked, part of the cornice of the Bank of California fell, and the coping of the Hall of Justice was cracked. The latter was one of the few buildings which escaped uninjured in 1906.

ON July 9, at 2h. 2·5m. a.m., a strong earthquake occurred in Hungary, the epicentre being at or close to Kecskemet, which lies about fifty miles south-east of Budapest. In this town, of some 50,000 inhabitants, nearly every house was damaged, some so seriously that they collapsed. In the neighbourhood of Kecskemet ten persons were killed by the fall of a house, and two others at Nagy Körös, twelve miles to the north-east. The shock was felt over a large part of Hungary, and was evidently of unusual strength when compared with previous movements in the same seismic centre. In his catalogue of Hungarian earthquakes for 1865–84, Fuchs records only seven slight shocks at Kecskemet or in the surrounding district.

ARRANGEMENTS have been made to hold the autumn meeting of the Iron and Steel Institute at Turin on October 2 and 3 next. On October 2 the members of the institute will be welcomed by the civic authorities of Turin, the Chamber of Commerce, and the reception committee of the Associazione fra gli Industriali Metallurgici Italiani. After the reception, the Carnegie gold medal for research for 1910 will be presented to M. Félix Robin, of Paris, and papers will be read and discussed. At the conclusion of the meeting, beginning on October 4, a tour in Italy has been arranged to visit Genoa, Pisa, Rome, Naples, Florence, Milan, and other places. Members desirous of attending the meeting must signify their intention on reply forms, to be obtained from the secretary of the institute, not later than August 22.

FROM a circular just received from South Africa we find that the ninth annual meeting of the South African Association for the Advancement of Science was to be held last week at Bulawayo under the presidency of Prof. P. D. Hahn. The four sections, with the name of the president in each case, are as follows:—Section A, astronomy, mathematics, physics, meteorology, geodesy, surveying, engineering, architecture, and irrigation; president, the Rev. E. Goetz. Section B, chemistry, geology, metallurgy, mineralogy, and geography; president, Mr. A. J. C. Molyneux. Section C, bacteriology, botany, zoology, agriculture, forestry, physiology, hygiene, and sanitary science; president, Dr. E. A. Nobbs. Section D, anthropology, ethnology, education, history, mental science, philology, political economy, sociology, and statistics; president, Mr. G. Duthie. The South African medal and fund for 1910 has been awarded to Dr. L. Peringuey, director of the museum, Cape Town.

THE United States Weather Bureau is forming in its library, at Washington, a collection of meteorological photographs, and will welcome additions thereto from all parts of the world. The following classes of pictures are among those desired:—(1) views of meteorological offices, observatories, and stations; (2) pictures of meteorological apparatus; (3) portraits of meteorologists—views of their homes and birthplaces; (4) views showing the effects of storms, inundations, freezes, heavy snowfall, &c.; (5) cloud photographs; (6) photographs of optical phenomena (rainbows, halos, Brocken specter, mirage, &c.); (7) photographs of lightning and its effects; (8) photographs of meteorologically interesting pictures in old books, or of early prints and paintings (*e.g.* contemporary pictures of the damage wrought by the great storm of 1703 in England). Persons who are willing to present such pictures to the Weather Bureau, or will furnish them in exchange for Weather Bureau publications, are requested to address: Chief U.S. Weather Bureau (Library), Washington, D.C.

DR. W. T. SHEPHERD has contributed to the Psychological Monographs, issued in connection with *The Psychological Review*, a paper entitled "Some Mental Processes of the Rhesus Monkey." His experiments lead him to conclude that this monkey is able to discriminate colours with speed and precision when it is presented with foods (rice) variously coloured red, pink, yellow, and green; that it can be trained to discriminate between double-octave differences in pitch of musical tones; that, alike in the formation and in the inhibition of habits, it is superior to the raccoon and far superior to various other mammals that have been examined. Dr. Shepherd believes that monkeys learn only to a limited extent by imitation, and that, although they may acquire a generalised mode of action when confronted with a series of similar problems, there is no evidence that they form true general notions or can truly reason.

The Japan Magazine for last April contains an interesting article, by Mr. Mikimoto, on the culture pearl industry, describing the methods employed in the Bay of Ago. Every year during the months of July and August small pieces of stone are deposited in those parts of the sea where the pearl oyster is abundant. In the third year of the oyster's life it is removed from the sea, and into the shells are introduced small pearls or pieces of nacre to serve as nuclei for the pearls. These are allowed to develop for at least four years, when they are taken up and the pearls recovered. The success of the industry is much restricted by the great mortality among the oysters due to what is called "red currant," an accumulation of microscopic organisms in the water, and a seaweed known to the Japanese as Mirumo (*codium*), which by its growth smothers the young oysters. These artificially grown pearls are said to resemble those of natural growth in colour, lustre, and symmetry. It is interesting to note that most of the work in this industry is done by women, who are believed by the Japanese to be able to remain longer under water and to perform more and better work than men.

THE report of the Lancashire Sea-fisheries Laboratory and Fish Hatchery for 1910 contains a number of interesting papers dealing both with economic and with more purely scientific subjects. Mr. James Johnstone's memoir on internal parasites and diseased conditions of fishes contains a detailed description of a new genus and species of trematode (*Paracotyle caniculae*), and Mr. W. J. Dakin provides a note on a new sporozoan from the whelk, which he also regards as belonging to a new genus and species (*Merocystis kathae*). Prof. Herdman, in conjunction with Mr. A. Scott, contributes part iv., dealing with the year 1910, of his report on the intensive study of the marine plankton around the south end of the Isle of Man, and in conjunction with Mr. W. Riddell gives an

account of some plankton observations made on the west coast of Scotland, and compares them with those made in the Irish Sea. There is, indeed, much truth in the remark of these authors that, "for a complete understanding of the plankton changes throughout the year in the Irish Sea, it is essential that we should have full information, not merely as to the larger organisms of the zoo-plankton, but as to the planktonic conditions in general in both surface and deeper water along the north coast of Ireland and off the west of Scotland."

A PAPER on the educational treatment of stammering children, by Dr. J. T. McHattie, with discussion thereon, has been issued by the Medical Officers of Schools Association, and contains much information on the causation and remedial treatment of this distressing condition.

MESSRS. GOETSCH, CUSHING, AND JACOBSON publish an important experimental and clinical study on the functions of the hypophysis cerebri, a small organ situated at the base of the brain. If either experimentally or in certain cases of brain disease an increased discharge of the secretion of the posterior lobe take place, an increased amount of sugar appears in the blood, apparently indirectly through the action of the secretion in causing an increased discharge of the glycogen stored in the tissues. Later an increased tolerance for sugars is established, often with a tendency towards general obesity (Johns Hopkins Hosp. Bull., xxii., No. 243).

WE published recently (June 29) a short article on the progress of radiography in medical diagnosis, and alluded in particular to the work of the staff at Guy's Hospital in their investigation of pathological conditions of the intestine. In this connection we note the appearance of a new paper, a reprint of which has reached us, by Dr. A. C. Jordan, medical radiographer to Guy's Hospital (*Brit. Med. Journ.*, May 20), in which he shows that it is often possible to detect duodenal obstruction by the X-ray method after giving the patient a bismuth meal. Diseases of the duodenum are often extremely obscure, and this new method of diagnosing the condition will be welcomed both by the medical profession and the sufferers from such complaints.

To the Entomological Research Committee (Africa) the Natural History Museum owes a beautiful enlarged model of the tropical rat-flea (*Xenospylla cheopis*), which appears to be the main vehicle in the conveyance of bubonic plague to the human subject. The species is believed to have been a native of North Africa, but is now practically cosmopolitan. The model is about 12 inches in length.

WE have been favoured with a copy of part xxvi. of the elaborate work in course of publication by Messrs. Friedlander, of Berlin, under the auspices of the Royal Prussian Academy of Sciences, entitled "Das Tierreich," of which Prof. F. E. Schulze is editor. The first part was issued in 1896, and from the commencement the editor has been greatly assisted by Prof. Fritz Edler von Maehrenthal, of the aforesaid academy, whose death at Berlin on August 28, 1910, is deplored in a special leaflet, with portrait, accompanying the present issue. Dr. von Maehrenthal was born at Olmütz, Moravia, on January 2, 1857, and, after spending his youth at Gratz, eventually became chief official of the Prussian Academy. In the present issue of the "Tierreich" Prof. L. G. Neumann treats of the acarines of the family Ixodidæ in the detailed manner characteristic of the work as a whole. We are likewise indebted to Messrs. Friedlander for a sale catalogue of works and papers on recent and fossil mammals.

THE June number of *The Quarterly Journal of Microscopical Science* (vol. lvi., part iv.) contains a full description, by Mr. R. Kirkpatrick, of the remarkable sponge *Merlia normani*, which the author has now obtained in quantity from a depth of 60 fathoms near Porto Santo, Madeira. The nature of this enigmatical organism seems likely to give rise to as much controversy as did that of Haliphysema or Astrosclera. Mr. Kirkpatrick has at length settled down to the view that it is a siliceous sponge of the monaxonellid family Haploscleridæ, which, in addition to the typical skeleton of siliceous spicules, secretes a basal skeleton of calcite. This basal skeleton takes the form of a horizontal perforated lamina, and the perforations are filled with what is believed to be sponge tissue. The evidence brought forward for this view, if not quite conclusive, is certainly very strong. The upper part of the organism, which rests upon the basal lamina, is an undoubted haplosclerid sponge, characterised by a new type of microsclere, to which the name "clavidisc" is applied, a name to which exception might perhaps be taken on the ground that the spicule is characterised, not by anything resembling a key, but by something resembling a keyhole. The author considers that the canal system of the sponge belongs to a new type, to which he gives the name "hymenopylus," characterised by the fact that the very wide openings of the flagellate chambers are guarded by a delicate sphincter membrane. It is probable that the flagellate chambers of most sponges are "hymenopylous," and the condition is very well known in the Calcarea, but, of course, such a structure can only be made out in exceptionally well-preserved material. The arrangement of the prosopyles, consisting "simply of spaces between the fused rays of the stellate bases of the collar-cells," which the author is led to believe may possibly occur among other tetraxonid sponges, has, of course, been known for many years in the common British *Halichondria panicea*. In short, the canal system appears to be of the normal eurypylous type so common amongst the Monaxonellidæ, and it was hardly necessary to coin a new term for the special benefit of this sponge. The paper is admirably illustrated, and will be read with great interest by all spongologists.

EXPERIMENTS described by Dr. R. Seeger in the *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften*, Vienna (vol. cxix., part 9), indicate that hemiparasites of the tribe Rhinantheæ transpire much more freely than autotrophic plants. Thus *Euphrasia Rostkoviana* and *Odontites verna* gave off 19 milligrams of water in 10 minutes, as compared with 6 milligrams transpired by *Veronica chamaedrys*, 1·8 by *Hydrangea hortensis*, and 0·48 by *Rhododendron hybridum*.

A FULL description of the forestry court at the United Provinces Exhibition held at Allahabad in December last year appears in *The Indian Forester* (March and April). The exhibition comprised timber specimens and products, trophies of sport, and other forest products which occupied the three main buildings. In addition there were installed a turpentine distillery, a wood-pulp laboratory, wood-working machinery, a lac factory, various artisan demonstrations such as the Hoshiarpur wood carvers, and an exposition of katha extraction. The success of the section may be largely accredited to the energetic president, Mr. P. H. Clutterbuck.

A SHORT note on comparative trials with calcium cyanamide, ammonium sulphate, nitrate of lime, and nitrate of soda as artificial fertilisers, is contributed by Mr. F. J. Chittenden to the Journal of the Royal Horti-

cultural Society (vol. xxxvi., part 3). Calcium cyanamide or nitrolim and nitrate of lime are both products manufactured at a high electrical pressure and compete individually with the other two fertilisers tested. The results obtained with turnip crops indicate that the first two are of about equal value, but are slower in their influence than the last two. Nitrate of lime suffers from hygroscopic defects, and provides weight for weight rather less nitrogen than nitrate of soda. Calcium cyanamide also presents physical difficulties which have been obviated by the production of a hydrated form.

THE account communicated by Mr. T. G. B. Osborn in *The Annals of Botany* (vol. xxv., No. 98) of the organism, *Spongospora subterranea*, producing "corky" or "powdery scab" of potatoes, is interesting not only for its economic aspect, but also for the cytological results recorded. In the earliest stage, the organism was observed as a uninucleate amœba in the meristematic potato cells. The amœbæ divide to provide units for the invasion of new cells, as also to form several individuals in each potato cell. Eventually the various amœbæ in a cell unite to form a plasmodium. Later on nuclei become very apparent in the plasmodia before fusion occurs in pairs (karyogamy); two karyokinetic divisions ensue, after which the protoplasm round each nucleus rounds off into a uninucleate spore. The author concludes that Spongospora is a member of the Plasmodiophoraceæ, which group has many points of relationship to the Mycetozoa, differing chiefly in the parasitic habit, the method of division of the vegetative nuclei, and by the less constant presence of a flagellum on spore germination.

MR. R. CORLESS contributes to *Symons's Meteorological Magazine* for June a useful article on the distribution of rain in a barometric depression. It is known that the heaviest rain usually falls on the left side of the path of the centre of a depression, irrespectively of the direction of its motion. The reason for this is shown by a diagram and a simple formula. For the sake of argument, the author considers a depression in which the wind at some altitude is blowing tangentially to the isobars, and for the immediate purpose all that is required is that when the path of the air is straight the relation vd=constant holds good between v, the wind velocity, and d, the distance between the consecutive isobars. When the path is curved cyclonically, the value of v as determined from this equation is theoretically too large; the error increases with increasing curvature, and the maximum curvature is shown to be on the left side of the path of the centre. The air has no alternative but to rise, and an ascending current of air is admittedly a cause of rain; it is in this region (the left front quadrant of the depression) that heavy falls of rain actually occur. Of course, rain falls in other parts, but its origin may be quite different from that here suggested.

UNDER the title "La Temperatura in Italia," the Italian Central Meteorological Office has published, as part i. of vol. xxxi. of its *Annales*, a very complete summary of the mean temperature of Italy. The main part of the volume is devoted to tables giving the mean temperature for decades, wherever possible, for each year of the period 1866–1906. The mean temperature is computed from observations taken at 9h. and 21h., and from daily readings of maximum and minimum thermometers, by the formula $\frac{1}{4}(9+21+\text{max.}+\text{min.})$. Data are given for about 120 stations, though only a small number of these can supply information for the whole period. The later chapters contain summaries of the information given in the main tables. We find in them values of averages and extremes for months, seasons, and years. Numerous plates showing the geographical distribution add greatly to the value of the work. The preparation of the data has been in the hands of Dr. Filippo Eredia, whose name is a guarantee for the excellent arrangement of the results.

IN 1908 a number of experiments carried out by Mr. H. E. Watson, of Trinity College, Cambridge, added about 200 new lines to the spectrum of neon, bringing the total number of lines to 321. Further research, the results of which are published in the June number of *The Astrophysical Journal* (vol. xxxiii., No. 5, p. 399), has shown that certain regularities, suggesting subdivision into "series," occur in the oscillation frequencies of these lines. The lines appear to be divided naturally into three groups, one of 252 lines extending from the extreme red to λ 4071, a second of 29 lines extending from λ 3754 to λ 3370, and a third consisting of 40 lines between λ 3167 and λ 2736. On investigating the oscillation frequencies, Mr. Watson finds that there are distinct indications of regular differences which suggest the existence of a principal and two subordinate series, in which the lines are grouped in triplets and quadruplets with constant frequency differences, the whole arrangement resembling the blue section of the red spectrum of argon investigated by Rydberg. The investigation of these brighter lines and of the numerous weak lines is being continued, and it is hoped that, by methods not purely mathematical, a further elucidation of this remarkable spectrum will result.

IN the abstract of Prof. Silvanus P. Thompson's paper on harmonic analysis, printed in NATURE of June 29 (p. 607), it was stated that the process described to find the coefficient of any term in the harmonic series set down was subject to a limitation. This limitation was expressed in the abstract issued by the Physical Society, but was omitted in the abridgment published in NATURE in order to bring the report of the society within reasonable limits of space.

OUR ASTRONOMICAL COLUMN.

A NEW COMET, 1911*b*.—A telegram from the Kiel Centralstelle announces the discovery of a new comet by Mr. Kiess at the Lick Observatory on July 6. At 15h. 23·7m. (Lick M.T.) the position was

R.A.=4h. 51m. 51·8s., dec.=35° 15′ 2″ N.

A later telegram gives the position on July 7, at 14h. 39·7m. (Lick M.T.), as

R.A.=4h. 52m. 54s., dec.=34° 52′ 17″ N.

The comet is fairly bright, magnitude 9·0, and has a tail, but its position, about 1½° north of ι Aurigæ, makes it a difficult object to observe in these latitudes. At 1 a.m. the altitude of ι Aurigæ is about 8°, and its direction is north-east.

NOVA LACERTÆ.—No. 5, vol. xxxiii., of *The Astrophysical Journal* contains a note by Prof. Frost discussing the observations of Nova Lacertæ and its spectrum, made at the Yerkes Observatory between December 31, 1910, and May 6.

A suspected nebulosity around the star, shown on the earlier photographs, was not confirmed by later observations with the telescope readjusted. Despite its distinctly red colour, the light from the nova was found to be strongly actinic, a phenomenon accounted for by the considerable extension of the spectrum into the ultra-violet. With the 40-inch telescope, Prof. Barnard found that a sharp crimson image of the nova, due probably to Hα, was formed 9 mm. further from the object-glass than the usual image, which conformed with the ordinary stars.

Two series of spectrograms were secured, one with the Bruce spectrograph, the other with an objective-prism

camera having a U.V. 15° prism; the scale of the latter is such that the distance on the plate from Hβ to Hθ is 3 mm. The outstanding features of the spectra are broad bright hydrogen lines, and a very strong bright band which Prof. Frost designates λ 4640. On the Bruce spectrogram (scale, 1 mm.=26·0 A.U.) dark shadings and bright maxima are suspected within these bright lines, and dark lines are seen on the more refrangible edges, especially in the cases of Hβ and Hγ. The displacements of the lines, if interpreted by line-of-sight motions, would indicate velocities varying from −1300 to +760 km. per second. Spectrograms taken on May 4 and 6 indicate a strengthening of the chief nebular line at λ 500, thereby suggesting that the change to the nebular state, apparently common to all novæ, had set in.

A number of observations of position, magnitude, and colour of the nova are recorded by various observers in No. 4509 of the *Astronomische Nachrichten*.

THE TAIL OF HALLEY'S COMET.—As an extract from No. 3 of *Ciel et Terre* we have received a paper in which Prof. Eginitis summarises the discussion concerning the appearance of the tail of Halley's comet on the night of May 20, 1910. Having demonstrated that an error of observation, at Athens, is out of the question, he explains the apparent digression between his observation and some others by the suggestion that at that time the earth was situated on, or very near to, the axis of the main tail. Thus only the nucleus bounded by nebulosity would be seen, and the form observed would be one that would change rapidly as the angle under which it was seen changed. The differences are thus reduced to a question of perspective, and it is argued that this would change quickly at that critical period.

THE GREAT RED SPOT ON JUPITER.—Mr. Stanley Williams, writing to the *Astronomische Nachrichten* (No. 4507), confirms the abnormal change of longitude of the Red Spot, which was observed by the Rev. T. E. R. Phillips and others. In addition, he remarks upon the great change in the visibility of the spot itself which has recently taken place. For several years the spot has been indistinct and not of its earlier characteristic red colour, but lately it has been, to Mr. Williams, not only a comparatively conspicuous object, but also strongly coloured. It would seem that the spot is now free from the overlying material which has for some time masked its characteristic clearness and colour. Mr. Williams's transit times, taken on May 10 and 17 and June 1 and 8, confirm the change of longitude, and show that the length of the spot has not changed; the difference of longitude, −7·7°, between June 1 and 8, if real, is remarkable.

DEFINITION OF THE TERM "DOUBLE STAR."—Having for some years been desirous of establishing a definite scope for the term "double star," Prof. R. G. Aitken recently prepared a scheme for this purpose and submitted it to the chief double-star observers of the world. The majority agreed that some restriction to the use of the term is necessary, while others believe that the difficulties in establishing a rigorous system would outweigh the advantages accruing from its adoption. Prof. Aitken publishes his scheme, and the correspondence respecting it, in No. 4505 of the *Astronomische Nachrichten*. His definition of a double star includes any two stars which come within the following limits of distance:—

1″	if combined mag. of components is fainter than		11·0
3″	,,	,,	,, 9·0 B.D.
5″	,,	,,	lies between 6·0 and 9·0 B.D.
10″	,,	,,	,, 4·0 ,, 6·0 ,,
20″	,,	,,	,, 2·0 ,, 4·0 ,,
40″	,,	,,	is brighter than 2·0 B.D.

JUBILEE MEETINGS OF THE INSTITUTION OF NAVAL ARCHITECTS.

THE jubilee meeting of the Institution of Naval Architects opened on Monday evening, July 3, with a reception by the president, the Marquis of Bristol, which was attended by members and delegates from all parts of the world. H.R.H. the Duke of Connaught took the chair at the meeting on the morning of July 4 as honorary president of the congress, and the president's address was delivered at this meeting. Reference was made to the death of the late president, Lord Cawdor, whose personality and zeal marked him out as a leader whom men would be proud to follow. The present congress had a twofold purpose—to commemorate the jubilee of the institution and to bring together from all parts of the world the great leaders in this sphere of industrial activity. The council desired to do honour to their guests from abroad, and had determined to invite the following to accept honorary membership of the institution, the highest honour in their power to confer:—H.M. the King of Norway, H.M. the King of Spain, H.M. the King of Sweden, H.I.H. Prince Henry of Prussia, H.I.H. Archduke Ferdinand, H.R.H. the Duke of Connaught, H.R.H. the Duke of Genoa, Prince Roland Bonaparte, Lord Rayleigh, Admiral Dewey, Admiral Togo, and Admiral Ijuin.

Sir William H. White gave an interesting account of the history of the Institution of Naval Architects, in which he referred to Sir Nathaniel Barnaby, the only survivor of the little group of men whose meeting on January 16, 1860, practically secured the establishment of the institution. Looking back upon work which has been done by the institution, it may be claimed that the intentions of its promoters, on the whole, have been well fulfilled; in some respects they have been surpassed. The meetings of the institution have afforded exceptional opportunities for the discussion of questions affecting the science and practice of naval architecture and marine engineering, the construction of warships and of merchant ships, the shipbuilding policy of Great Britain, the safety of life and property at sea, the introduction of new materials of construction and structural arrangements, the development of experimental methods of research, the introduction of new methods of ship calculations and design, and the discussion of new inventions of various kinds. Before the institution was founded, naval science had no home in England; its treasures lay scattered far and wide in the form of memoirs and papers contained in the Proceedings of the Royal Society or in other publications. Everything worthy of publication now naturally finds its way to the Transactions, and through them to naval architects, marine engineers, and others interested in these subjects throughout the world. Every great movement may be said to have been chronicled for fifty years.

Fifty years' architectural expression of tactical ideas formed the subject of a paper by Admiral Sir Cyprian Bridge. In the year 1860 what may be called the seventeenth-century type of man-of-war was still represented in the British Navy. The gun, as the weapon without a rival, conspicuously dominated tactics. The great change introduced in 1871, the virtual abolition of the broadside system of arming ships, occurred at a time when the contest between the gun and armour was in full progress. Tactical considerations receded into the background. In 1871 we adopted as a weapon of war the Whitehead locomotive torpedo. It is a remarkable fact that the adoption of this weapon and the limitation of a ship's gun-armament to a small number of the heaviest guns that she could carry occurred almost simultaneously. We made no tactical provision for dealing with torpedo attacks; reliance was placed on passive defence arrangements exclusively. The French were the first to break away from the position above indicated. They had a vivid perception of the great tactical principle that concentration of the effect of weapons should be the end aimed at, and that concentration of the weapons themselves is merely the means. They armed their ships in accordance with this principle, and other nations had to follow their example. The ships launched or designed for our own navy during the last dozen years of the nineteenth century and the first two or three years of the twentieth supply monumental evidence of the reviving, but far from dominant, influence of tactics.

Fifty years' changes in British warship machinery were dealt with by Engineer-Vice-Admiral Sir Henry J. Oram. In 1860 the Navy List included a total of 499 ships, having a collective indicated horse-power of 540,000. In 1910 the number of warships was 585, of approximately 5,000,000 indicated horse-power. The founding of the institution

coincided with the abandonment of the paddle-wheel in favour of the screw-propeller. The warship fitted with the most powerful machinery in 1860 was the *Warrior*, which had engines of 5469 indicated horse-power. The introduction of surface condensers was referred to, as also triple-expansion engines, the evaporator, and the steam turbine. The author also dealt with the troubles experienced in finding suitable boilers.

Mr. C. E. Ellis described the advances made in the manufacture of armour for ships during the last fifty years. To resist the attacks of guns of ever-increasing power, the thickness of side armour was increased from 5½ inches in the case of the *Agincourt* (1868) to 24 inches in the *Inflexible* (1881). The introduction of compound armour effected a revolution in ship protection. Its partial adoption for the turret protection of the *Inflexible* effected a saving of 600 tons in weight. Since then the efforts of Krupp, Captain Tresidder, and Harvey have led to great reduction in the weight of armour required. In evidence of this, a 12-inch plate, tested in 1897, was attacked by three armour-piercing projectiles of high quality. In each case the projectile was completely broken up, and no cracks appeared in the plate.

Dr. S. J. P. Thearle traced the developments in mercantile ship construction. Fifty years ago some of the ships of the mercantile marine were being built of iron, some of wood, and a small proportion were of composite construction. In 1860 the length of an average cargo steamer was less than 200 feet; now it has reached to 350 and 400 feet. Much of the development has been owing to the introduction of mild steel for iron. Finality has not yet been reached, nor is it likely to be in the near future.

It is of interest to note from the Hon. C. A. Parsons' paper, on the marine steam turbine, that there are now a total of 281 war vessels, 87 mercantile vessels, and 10 yachts fitted with his well-known turbines. The total horse-power of these amounts to 5,841,000.

An account of the progress of naval construction in Japan was given by Rear-Admiral Motoki Kondo. At present there are four navy yards in Japan, and two large private shipbuilding yards, capable of turning out the heaviest warships complete with their machinery. Armour plates of trustworthy quality are now being produced in the Kure Navy Yard. The author understands that the process is a special one invented by Japanese engineers, and that the results are fully up to the best armour plate of the day. The progress of naval engineering in Japan was described by Engineer-Rear-Admiral Terugoro Fujii, and the development of merchant shipbuilding in the same country by Dr. S. Terano and Mr. M. Yukawa. These acknowledged the debt which Japan owes to engineers in this country for advice and help.

A paper on the design and service performance of the Transpacific liners *Tenyo Maru* and *Chiago Maru* was presented by Prof. S. Terano and Prof. Baron C. Shiba. These vessels were built in Japan; they are the largest vessels yet produced in the East, and are the first turbine steamers in Pacific waters. During the last year, and owing to the uncertainty of oil-fuel supply in Japan and China, the owners decided to burn coal. Six of the boilers were converted to use coal, and the remaining seven still burn oil. It is found that the consumption of coal is 20 to 22 tons as against 14 tons of fuel oil.

Among the many other papers presented is one by Prof. A. C. E. Rateau, on the rational application of turbines to the propulsion of warships. Owing to the low efficiency at ordinary speeds, turbine machinery reduces by one half the radius of action. This does not have much importance to Great Britain, as she has naval bases in all the seas of the world; but other nations are not in the same position as regards turbines; indeed, one of the most powerful of these is about to replace turbines by reciprocating engines for her new battleships. The author describes a combination of reciprocating engines and turbines, introduced into the French Navy in 1906, which appears to meet the case. The destroyer *Voltigeur*, fitted with this system, shows consumptions, at speeds below 20 knots, slightly above those obtained in destroyers fitted with reciprocating engines. Above 20 knots the consumptions remain fewer than those of all other destroyers, even with turbines only.

On Wednesday, July 5, a large company proceeded to the National Physical Laboratory for the opening of the experimental tank. An account of the opening is given in another article in this issue.

THE OPENING OF THE NATIONAL EXPERIMENTAL TANK AT THE NATIONAL PHYSICAL LABORATORY.

THE National Experimental Tank for experiments on models of ships, recently completed at Teddington, was formally opened on Wednesday, July 5, and the great public interest taken in the work was evidenced by the number of distinguished guests who travelled to Teddington to be present at the ceremony. The chair was taken by Sir Archibald Geikie, who, as president of the Royal Society, is chairman of the general board of the laboratory, and he was supported by Lord Rayleigh, the chairman of the executive committee, with Lady Rayleigh, the Marquis of Bristol, president of the Institution of Naval Architects, and Lady Bristol; while among those occupying seats on the platform were Mr. A. F. Yarrow, Dr. Glazebrook, the director of the laboratory, and Mrs. Glazebrook, Sir Wm. and Lady White, Mr. G. S. Baker, the superintendent of the tank, and Mrs. Baker, H. E. Senor Edwards, Sir Wm. Crookes, Mr. R. W. Dana, Rear Admiral Capps, Herr Hüllmann, M. Bertin, Sir Norman Lockyer, Mr. Alex. Siemens, Sir J. W. Swan, Rear Admiral Moore, Mr. A. B. Kempe, Sir J. Rose Bradford, Sir J. Larmor, Sir Chas. Parsons, Prof. Unwin, Sir J. Wolfe Barry, Sir David Gill, and Mr. F. W. Black.

Sir Archibald Geikie, in opening the proceedings, referred to the efforts which had been made since 1901 by the Institution of Naval Architects to secure the funds necessary for the construction at the National Physical Laboratory of a tank for ship-model experiments of a national character, where facilities could be provided for experimental work necessary to shipbuilders to enable them to improve and perfect the principal features in the design of their vessels. The project has now been realised owing to the generosity and enthusiasm of Mr. A. F. Yarrow, who has provided the sum of 20,000*l.* for the construction and equipment of the tank, while the Institution of Naval Architects has secured guarantees amounting to 1340*l.* per annum towards the sum of 2000*l.* per annum for ten years considered necessary to ensure the successful working of the tank.

Lord Rayleigh, to whom fell the task of declaring the tank open, spoke of the pioneer work accomplished by the late Mr. William Froude, who in 1871 started a tank at Torquay, and by his investigations established the fundamental principles to be followed in the application of this method of research to the science of shipbuilding. The Torquay tank was followed by the Admiralty tank at Haslar, where the work so well begun by the father is now ably continued by his son, Mr. R. E. Froude. Other tanks are now in existence in shipbuilding yards in this country, as well as on the Continent and in the United States of America. At the request of the Institution of Naval Architects, Dr. Glazebrook has visited a number of these tanks, and every assistance has been cordially rendered him, in particular by M. Bertin in Paris and by Prof. Busley and Herr Gebers in Germany, in the effort to ensure that the new national tank, for which the laboratory and the nation are indebted to Mr. Yarrow, shall be thoroughly well equipped for its work. To the realisation of the scheme the architect, Mr. Mott, and the contractors, Messrs. Dick Kerr and Co., have also largely contributed, while the superintendent of the tank, Mr. Baker, and his assistants have worked hard to ensure that the details of the equipment should be in every way satisfactory.

In his further remarks Lord Rayleigh made reference to some of the more important of the principles established by Mr. Froude, and especially to the principle of dynamical similarity, which laid down the conditions and relations governing the application of "model" methods to problems of naval architecture, as well as to similar problems in aëronautics and other subjects. In illustration of this

principle, instances were adduced of its application in the domain of general physics, among which may be mentioned Lord Kelvin's proof of the "gravitational rigidity" of the earth.

In response to an invitation from Lord Rayleigh and a general demand from the assembled guests, Mr. A. F. Yarrow spoke of the needs, national and individual, which it is hoped the tank will help to fill. He was glad to have the opportunity of thanking those who have co-operated in furthering the scheme for the construction of a national tank, and especially the Institution of Naval Architects and Sir Wm. White. As in other branches of engineering practice, scientifically organised experiment is necessary to enable the shipbuilder to take advantage of every possible improvement in design. In the stress of competition with other nations it is imperative that no means of advance should be neglected. Shipbuilders must cooperate in furthering the development of their profession, on which the safety of the nation largely depends. The Admiralty has in the past led the way to progress, and it is important that in the future it should continue to encourage firms who show keenness to initiate improvements.

Lady Bristol was then invited to start the carriage by which the models are towed along the tank, and an experimental run was made and a record obtained of the resistance of a model specially prepared for the experiment. This record, in the opinion of the experts who examined it later, was of an extremely satisfactory character.

In replying on behalf of the Institution of Naval Architects, Lord Bristol spoke of the assistance given by the institution in the work of establishing the tank, and of the important practical results which it is hoped may be the outcome of the work to be undertaken.

At the conclusion of the proceedings connected with the opening ceremony, the visitors were entertained at tea in the grounds of Bushy House, and had the opportunity of visiting other departments of the laboratory.

A description of the tank and its equipment were given in NATURE in the number for June 15 of the current year.

ASSOCIATION OF TECHNICAL INSTITUTIONS.

SUMMER MEETING AT CAMBRIDGE.

THE Association of Technical Institutions holds two public meetings every year, the annual meeting in London in the winter, at which the important business of the year is discussed, and the summer meeting, held in different places throughout the country, which the members regard as much a friendly gathering for the informal interchange of information as a serious conference to listen to learned papers. Nevertheless, at the summer meeting, which was held at Cambridge on Thursday and Friday last, very important questions formed the subject of the papers.

Training of Technical Teachers.

On the first day the association discussed the qualifications and the training of teachers of technological and commercial subjects, papers being submitted by Mr. C. T. Millis, principal of the Borough Polytechnic, S.E., Mr. A. Nixon, principal of the Municipal Evening School of Commerce, Manchester, and Dr. T. Percy Nunn. In view of the extension of the provision in both day and evening schools of instruction in technological and commercial subjects, and of the still further extension which could be brought about by the raising of the school-leaving age, the council of the association felt that a discussion of the qualifications and the training of teachers would serve a useful purpose, and it must be said that if nothing very definite was produced by the papers, or by the subsequent discussion, the subject is a very thorny and difficult one, and any light thrown upon it is helpful. Mr. Millis and Mr. Dixon dwelt most strongly on the need for practical or workshop experience in the teacher, while Dr. Nunn represented more the pedagogic aspect of the case, and insisted on his qualities as a teacher rather than as a skilled workman. All three papers, of course, regarded the combination of the two qualities as ideal.

Mr. Millis summed up the essential and requisite qualifications in the training of a good technical teacher as follows:—(1) a fairly good education; (2) a liking for teaching others; (3) a sound practical knowledge of the trade or industry which he has to teach—this must be gained from actual experience; (4) a knowledge of the growing trade literature and of the improvements and changes in the methods and processes of manufacture; (5) attendance at classes in the trade subject he has to teach; (6) a sound knowledge of the science or art subjects cognate to the trade or industry; (7) ability to teach both theoretical and practical work; and (8) ability to teach with energy and enthusiasm.

Dr. Nunn admitted at the outset that on one hand the belief was held that all teachers would be the better for training, but that on the other some people regarded the idea of training the highest class of technological teachers as almost an absurdity. The latter view, he contended, was not based upon their universal efficiency. "Some of these teachers have been and are among the most brilliant masters of the craft of exposition. Others have been so amazingly bad that, like ancient heroes, they have become centres of legend. Their reputation for boring and bewildering their students has grown into the cherished mythology of the institution which their genius as investigators illuminated." Yet it was the training of the teachers at the other end of the technological hierarchy—the teachers of workshop arithmetic, science, &c., preparatory to technical instruction proper—which carried us to the heart of one of the most thorny educational problems. School teaching, especially on the scientific and mathematical side, Dr. Nunn remarked, should aim at illuminating the practical value of knowledge in relation to adult activities in which the boy can imaginatively enter. The following quotation from Dr. Nunn's paper sums up his view of the training of the preparatory teacher:—

"If there is to be no break between 'general' and technical education; if the technical ideal is to rule throughout, then there must also be continuity in the training of the teachers. There should be no teachers of mathematics and science who have not come into real touch with the technical spirit in its new and liberal form, and have not added to their academic equipment the practical outlook and sympathy which it generally lacks so woefully. Side by side with them, for the greater part of their training, should be the teachers whose stronger technical bias marks them out for charge of the preparatory technical work of the central elementary and continuation schools. Some actual workshop experience should be an essential constituent of their course of preparation. Finally, we should have the technical teacher proper, the man who comes to his class daily from the workshop or the mill. The ideal would be reached where there was the closest association in training between the man who has real technical knowledge, but is ultimately drawn to teaching, and the man who, having received some training as a teacher, spends the greater part of his life in the actual practice of the trade which he teaches in the technical institute."

The general opinion of the members who took part in the discussion is well represented by Dr. Walmsley, of the Northampton Polytechnic, who declared that the training of the technical teacher was to be sought, not in the class-room, but in the workshop.

The School Attendance Bill.

On Friday morning the members listened to a most able exposition of the Government's Education (School and Continuation Class Attendance) Bill by Mr. P. Sharp, secretary to the St. Helen's Education Committee. Sir H. F. Hibbert, president of the association, occupied the chair, and pointed out that the carrying of the Bill into practice would mean large additions to elementary day schools, large additions to the staff, and considerable increases in the number of evening continuation schools. The Bill would involve the abolition of half-time, and its consideration would therefore bristle with difficult points so far as Lancashire and Yorkshire were concerned. The views of the association are represented in a resolution, passed at the suggestion of Mr. Hewitt (Liverpool), seconded by Principal Reynolds (Manchester), to the effect that, "while cordially approving of the general principles of the Bill in the effort to secure continuous education of

all scholars under suitable conditions to sixteen years of age, this association is of opinion that the provisions of the Bill as introduced require considerable amendment, especially in the direction of fixing more definitely the age of fourteen as the normal age for leaving the day school and in the incidence of compulsion upon employers to afford facilities for the attendance of young people at continuation schools by the reasonable limitation of their hours of labour."

At the close of the business of the meeting the president presented, on behalf of the association, a handsome silver rose bowl and four candlesticks to Dr. R. S. Clay, principal of the Northern Polytechnic Institute, Holloway, "in recognition of his valuable services as honorary secretary from 1907 to 1911."

The master of Caius presided at a dinner on Thursday night at Caius College, and the president of Queen's College received the members on Friday night.

RALPH S. HYAMS.

THE OPENING OF THE NEW BUILDINGS OF THE ROYAL COLLEGE OF SCIENCE FOR IRELAND.

THE scientific work of the Department of Agriculture and Technical Instruction for Ireland received welcome recognition through the opening of the new buildings of the Royal College of Science for Ireland by the King, accompanied by the Queen, as the first act of the royal visit to Dublin on Saturday last, July 8. The ceremony was under the control of the Commissioners of the Board of Public Works, and a picturesque temporary hall had been constructed in the Great Quadrangle, through the open side of which the front of the new college was visible. The vice-president of the Department of Agriculture and Technical Instruction (the Rt. Hon. T. W. Russell, P.C.), the higher officials of the Department, and the professors of the college, had the honour of being presented to their Majesties. The King was pleased to announce that he had conferred a knighthood on Prof. W. Noel Hartley, F.R.S., dean of faculty of the college, whose absence through temporary illness was greatly regretted. The architects, Sir Aston Webb, R.A., and Mr. T. Manley Deane, and the builder, Mr. W. H. McLaughlin, were presented to his Majesty, who knighted Mr. Deane upon the spot. A pleasing feature was the introduction to their Majesties of a deputation of the foremen engaged upon the works.

The Minister in Attendance (the Rt. Hon. Augustine Birrell, P.C.) then asked the King to open the college, and their Majesties, conducted by the officers of the Board of Works, visited the building. Though the ceremony had little of an academic character, the large number of visitors honoured with an invitation must have realised the place taken by science in the educational system now being built up in Ireland, and the honour conferred on Prof. Hartley will be warmly appreciated. When the classes begin work in October in the handsome building now provided, it is hoped that a scheme of correlation may be introduced by which the Irish universities will take advantage of the courses of instruction in applied science in the college. It is important to remember that the maintenance of such courses, from the days of the Science and Art Department onward, has been recognised as a part of the system of public education, and that the new building of the Royal College of Science for Ireland represents visibly the stimulus given to scientific observation and research by Sir Horace Plunkett and his colleagues when they reorganised the agricultural and technical instruction of the country.

THE EUGENICS EDUCATION SOCIETY.

THE annual report of the Eugenics Education Society shows how much progress has been made by the society during the three years of its existence. Besides quick growth of the parent stem, branches have spread from Liverpool to New Zealand; indeed, in New Zealand eugenic ideas seem to be making their way into legislation.

The main feature of the report, however, is the address of the new president, Major Leonard Darwin. Major Darwin emphasises the view that the study of heredity and its application to sociology is the main function of eugenics. He says:—

"Although the science of heredity is now young, yet certain not hitherto widely recognised conclusions can already be preached with absolute confidence:

"(1) That men are very differently endowed by nature in inherent mental and bodily qualities. . . .

"(2) That in normal conditions, although [individual] children differ widely from their parents, yet each generation closely resembles its predecessors in average inherent qualities; a truth which applies to every nation, and every separable section of a nation.

"(3) That it follows from these premises that, if one nation is more highly endowed than another in inherent qualities, that superiority will remain with it generation after generaton in the absence of disturbing causes. . . .

"(4) That if the least naturally gifted sections of a nation are reproducing their kind more rapidly than are those more highly endowed in mental and physical qualities, then the higher are being swamped by the lower, and the nation is decadent. . . .

"(5) Lastly, that whilst every effort to improve the environment of the nation should be made, modern science indicates that the beneficial results on the race of possible changes in external conditions are, in nearly all cases, likely to be far less than was formerly believed to be the case, the advantages being, moreover, probably dependent on the maintenance of the reforms in question; whereas no assignable limit can be placed to the amount of the improvement in the condition of the nation which might in time result from reforms affecting its inherent qualities, the results thus attainable being also of a vastly more permanent character."

In the necessary application of these principles in practice, Major Darwin places in the forefront the need of legislative power to segregate the feeble-minded. He says:—"Here the difficulties encountered ought not to be great, since public opinion is already largely on our side." Doubtless, instructed public opinion is almost or quite unanimous. But, unfortunately, instructed public opinion has little voting power in present political conditions, and the long delay in carrying out the recommendation of the Royal Commission on Mental Defect is impressing on us the unwelcome fact that the Government and Legislature will take no action, even in a case which is urgent and patent to every thinking man, unless there are votes behind it. All the more need exists, therefore, for the efforts of such associations as the Eugenics Education Society to awake the nation to the evils of further inaction.

On the other side, Major Darwin rightly points out that much might be done by the adjustment of taxation to give really effective economic relief to households consisting of large families of sound stock. He also revives the suggestion that the Government as an employer should pay salaries to include an allowance for every living child. As Government employees are usually picked men, this proposal has definite eugenic value.

Major Darwin concludes with a striking passage on the moral question. He says:—

"With regard to the moral aspects of eugenics, what is it which has hitherto been the chief aim of the moral teacher? Has it not been to enforce the necessity of self-sacrifice for the sake of our fellow creatures? The eugenic reformer now demands an enlargement of this code in the light of facts unknown to our ancestors, and pleads for the self-sacrifice of this generation for the sake of the moral and physical welfare of the countless millions of the unborn of the future. May not this be the greatest moral question of all?"

W. C. D. W.

PERUVIAN ANTHROPOLOGY.

UP to the present, the dearth of knowledge regarding the people of Peru has been due to the almost complete lack of anthropological examination of the living subject and to the nature of the material available, consisting largely of skulls accidentally or artificially deformed, normal specimens from this region being rare in our existing collections. We knew in a general way that Peru, shortly before the conquest, was peopled by at least three

or four Indian races: the Aymara and Quichua in the central and southern highlands; the Huancas in the north; the Yungas or Chinchas along the coast, besides several still unclassified tribes in the north-eastern and northern territories. From recent accessions of material collected by the American museum, we are now able to differentiate the Aymara, representing a dolicocephalic type, from the middle coast people, who are brachycephalic. Further information has now been collected by Dr. Ales Hrdlicka, curator of physical anthropology in the United States National Museum, who has recently made a hasty tour through the coastal region and a more careful examination of two important sites, Pachacamac and Chan-chan or Gran Chimu. The results of his investigations are published in vol. lvi., No. 16, of the Smithsonian Miscellaneous Collections.

It now appears to be certain that the whole, or the greater part, of the Peruvian coast was originally peopled by a race of a single type, brachycephalic Indians of moderate stature. The remains of the earliest people are found in the huacas and some cemeteries associated with pottery of simple but interesting forms. Metal is scarce, and when found is gold. These people were followed by others of the same fundamental type, but of different habits, as is shown by the fact that their skulls have been subjected to occipital flattening and fronto-occipital deformations. In their graves are found copper and brass, with a little gold and some simple pottery. Upon this brachycephalic people a dolichocephalic race, probably from the north, intruded, and were the makers of the more highly ornamented pottery, some specimens of which are illustrated in this memoir.

The material collected by Dr. Hrdlicka contributes some other interesting facts. No case of rachitis was observed, and in only one vertebra was there indications of tuberculosis; but the evidence is not quite conclusive, and the age of the grave is uncertain. The specimens indicating syphilis were recent. Fractures were rare, the setting defective, and there were no indications of surgical skill. The evidence for trephining is confined to a single case. Finally, it is clear that the ordinary collections of Peruvian pottery possess no scientific value, as it is usually a heterogeneous mixture of specimens of different races and epochs. The work of exploration must begin *de novo*, and the new race of archæologists must adapt those methods of scientific excavation of which the work of Dr. Arthur Evans in Crete and Prof. Flinders Petrie in Egypt are such excellent examples.

AËRONAUTIC INVESTIGATIONS.[1]

THE Advisory Committee for Aëronautics was appointed in April, 1909. The first report of the committee was prepared in April, 1910, and presented to Parliament in July of that year. At the date of the preparation of that report no very large amount of experimental work had been completed: the first year's work was necessarily largely devoted to an examination of the ground to be covered, with a view to the determination of the questions upon which experimental information was most urgently required, and to the design and construction of the necessary apparatus.

The aim of the present report is to give a general account of the work of the committee during the year 1910–11. The technical papers giving the detailed results of the various investigations which have been carried out by the experimental department, with other reports and memoranda of general interest which have been laid before the committee, are no longer included with this report, but will be collected together in a volume to be issued separately. This will be referred to as the Technical Report of the Committee for the year 1910–11.

During the past year the committee has had under consideration a large number of questions which have arisen in connection with the constructional work in progress at Farnborough and at Barrow. At the National Physical Laboratory, also, a considerable proportion of the experimental work has been directed towards the solution of specific problems of airship design and the determination of the necessary experimental data. In addition, research of a somewhat more general character has been carried out, and some results of fundamental importance with reference to the future work to be undertaken have been arrived at.

Equipment for Experimental Work.—The principal apparatus which has been installed at the National Physical Laboratory for the purpose of the researches in aëronautics now in progress was described in the report of the committee for 1909–10. The most interesting and novel addition to the equipment during the past year is a circular rotating water channel, to be used for determining the forces acting on plates and small models in a circular stream of water. It is hoped that, with the aid of this, certain data of fundamental importance in connection with the motion of an airship may be determined, and, in general, that the forces acting on aircraft when executing turning movements in the air may be investigated. In addition, a special water tank has been provided for the study, by visual and photographic methods, of the eddying motion in the rear of plane and curved surfaces, balloon bodies, &c.

Air and Water Channels.—The laboratory has now at its disposal for resistance experiments two air channels—the larger air channel of 4 foot square section, specially constructed for the aëronautical work, and the circular channel of 2 foot diameter, previously employed by Dr. Stanton in his researches on the resistance of models in a current of air—and a water channel which continues to be of much value for obtaining results from which the corresponding data for air can be immediately deduced.

With these various means a large amount of experimental work has been carried out throughout the year. This work has included the determination of the resistance of a number of airship bodies of different forms, and the measurement for these forms of the "lift" and "drift" at various angles to the wind; the investigation of the relative stability of different airship models, and of the stabilising action of fins of different area and in different positions; the determination of the efficiency of various types of rudders and lifting surfaces, plane and curved; the air resistance of wires, stationary and vibrating, of stays and ropes, of model gondolas, model radiators, &c.; the investigation of the forces due to the wind acting on models of dirigible sheds of different forms; and of the forces acting under various conditions on a model of a girder of the type employed in the new Paulhan aëroplane.

Resistance and Directional Stability of Airship Models.—Perhaps the most interesting investigation among those enumerated above is that on airship models. The investigation has comprised a large series of observations on models of different forms, carried out at intervals throughout the year. The work has been directed to the determination of the head resistance for motion parallel to the axis, the "lift" and "drift" for motion oblique to the axis, the magnitude of the moment tending to increase the obliquity—called hereafter the negative righting moment—when the ship is at different angles to the relative wind, and the amount of fin area necessary to give a positive, in place of a negative, righting moment.

The work has been carried out in cooperation with the superintendent of the Army Aircraft Factory, who provided the models for the tests, the head and tail curves for which were systematically varied according to a plan devised by him. The object of the tests for head resistance was to determine the amount of change in resistance due to specific alterations of the curvature in head or tail, and ultimately to determine the forms of minimum resistance for a given gross lifting power and for a given net lift. The experiments led to the adoption of certain curves for head and tail, with a ratio of total length to maximum diameter of about 6 : 1.

The experiments on models inclined to the current determined the amount of dynamic lift obtainable owing to the inclination of the airship to the horizontal, as distinct from that directly due to the elevating planes, and at the same time the increase in head resistance owing to the obliquity.

The complete investigation of the conditions affecting the stability of path of an airship will no doubt take a

[1] From the Report of the Advisory Committee for Aëronautics for the Year 1910–11. [Cd. 5706.] (London: Wyman and Sons, Ltd., 1911.) Price 1½*d*.

considerable time to complete, but results of practical importance have been obtained in the determination of the negative or positive righting moments acting on models of airships of different forms. If an elongated model of the customary fish-shaped form be supported in a current so that it can turn about an axis through its centre of gravity, it tends to set itself at right angles to the current; when it is oblique to the current a moment acts on it tending to increase the obliquity. The amount of this moment has been investigated for different angles of obliquity in the case of several models; combined with the measurements of "lift" and "drift," this enables the magnitude and line of action of the resultant force on the model at any obliquity to be determined.

The next step was to find the amount of fin area necessary, and the best position for the fins, to give a positive in place of a negative righting moment. Experiments for this purpose have been carried out, and have led to interesting results. It was found, even with a considerably elongated tail, that if the fin were placed towards the rear of the tail and close to the body, the portion of the fin nearest the body was comparatively inactive, owing to the slow movement of the stream in this region. This slow motion of the stream near the tail was confirmed by photographs taken to investigate the nature of the flow past fish-shaped models.

These experiments have enabled the amount of fin area necessary to give a positive righting moment to be determined. Other questions which have to be investigated in connection with the general problem of stability are the effect of the instability of the wake, which does not leave the tail symmetrically when an airship body is moving parallel to its axis, and the "damping" action of the air as regards any motion which involves rotation, as when oscillations are set up, or in turning. Apparatus has been constructed with the aid of which it is hoped that the damping coefficient may be determined, and the effect of wake instability examined.

Air Resistance of Wires and Ropes.—The experiments which have been carried out on wires and ropes have also furnished results which will probably be of general interest. The tests were made on a large number of wires and ropes, including smooth wires of diameters ranging from 0·04 to 0·25 inch, with wire ropes of five or six strands and hemp ropes of three strands of diameters ranging from 0·1 to 0·6 inch.

The air resistance of the stranded ropes, per unit of the sectional area exposed to the wind, is found to be of approximately the same amount as that for small square plates. No great difference was found between wire ropes and hemp ropes at the same velocity. In the case of smooth wires, the resistance per unit of sectional area is appreciably less, the difference being of the order of 20 per cent.

Experiments were also made on the air resistance of vibrating wires; no appreciable effect on the air resistance was found at the vibration velocities reached, whether the wires were made to vibrate in a plane parallel to the direction of motion or perpendicular to it. It may be inferred, therefore, that in practice the air resistance of wires can be calculated on the basis of the values given for stationary wires in the table printed in the account of these experiments given in the technical report.

It is of interest to note that the values found at the National Physical Laboratory are in close agreement with the results obtained, also during the past year, for the resistance of stationary wires and ropes at the well-known aërodynamical laboratory at Göttingen under the direction of Prof. Prandtl. The work on airship models, and the results for the resistance of inclined plates, are also in general accordance with the observations of a similar character which have been made at Göttingen.

Wind Resistance of a Radiator of Honeycomb Type.—Experiments have also been made on the wind resistance of the honeycomb form of radiator. For the purpose of these tests, a scale model was made and its resistance compared in the wind channel with that of a solid block of the same external dimensions. The conclusion was that the wind resistance of such a radiator, in which the net area is about 25 per cent. of the total area, is approximately one half that of a flat board of the same dimensions.

It was considered of some interest to determine also the velocity of the air flow through the tubes of the honeycomb, and its variation with the length of the tube. In these experiments the tubes of the actual radiator were employed, and with a tube length of about 4 inches the wind velocity in the tube was found to be about three-fourths of the mean wind velocity outside. Reducing the length of the tube by one half produced an increase of only about 15 per cent. in the air velocity through the tube.

The general conclusion was that the honeycomb form of radiator is fairly efficient, and it does not appear that any considerable increase in efficiency can be obtained by diminishing the length of the tubes or by increasing the ratio of diameter to length beyond the value, viz. 1 : 12, which obtained in the type tested.

Other Tests in the Air Channel.—Among the other investigations which have been made in the air channel may be mentioned a series of tests on models of dirigible sheds of different design to determine the resultant force on each due to the wind; tests to determine the wind resistance of a model gondola; and a number of experiments on a model of the girder designed by Fabre and used in the new type of Paulhan aëroplane. The experiments on this girder were directed to the determination of its head resistance at various angles to the relative wind and also of the lift obtained from it when inclined about an axis parallel to its length. It was found that the efficiency of the girder, regarded as a small biplane, was about 50 per cent.

Small Water Channel for Visual and Photographic Work.—A small water channel has been constructed with a view to the investigation of the nature of the flow round an obstacle in a fluid medium. In this a steady stream of water is kept in motion, into which small models of plates, aërofoils, airship bodies, &c., can be introduced, and the nature of the flow can be studied with the aid of colouring matter added locally to the water.

With this apparatus interesting photographs have been obtained of the flow past plates and balloon models. These have shown that even for an elongated fish-shaped airship model the relative velocity of flow near the tail is considerably less than in the main stream, thus explaining the relative inefficiency, as regards the production of a righting moment, of the portion of a stabilising plane close to the body in this region.

Some valuable information has also been obtained with this apparatus as to the eddy formation in the rear of plane and curved plates, and the experiments on these will be continued.

Wind Pressure on Square Plates.—In connection with questions arising out of the model tests and the determination of the correction factor, if any, to be applied in passing from the results obtained in small model experiments to the corresponding full-scale values, an examination has been made by Messrs. Bairstow and Booth, of the National Physical Laboratory, into the experimental results obtained by different observers for the air pressure on square plates. Both Eiffel and Stanton in their experiments on square plates have found that the wind resistance per square foot of a small plate is less than that of a large plate, the difference, according to Stanton, as between plates 2 inches square tested in the wind channel and plates 10 feet square exposed in the open being about 20 per cent.

In the report of the committee for the year 1909–10 (p. 38) Lord Rayleigh pointed out the general form which, according to dimensional theory, the law of variation of resistance with dimensions must assume, and showed that such a variation as found by Stanton for square plates involved also a departure from the law according to which the resistance of a plate in a current of air is taken to be proportional to the square of the velocity. Messrs. Bairstow and Booth have shown that a formula can be found, falling under the general type indicated by Lord Rayleigh, which accurately represents the results both of Eiffel and Stanton over the whole range to which their experiments extended when both the dimensions of the plate used and

the air velocity at which the results were obtained are taken into account.

The question is one which is at present mainly of theoretical interest, and the importance of which lies in the light it may throw on the comparison of water and air resistances. Lord Rayleigh in a second note, also printed in the technical report, has discussed the matter further, and has pointed out some difficulties in reconciling the general formula with certain conclusions from experiment. Some evidence is furnished by results recently obtained by Dr. Stanton in experiments on the flow of air in pipes and by the study, by visual methods, of the flow past obstacles in a water channel, but the matter demands further investigation before a final conclusion can be arrived at.

Friction of Air in Pipes.—Among the reports included in the technical report is a preliminary communication by Dr. Stanton of some results obtained for air friction by means of experiments on the flow in pipes, in which the effect of changes in the dimensions and roughness of the pipes is discussed. Some of the pipes tested were artificially roughened by cutting right- and left-handed screws along the inner surface of the pipes of pitch and depth proportional to the diameters. It is interesting to note that the dimensional relation for these artificially roughened pipes is precisely similar to that found by Messrs. Bairstow and Booth in their examination of the experiments on the normal resistance of flat plates of different sizes, referred to above.

Whirling Table and Propeller Tests.—A description of the whirling table and of the design of the dynamometer was given in the report of the committee for the year 1909–10. A number of tests on propellers of different types have been carried out with the apparatus there described, and particulars of some of these tests are given below. Recently, with a view to obtain increased propeller speeds, up to 3500 revolutions per minute, and a greater range and sensitiveness in the measurements, a motor of greater horse-power has been provided to drive the propeller, and a new dynamometer has been designed and constructed. A brake has also been added, since at high propeller speeds the propeller alone in some cases drives the whirling arm faster than is desired.

With the view of reaching as high an accuracy as possible in the future tests, especially at the higher speeds of translation, a careful study has been made of the motion set up in the air of the whirling table shed by the rotation of the whirling arm. As a result of the experiments, it was found that when the end of the arm was travelling at a speed of 35 miles per hour the mean velocity of the air in the shed at the boundary of the circle described by the arm was about 2 miles per hour, while the velocity of the air into which the arm was entering was 1·6 miles per hour. The air velocity was also found to be approximately proportional to the arm speed. The second figure gives the air swirl correction to the arm speed at 35 miles per hour required for the purpose of the propeller tests. In all future tests a direct determination of the swirl velocity will be made and the necessary correction applied.

Effect of Blade Area on Propeller Efficiency.—At the request of Captain Sueter, a series of tests was made to determine the effect on propeller efficiency of varying the width of blade. The tests were made on model propellers designed and supplied by Messrs. Vickers, Ltd., whose representative visited the National Physical Laboratory for a few days in order to take part in the work. Messrs. Vickers were also good enough to furnish the results of tests made at Barrow on a full-sized propeller, in order that these might be compared with the results of the small model experiments made at the laboratory.

For comparison with the full scale results, a test was first made on the corresponding model propeller at a speed of translation having a ratio to the test speed of the full-sized propeller equal to the ratio of the square roots of their linear dimensions. It was found that, for the same slip, the thrust and efficiency given by the model experiments differed only by a small amount from the values they should have as deduced by calculation from the full scale tests. The experiment is important from the point of view of the prediction of full scale results from small model tests, but the work so far done is not sufficient to justify any general conclusion as to the validity of the "model" law, which proved in this instance to be correct. It is hoped that further comparisons may be carried out shortly.

The further tests on the series of models were made at the speed of translation suggested by this preliminary work, and by reducing the width of blade from that used in the above experiment an increased efficiency was obtained. It was found that the maximum efficiency was reached at a disc area ratio of approximately 0·19.

Other Propeller Tests.—A series of tests has been made for the superintendent of the Army Aircraft Factory on some Ratmanoff propellers, to the design of M. Drzewiecki, who also paid a visit to the laboratory. These tests are not yet entirely completed, the intention being to carry them up to speeds of the propeller tip in the model equal to those occurring in practice with the full-sized propeller. For this work the new apparatus recently installed is required.

The particulars given in the detailed account of the propeller tests of the work so far done will, however, be found of interest. As is well known, the aim in the design of this propeller is that each element of the blade should strike the air at the same angle of maximum efficiency, the propeller being run at a definite ratio of translational speed to speed of rotation. The maximum efficiency reached with any of the propellers tested, at the propeller speeds attainable at the time when the tests were made, was 67 per cent., at a speed of translation of about 30 miles per hour.

In addition to the above, other experimental tests have been made, and some propellers have been tested for private firms or individuals.

Balloon and Aëroplane Fabrics.—A considerable amount of work has now been carried out at the National Physical Laboratory in connection with the testing of fabrics. The materials tested have included rubbered fabrics by various makers, oilskin, varnished silk, and other fabrics with special proofing, goldbeaters' skin, &c.

Strength Tests.—The apparatus employed for tensile tests has been supplemented by a testing machine by Messrs. Avery. This has been modified to enable wide variations in the rate of loading to be obtained. The dimensions of the test specimen now regularly employed are 20 cm. between the jaws of the testing machine by 5 cm. wide, and the usual rate of loading is such as to fracture the specimen in not less than two minutes.

Experiments to determine the effect of varying the rate of loading have been made, and it was found, for a particular fabric, that the ultimate strength found by rapid loading was about 14 per cent. higher than that found by slow loading. The rate indicated above as that now employed is practically equivalent to a dead-slow rate.

The existence of the speed effect just mentioned suggested the probability of a fatigue effect, and this question was also investigated. Some difficulty was experienced in devising a satisfactory method of test, as owing to the large and unavoidable variations between one sample and another, the usual methods of making fatigue tests are not applicable. With the method finally employed it was found that the strength of the particular fabric tested to withstand repeated applications of stress was about 11 per cent. lower than the strength taken on a single specimen loaded to rupture.

Bursting Tests.—Difficulties were originally found in making bursting tests owing to the fact that most of the earlier cylinders tested broke at the join. Finally, a cylinder of diagonally doubled material was obtained which did not burst at the join, and which broke at very high stresses. Damage done in this test led to the redesigning of the apparatus, and in the new apparatus arrangements have been made to enable the cylinder to be subjected to longitudinal tension in addition to internal pressure.

An account is given in the technical report of an interesting series of tests carried out with this apparatus. In these tests the ratio of the circumferential to the longitudinal stress varied from 2 : 1, corresponding to pure bursting test, to 0 : 1, corresponding to a pure tension. The tests appeared to indicate that the strength in warp or weft is approximately independent of stress applied in the direction at right angles. The behaviour of fabrics under various ratios of compound stress is being further examined

by a graduated series of tests on a number of bags of a specially selected fabric.

In the above tests it was found that bags of parallel doubled material and of the same material diagonally doubled appear to be of nearly the same strength for a 1 : 1 ratio of stresses, while the tensile strength of the latter determined in the usual way is only half that of the former.

An account is also given by Mr. O'Gorman in the technical report of a large number of bursting tests carried out at the Army Aircraft Factory on a variety of fabrics. The object of these tests was to obtain a comparison with the ordinary tensile tests. The results showed that, on the average, the bursting tests on parallel doubled rubbered cotton gave results a little higher than the tension test, while for diagonally doubled fabrics the mean of the bursting tests was about 1½ times as great as the tension test. For single oilskin the bursting test gave a slightly lower figure than the tensile.

Tearing Tests.—Some tests have been made to determine the effect of a small wound in the fabric on its strength, with the view of indicating, if possible, the factor of safety necessary to ensure that such a wound or tear shall not immediately spread. The disturbance of stress distribution caused by such a wound is accommodated within a large but finite area of the fabric, which may be called the "danger rectangle." It was expected that the applied stress causing rupture of a specimen containing a relatively small cut of fixed magnitude would be independent of the dimensions of the specimen provided it were at least as large as the "danger rectangle," and the results obtained were in agreement with this theory. The necessary factor of safety for wounds of different sizes was given, for the particular fabric tested, as the result of these experiments. The work was limited to wounds of small size, which would, however, include ordinary bullet holes; apparatus is under construction to enable the work to be extended to wounds of larger dimensions.

Permeability Tests.—A large number of rubbered and other fabrics have now been tested for permeability by hydrogen. The apparatus employed continues to give satisfactory results, which can be relied upon to a high degree of accuracy. The practical conclusions to be drawn from these tests, especially when considered in conjunction with the weathering tests, would appear to be of considerable importance.

In the case of rubbered fabrics, the permeability is found to be more or less directly dependent on the quantity of rubber employed; the lighter rubbered materials show a higher permeability, a number of samples tested exceeding the maximum of 10 litres per square metre per twenty-four hours usually allowed in French specifications. This is especially the case with the parallel doubled cloths examined, and the work done points to the superiority of diagonal doubling from this point of view. The permeability of rubbered fabrics increases rapidly with rise of temperature, the increase being as much as 9 per cent. per degree centigrade in the samples tested.

Samples of oilskin, varnished silk, and of other fabrics proofed in various ways have also been tested for permeability. The exact nature of the proofing is not in all cases known. Some of these have shown excellent qualities as regards their hydrogen-holding capacity, the permeability in many of the samples being less than 1 litre per square metre per twenty-four hours, and in some instances not exceeding a quarter of this amount, with a less weight than that of the lighter rubbered fabrics above referred to. In some of these fabrics the hydrogen-holding capacity appeared to improve with rise of temperature.

Tests have also been made on a number of samples with joins. In the rubbered fabrics tested, and in some of the others, the permeability of the join was no higher than that of the rest of the fabric, but with proofing other than rubber the join has sometimes been found to have a much higher permeability. This is a point, therefore, to which attention must be paid. The joins have also sometimes shown a deficiency in tensile strength.

Weathering Tests.—The weathering tests of fabrics have been directed to the determination of the rate of loss of tensile strength and the rate of increase of permeability due to exposure in the open. The rate of diminution in tensile strength does not show any very important difference between the rubbered fabrics tested and those proofed in other ways. It is of interest, however, to note that the rate of deterioration was usually found to be most marked during the second month of exposure. Thus for one fabric the losses in strength in the first three months of exposure were approximately 9, 28, and 10 per cent., and similar figures have been obtained for other fabrics.

As regards the effect of exposure on permeability, the difference between the rubbered fabrics tested and some of the fabrics proofed in other ways has been very marked. In unprotected rubbered fabrics the deterioration in hydrogen-containing capacity has usually been comparatively rapid. The effect of the usual yellow protective colouring is, however, considerable. In several uncoloured samples, after fifty days' exposure in the open, the hydrogen leakage has been found to exceed 100 litres per square metre per twenty-four hours. A number of yellow fabrics, however, which have been exposed for some five or six months, are still moderately gas-tight, and, further, as regards tensile strength, are only a little weaker than the unexposed samples. From the more recent tests it appears that sunlight is the most important factor in producing deterioration.

On the other hand, the oilskins, varnished silk, &c., tested have not, in general, shown any appreciable increase in permeability with exposure. If taken down for test on a warm day, their hydrogen-holding capacity has often been found to have improved. In some cases where a sample has shown deterioration, it has again improved after further exposure, the temporary increase in permeability being probably due to crumpling when cold.

A very complete scheme of tests on rubbered and other fabrics is now in progress to examine more closely the rate of deterioration with exposure, and to distinguish between the relative effects of sun and moisture. Tests of various proofing materials are also being carried out at the laboratory, and some satisfactory results have been obtained.

Light Alloys.—A considerable amount of experimental work has been carried out on light alloys intended for structural work on airships and aëroplanes. Samples of the alloy known as "duralumin" have been supplied by Messrs. Vickers, Ltd., and the mechanical tests made on these were in general agreement with the results found at Barrow. Samples of channel bar tested at the National Physical Laboratory gave a tensile strength of 25·7 tons per square inch, and samples of wire 30 tons. Further investigation of this alloy will be undertaken, including ageing, fatigue, and corrosion tests, special attention being paid to the question of the permanence of the material. Tests of this kind are being made by the metallurgy department in conjunction with similar work on light alloys prepared in the laboratory. Some of these, at present being studied in connection with the work for the Alloys Research Committee of the Institution of Mechanical Engineers, are showing very promising results, tensile strengths up to 34 tons per square inch having been obtained, together with reasonable ductility and without recourse to special thermal treatment. When these new alloys have been more fully studied it is hoped that some of them will prove of service for aëronautical construction.

Meteorological Work.—The preliminary programme of experimental work adopted by the committee upon their appointment included the following items:—

(32) General information relating to the variation of wind velocity and phenomena connected with gusts of wind.

(33) Relative variation in speed and direction of the wind at different heights above the earth's surface.

(34) Vertical movements in the air.

(35) Rotary movements in the air.

(36) Electrical phenomena.

(37) Formation of clouds, snow, hail, &c.

The items numbered (32) to (35) were dealt with provisionally in a memorandum on details of wind structure, &c., by Dr. Shaw, presented with the report of the committee for last year. This has been followed up by further experimental work on vertical motion and rotary motion in the atmosphere at Pyrton Hill, by Mr. J. S. Dines, under the direction of the Meteorological Office. The results of the investigation are presented by three memoranda included in the technical report.

Electrical phenomena in connection with ballooning have been the subject of various communications to the committee.

Vertical Motion in the Air.—With reference to the first of the three memoranda above mentioned, the method which has up to the present been employed for the study of vertical motion in the air consists in observing, by means of self-recording theodolites, the variations in azimuth and altitude of a pilot balloon. With two such theodolites the path of the balloon can be determined both as regards its horizontal and its vertical motion, and the changes in vertical velocity due to air currents can be identified.

For the purpose of this work special self-recording gear was designed for attachment to an existing theodolite; two theodolites fitted with this self-recording gear, and specially constructed for the work, are now being provided. The apparatus is one which may be useful for many purposes besides that which has immediately led to its construction. The azimuth and altitude at any instant can be read off from the record with an accuracy of about one-tenth of a degree; this is sufficient for the purpose. The process of observing is thus simplified; with the self-recording instrument a balloon can be followed continuously without moving the eye from the instrument, and, further, the record can be taken by one observer only, whereas two are necessary in working with the eye-observing instrument.

A considerable number of records with this apparatus have already been obtained, and the results are in every way satisfactory. The records furnish definite evidence of the existence of vertical currents, but it is not yet possible to give any general discussion as to the conditions affecting vertical motion in the air as deduced from these observations.

Rotary Motion in the Air.—For the study of rotary motion in the atmosphere a special anemometer head has been designed to indicate both velocity and direction, with an apparatus to record automatically vector diagrams of the wind, from which the velocity and direction at any instant can be read. Full details of the construction are given in Mr. Dines's description.

In the earlier observations the head was mounted at a height of 36 feet above the ground; more recently a steel windmill tower has been erected for the purpose of these observations, and the head is now mounted on this at a height of 98 feet above the ground. There is no noticeable difference in the character of the diagrams taken at the two levels. The observations do not support the idea that eddy motion is the cause of the gustiness of the wind.

Some interesting particulars are given in Mr. Dines's report of comparisons between simultaneous records of velocity obtained from this anemometer and from a standard anemometer mounted on a house at a distance of 150 yards. As was anticipated from the work of previous experimenters, the individual gusts were not, as a rule, in agreement on the two records, but it is surprising to find that in certain cases squalls of five minutes' duration recorded by the anemometer on the house did not appear at all on the 98-foot record. A possible explanation of these differences is that an increase of wind velocity of as long as five minutes' duration may be confined to quite a narrow belt.

Gustiness of the Wind.—To aid in the study of gustiness, apparatus has been designed to register simultaneously the pull of a kite wire and the length of wire paid out. The tension record shows the fluctuations due to gusts, while, from the length of wire, with a knowledge of the vertical angle, the height of the kite can be approximately determined. A number of records have been obtained with this apparatus, and the discussion of these records by Mr. Dines will, it is thought, be found of great interest.

The mean gustiness found at altitudes from 500 to 1000 feet was 60 per cent. of the gustiness from 0 to 500 feet. Above 1000 feet no certain rule can be deduced from the observations. Easterly winds gave uniformly high gustiness factors; the anemometer at Pyrton Hill, where these records were obtained, is situated at the foot of the western slope of the Chiltern Hills, so that the gustiness of this easterly group of winds may be due to the previous passage of the air over the range. The decrease of gustiness with height does not appear to be dependent upon direction to any noticeable extent.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—At the Degree Congregation held on July 8 the honorary degree of Doctor of Laws was conferred on the Rt. Hon. Sir Joseph Ward, Bart., K.C.B., Premier of New Zealand. The following were admitted to the degree of D.Sc.:—William Ernest Fisher, David Frazer Harris, and Frederick Steward.

The Worcestershire County Education Committee has made a grant of 300*l.* to the University.

Mr. R. R. Cormack, lecturer in economic mineralogy, has resigned.

Mr. F. Lawrence Talbot has been appointed external examiner in the biology and chemistry of fermentation.

The following gentlemen have been appointed honorary assistant curators of the pathological museum for three years:—Dr. Stanley Barnes (medicine), Mr. A. W. Nuthall (surgery), Mr. J. T. Hewetson (diseases of women), and Mr. L. S. Sedgwick (comparative pathology).

Mr. J. Furneaux Jordan has been appointed Ingleby lecturer for 1912.

Prof. R. Beazley is to represent the University at the laying of the foundation-stone of the National Library of Wales, at Aberystwyth, by the King on July 15.

The tenure of the Walter Myers travelling studentship by Dr. John Dale has been extended for a further period of six months.

PRINCETON UNIVERSITY, it is announced in *Science*, has received gifts amounting to more than 20,000*l.*, of which 8000*l.* is for a lectureship in public affairs.

MISS STANCOMBE WILLS, an adopted daughter of the late Lord Winterstoke, has presented 10,000*l.* to Bristol Grammar School in memory of Lord Winterstoke.

DR. R. A. HARPER, since 1898 professor of botany in the University of Wisconsin, has accepted the offer of the Torrey chair of the same subject at Columbia University. Prof. Harper has had a somewhat unusual record, having begun his academic career as professor of the Greek and Latin languages at Gates College. From 1891 to 1898 he was professor of botany and geology at Lake Forest University.

THE Toronto correspondent of *The Times* states that Sir William Macdonald has completed a large purchase of land on the slope of the mountain adjoining Mountroyal Park, and will give the property to McGill University for a new campus and residential buildings. The purchase price was more than 200,000*l.* Including the cost of Macdonald College and its endowment, this brings Sir William Macdonald's total gifts to McGill University to about 2,000,000*l.*

IT was announced at the prize distribution at University College, London, last week, that Mr. R. C. Forster has made a further gift of 30,000*l.* to the fund for providing new chemical laboratories at University College. As Prince Arthur of Connaught, president of the appeal committee, wrote in acknowledging Mr. Forster's generous gift, this method "of commemorating Coronation year by promoting scientific study and research is a most happy one," and it may well be hoped that other wealthy men may adopt it so that the remainder of the sum required for the new laboratories may be subscribed at an early date. Early in the year, as was announced in NATURE (vol. lxxxv., p. 448), Mr. Forster gave 4500*l.* to complete the purchase of the site for the new laboratories. We trust that his generosity may inspire others to contribute, as further sums are still needed to complete the fund to supply a pressing need at University College.

A RURAL SCHOOLS' EXHIBITION was one of the features of the Royal Agricultural Society's Show held recently at Norwich, and in connection with it the County Councils Association arranged on July 1 a conference on rural education. After a paper by Mr. Cloudesley Brereton on education in relation to agriculture, Sir George White, M.P., gave an address, in which he referred to the further education of school children. A leaving age of even fifteen years, he said, may be of little real value unless the great object of the teacher is to make the child think. "People," he remarked, "see a number of boys working

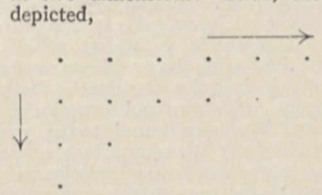
in a manual class, say a carpenter's shop, and the first question they ask is, Are you going to make them all carpenters? They do not see that it is not the wood or the tools that are of consequence, but the play of intelligent thought that brings them together to produce a certain object which has been already formed in the brain. Those who assist in production should know something of the processes—such as a knowledge of mechanics—the principles upon which an industry depends, and the nature and property of the material they are using; then the work becomes more interesting, and the proficiency of the worker a matter of concern to himself as well as to his employer, and it is this conviction which has produced our technical schools. The time has surely come when manual training should be available and free to every scholar in our schools, and domestic economy in all its branches to every girl."

THE will of the late Dr. Harry Bolus, of Kenilworth, near Cape Town, contains a munificent provision for scientific and educational objects. Dr. Bolus's herbarium and library, the collection of which had been one of the principal works of his life, are left to the South African College, Cape Town, an institution in which he had previously shown his interest by a large contribution to the foundation of the chair of botany, which is called by his name. He leaves a sum of 20,000*l.*, invested in Government Stock at 4 per cent., on trust for the upkeep and extension of the herbarium and library. This amount will later be increased by an additional sum of 7000*l.* A further amount of 21,000*l.* is also left to the same college for the foundation of scholarships. It is directed that in the selection of scholars to benefit under this fund regard shall be paid to necessitous circumstances and proof of industry, and not exclusively to ability. Eventually Dr. Bolus's landed property, on which is situated the house in which he lived and in which he did the greater part of his botanical work, becomes the property of the college, the proceeds to be applied to the purposes previously indicated. This is the largest bequest ever made to an educational institution in South Africa.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 29.—Sir Archibald Geikie, K.C.B., president, in the chair.—Francis **Darwin** and Miss D. F. M. **Pertz**: A new method of estimating the aperture of stomata. The apparatus here described under the name of *porometer* is similar in principle to that devised in 1873 by N. J. C. Müller, but differs from it completely in construction. By a simple arrangement a current of air is drawn through the stomata of a living leaf, its velocity being measured by the fall of a water-column. At a constant pressure the rate of air-flow is necessarily dependent on the size of the stomatal pores, and it is accordingly found that agencies such as darkness or loss of water supply, which are known to diminish stomatal aperture, cause a striking drop in the rate of air-flow as recorded by the porometer. In studying the effect of severing the leaf stalk, and thus cutting off the water supply, it has been proved that the first effect of withering is a wide opening of the stomatal pore, confirming F. Darwin in Phil. Trans., B, vol. cxc., 1898, p. 548. The porometer has been found of value in attacking the question of the causal relation between stomatal aperture and transpiration. This subject, on which a large number of observations have been made, will be fully treated elsewhere. In the present paper a single experiment is given illustrating the parallelism between the transpiration rate and the condition of the stomata as revealed by the porometer.—S. **Chapman**: The kinetic theory of a gas constituted of spherically symmetrical molecules. This paper may be regarded as a sequel to Maxwell's kinetic theory of a gas the molecules of which repel one another according to the famous fifth-power law (Phil. Trans., 1867). Maxwell's deductions from his hypothesis were found not to agree with fact, but the theory was valuable, because it was the only mathematically rigorous kinetic theory in existence. When he wrote a later paper on the same subject (Phil. Trans., 1879) he was aware of the defects of his assumption, but was prevented by certain analytical difficulties from generalising his theory by adopting a wider hypothesis. In this paper these difficulties have been very largely overcome. With the same rigour as in Maxwell's theory, formulæ are deduced for the coefficients of viscosity, diffusion, and thermal conductivity in a simple or compound gas. The molecules are assumed to be spherically symmetrical, but no particular kind of interaction is postulated. The latter, however, is involved in the formulæ by the occurrence, as factors, of two definite integrals. Certain relations may be deduced without the evaluation of these factors. The most interesting of these is $\delta = \frac{5}{2}\mu C_v$, where δ is the thermal conductivity, μ the viscosity, and C_v the specific heat at constant volume. This formula, which was also obtained by Maxwell, has always been regarded as a special consequence of his hypothesis, whereas it only depends on the spherical symmetry of the molecules, and is true for rigid-elastic spheres, among other cases. In general, the formulæ can be completed only by the evaluation of the before-mentioned factors. In the paper this is done for the case of rigid-elastic spherical molecules, for centres of force repelling according to the inverse nth power law of distance, and for the case of rigid-elastic spheres surrounded by fields of attractive force. The last case furnishes a rigorous proof of Sutherland's formula for viscosity, and some important corrections to his theory are made. Finally, the formulæ obtained are compared with experimental results to test the accuracy of the various laws considered, and to obtain improved data concerning the molecules and other physical constants of gases.—Major P. A. **MacMahon**: Memoir on the theory of the partitions of numbers. Part vi.—Partitions in space of two dimensions, to which is added an adumbration of the theory of partitions in space of three dimensions. In this part the author considers the partitions of a number, the parts being placed at the nodes of an incomplete lattice in two dimensions. Thus, the lattice being of the nature depicted,



the parts are in descending order of magnitude in each row and in each column. The enumerating generating function is required. It is found that for a lattice of given specification and a given restriction upon the part magnitude the generating function satisfies a functional equation. From this the functional equation satisfied by the corresponding inner-lattice function, as is defined in part v., is deduced. This investigation then turns upon the determination of the fundamental solutions of this equation and the expression of the generating function by means of them. The complete solution of the problems in hand is thence obtained, and the inner-lattice function is shown to be expressible in an elegant determinant form. At the end of the paper the subject of three-dimensional partitions is broached. It is shown that the method of lattice functions is again available, and the particular case of partition at the summits of a cube is worked out in detail from this point of view. The further investigation of this interesting question is reserved for a future communication.—W. T. **David**: Radiation in explosions of coal gas and air.—Dr. T. E. **Stanton**: The mechanical viscosity of fluids. The paper deals with the experimental determination of the ratio of the shearing stress to the rate of change of distortion in fluids which are in sinuous or eddying motion. Thus in a fluid in eddying motion flowing through a parallel pipe of circular cross-section, if F is the mean shearing stress on any cylindrical surface of radius r concentric with the pipe, and v the average velocity in the axial direction of the fluid in this surface, then writing $F = \mu' \frac{dv}{dr}$ the object of the experiments was the determination of μ' as a function of the dimensions

of the pipe and the velocity of flow. This ratio has been called by Osborne Reynolds "mechanical viscosity," to distinguish it from the corresponding ratio when the field is in steady or laminar motion, which is the ordinary coefficient of viscosity. The fluid chosen for the purpose of the experiments was air flowing at speeds up to 2200 cm. per second through pipes 5·08 and 7·35 cm. diameter. A small Pitot tube of width 0·25 mm., connected to a very sensitive gauge reading to 0·005 mm. of water, has been used for measuring the distribution of velocity, and a second sensitive gauge has been used for measuring the shearing forces. The results of the experiments are as follows:—(1) In pipes artificially roughened so that air friction varied as square of velocity of flow, the value of μ' was found to be proportional to the product of speed of flow v ., and linear dimension of pipe l, *i.e.* $F=kv_c l\frac{dv}{dr}$ where k is a constant depending on the roughness. (2) In ordinary smooth pipes the corresponding relation was given by $F=Cv_c f\left(\frac{V}{v_c l}\right)\frac{dv}{dr}$ where C is a constant and $f\left(\frac{V}{v_c l}\right)$ a function of the kinematical coefficient of viscosity V and the above product $v_c l$. (3) In ordinary smooth pipes of different diameters, owing to the existence of a region of viscous flow at the boundaries, exact similarity between the distributions of axial velocity from centre to walls only obtains when the two viscosities (μ and μ') are the same for each pipe.—Dr. G. W. C. **Kaye**: A silica standard of length. The general properties of fused silica, and in particular its remarkably low coefficient of expansion, render this substance specially suitable for the construction of permanent length-standards of the highest class. The coefficient of expansion of platinum-iridium, which has hitherto been the material almost exclusively employed in the best work, is about 9×10^{-6} per degree C., while that of silica over the ordinary range is about $0{\cdot}4\times10^{-6}$, *i.e.* one-twentieth of this amount. It is true that the best qualities of invar—M. Guillaume's nickel-steel containing 36 per cent. Ni—have expansion coefficients comparable with that of silica, but experience has shown that while invar is eminently useful for working standards, it is quite unsuitable for primary standards, owing to its large thermal hysteresis. Fused silica, on the contrary, has been found to be practically entirely free from this defect; it enjoys, in the matter of cost, an enormous advantage over platinum-iridium; furthermore, in view of the fact that primary standards are always handled by trained and skilled observers, its comparative fragility is of small consequence. Modern methods of manufacturing and working silica have rendered it possible to construct a silica line-standard metre. The present model, the first of its kind, consists of a silica tube into which are fused at its ends optically worked plane parallel slabs of silica. These carry the graduations, and their undersides are platinised. The graduations, defining the metre length, are made by cutting through the platinum film with a ruling diamond. The platinum deposit permits the ruling of very beautiful clean-edged lines. The bar is supported at the Airy points so that the slabs are horizontal. The lines are viewed from above through the slabs, and are thus seen to advantage. The apparent length of the standard is independent of any change of tilt of the cover-slips which are used to protect the platinum films. The thickness and position of the end slabs are so arranged that the image of each reference line lies in the "neutral plane" when the bar is immersed in water. The silica metre was annealed at about 450° C., and shrunk a little more than half a micron in the process. It is anticipated that its future secular variation will be negligible so far as practice is concerned.—Ridsdale **Ellis**: The properties of oil emulsions. Part i.—Electrical charge. The electrical charge on the globules and the contact potential at the oil-water interface were obtained from measurements of the migration velocity in an electric field. The apparatus used by Whitney and Blake and by Burton for determining velocity of migration were found not to be accurate, since they did not take into consideration the electrical circulation which takes place, and other factors. To avoid these errors a microscopic method was employed, and corrections for electrical circulation and other effects were introduced into the method of calculating migration velocity. For determining contact potential in presence of electrolytes it was found necessary to modify the apparatus in order to enable the evolution of gas at the electrodes to be avoided, which would otherwise prevent readings being taken. It was found that the magnitude of the contact potential at the oil-water interface is of the same order of magnitude for oils of various kinds, whether very pure or containing large amounts of impurities. Further, the contact potential at the oil-water interface is of the same order of magnitude as that at the glass-water interface and at the interface between the suspended particles of colloidal metals, lycopodium, quartz, and other substances. From these and other considerations it would appear that the contact potential in neutral solution depends almost wholly on the dielectric constants of the suspended particle and of the medium in which it is suspended. The contact potential at the oil-water and glass-water interface is a maximum in neutral or slightly alkaline solutions. Thus the addition of caustic soda at first increases the contact potential at the oil-water interface, but when the concentration exceeds 0·001 N the contact potential is diminished, rapidly at first, and then slowly. In the glass-water interface the maximum potential appears to be in neutral solution. If hydrochloric acid is added the contact potential is reduced very rapidly for small concentrations, but only slowly for comparatively high concentrations.—Dr. W. H. **Young**: A class of parametric integrals and their application in the theory of Fourier series. In this paper the following theorem, *inter alia*, is proved:—If $f(x)$ and $g(x)$ are two functions the $(1+p)^{\text{th}}$ power and $\left(1+\frac{1}{p}\right)^{\text{th}}$ power of which respectively are summable, and if (a_n, b_n), (α_n, β_n), be their Fourier constants, then the series the general term of which is $(a_n\alpha_n+b_n\beta_n)\cos n\theta$ is the Fourier series of a continuous function, a simple expression for which is given. From this theorem follows as a corollary that if the series

$$\frac{1}{2}a_0\alpha_0+\Sigma_{n=1}\,(a_n\alpha_n+b_n\beta_n)$$

converges it has $\frac{1}{\pi}\int_{-\pi}^{\pi} f(x)g(x)dn$ for its sum, and more generally it always has this expression for sum when the summation is performed in the Cesaro manner. The method employed is shown also to lead to results of analogous nature, previously known. It involves the study of certain parametric integrals, and of a theorem in the theory of sets of points stated and proved in the paper, to the effect that if a set of points of positive content be shifted bodily a sufficiently small distance along the straight line on which it is situated, it necessarily coincides with its original position as to a sub-set of points the content of which may be made as near as we please to the content of the set.—Dr. W. H. **Young**: A mode of generating Fourier series.—H. R. A. **Mallock**: Pendulum clocks and their errors. The errors to which pendulum clocks are liable may be divided into three classes, viz.:—(1) those which may affect free pendulums oscillating *in vacuo*; (2) errors depending on the action of the air or gas in which the oscillation takes place; (3) errors due to the escapement and maintaining mechanism. In good clocks unexplained variations of rate are not uncommon, and may be as large as half a second a day, or even more. At any rate, a clock the rate of which continues constant within 1/200,000 for a year or more is exceptional, and anything which succeeds in securing a constancy of rate better than five parts in a million may be considered an improvement. In discussing the various sources of change of rate, all matters (so far as the author knows) which can alter the period by as much as 10^{-8} are taken into account. It appears that most of the anomalous changes of rate are due to variation of friction in the escapement and maintaining mechanism, which acts chiefly, but not exclusively, by altering the arc of vibration. A graphic method is given for determining in detail the action of escapements on the period.—Prof. Sydney J. **Hickson**: Ceratopora, the type of a new family of

Alcyonaria. A specimen of a compound tubular coral was obtained by the naturalists of the *Blake* off Cuba in 100 fathoms of water. This specimen was figured by Agassiz in his account of the expedition, and referred to as "a supposed Favosites is probably a bryozoan genus allied to Heteropora." A more detailed examination of the dried corallum shows the presence of long tuberculate spicules, in addition to the crystalline calcareous tubular skeleton, which is formed in a horny matrix. There are no tubulæ, and the tubular walls are not perforated. The evidence suggests that this coral is an alcyonarian belonging to the order Cænothecalia, and it is proposed to give it the name *Ceratopora nicholsonii*.—Dr. W. **Watson**: Note on the sensibility of the eye to variations of wave-length. The author has compared the width of Edridge-Green's monochromatic patch with the minimum change in wave-length perceptible as a change in hue in the yellow under exactly similar conditions, and finds there is a marked difference. It is also shown that an admixture of white light would not account for the increased sensitiveness when two monochromatic patches are compared.—E. N. de C. **Andrade**: The distribution of slide in a right six-face subject to pure shear.—Major C. L. **Williams**: The viability of human carcinoma in animals.—Prof. W. B. **Bottomley**: The structure and physiological significance of the root-nodules of *Myrica gale*.—H. W. **Harvey** and W. B. **Hardy**: Note on the surface electric charges of living cells.—Prof. C. S. **Sherrington** and Miss S. C. M. **Sowton**: Reflex inhibition of the knee flexor.—Prof. H. E. **Armstrong** and Dr. E. F. **Armstrong**: The origin of osmotic effects. IV.—Note on the differential septa in plants with reference to the translocation of nutritive materials.

Zoological Society, June 27.—Mr. Frederick Gillett, vice-president, in the chair.—Dr. R. **Broom**: Some new South African Permian reptiles.—F. E. **Beddard**: Two new genera of cestodes from mammals.—Miss Ruth **Harrison**: Some madreporaria from the Persian Gulf; with a note on the memoir and some further notes on *Pyrophyllia inflata* by Prof. S. J. **Hickson.** This memoir dealt with a collection of corals made by Mr. F. W. Townsend, the most interesting species obtained being *P. inflata* and *Trematotrochus zelandiae*, the latter of which was identical with the specimens from Cook's Straits, New Zealand, described as *Conocyathus zelandiae* by Prof. Martin Duncan. A new species of Heterocyathus was described, and Prof. Hickson appended a note on the affinities of Pyrophyllia.—C. L. **Boulenger**: Variation in the medusa of *Moerisia lyonsi*. This paper was based on an examination of 400 specimens. Nearly 14 per cent. of these were found to be abnormal, and to fall naturally into two well-marked groups containing completely distinct phenomena. The author discussed these separately and in detail, and stated that he knew of no form in which such a variety of abnormalities occurred as in Mœrisia.—Cyril **Crossland**: (1) The marginal processes of lamellibranch shells; (2) warning coloration in a nudibranch mollusc and in a chameleon. As a pendent to the second of these papers, Sir Charles **Eliot** contributed a paper on chromodorids from the Red Sea collected and figured by Mr. Crossland, containing an account of three species of Chromodoris, which were noteworthy as being varieties of known species or forms hitherto imperfectly described.

Royal Microscopical Society, June 28.—Mr. H. L. Plimmer, F.R.S., president, in the chair.—Mr. **Strachan**: The structure of scales from *Thermobia domestica* (Packard). The author showed that the longitudinal striæ which appeared to project at the free margin of the scale were in reality the walls of a set of longitudinal tubes, and when pressure was applied to the scales the tubes might be made to collapse and disappear, and in some instances, when heat was applied, both fluid and air bubbles were observed to traverse the tubes. These tubes were on the convex side of the scales. Radial striæ also crossed the longitudinal striæ at various angles, and the author illustrated his paper by an ingenious model composed of two sets of parallel thin glass tubes in close contact, almost filled with fluid and sealed at the ends, one set containing oil of turpentine, the other ethyl alcohol. One set of tubes was fixed, the other set, placed in contact with them, could be rotated over a considerable angle. By illuminating this model obliquely and varying the angle at which the tubes crossed, all the appearances of beaded, exclamation, and cuneate markings observed in the natural scales could be reproduced exactly.—Mr. **Murray**: Further report on the rotifera collected by the Shackleton Antarctic Expedition of 1909. *Rotifera of New Zealand.* There were collected forty-one species of Bdelloids, and twenty-six species of other orders. Three new species were described—*Callidina microcornis, Rotifer curtipes*, and *R. montanus*. A species of Pedalion (not identified) occurred as a plankton animal in a great lake (Wakatipu). These Bdelloid fauna of New Zealand appeared to be poor, considering the variety of conditions found in different regions. *Rotifera of S. Africa.* During a short stay at Cape Town nine Bdelloids were collected on the lower part of Table Mountain. There was one new species, *Dissotrocha pectinata*, related to *D. spinosa*. This small collection was noticeable for the absence of any of the species characteristic of tropical and subtropical Africa, many of which occurred in other parts of Cape Colony.—Conrad **Beck**: Use of an interferometer for measuring small distances.

EDINBURGH.

Royal Society, June 5.—Dr. James Burgess, vice-president, in the chair.—The absorption of light by inorganic salts. No. 1, Dr. R. A. **Houstoun**: Aqueous solutions of cobalt salts in the infra-red. No. 2, Dr. R. A. **Houstoun** and Alex. R. **Brown**: Aqueous solutions of cobalt salts in the visible spectrum. No. 3, Dr. R. A. **Houstoun**: Aqueous solutions of nickel salts in the visible spectrum and the infra-red. No. 4, Dr. R. A. **Houstoun** and John S. **Anderson**: Aqueous solutions of cobalt and nickel salts in the ultra-violet. The four papers describe the first of a series of researches in which it is proposed to determine the absorbing power for light of aqueous solutions of inorganic salts under different conditions of concentration and temperature throughout the ultra-violet and infra-red, as well as in the visible spectrum. The absorbing power of a solution is specified by A, the molecular extinction coefficient, which fulfils the equation $I = I_0 10^{-Acd}$, I and I_0 being the intensity of the light before and after passing through the solution, *c* the concentration of the solution in gm. mols./litre, and *d* the thickness in cm. of the layer traversed. A varies with the wave-length, but is independent of *c* except for wide ranges and at particular points in some spectra. The salts investigated were the fluorides, chlorides, bromides, iodides, nitrates, and sulphates of cobalt and nickel. The apparatus used in the visible spectrum was a spectrophotometer, in the infra-red a linear thermopile with highly sensitive galvanometer, and in the ultra-violet a quartz spectrograph in combination with a photographic photometer of an entirely new type. A was fully determined for the twelve salts from $\lambda = 0{\cdot}22\ \mu$ to $\lambda = 1{\cdot}27\ \mu$, and the results were shown in the form of curves of a highly striking nature, A being approximately for these salts an additive property of the acid and base even at high concentrations. Cobalt has bands at $0{\cdot}510\ \mu$ and $1{\cdot}3\ \mu$, nickel at $0{\cdot}405\ \mu$, $0{\cdot}690\ \mu$, and $1{\cdot}21\ \mu$. The sulphate radical exercises no absorption whatever; in the nitrates there is a band at $0{\cdot}302\ \mu$. The fluorides and chlorides have evidently a band just below $0{\cdot}22\ \mu$. The bromides have a band at $0{\cdot}285\ \mu$, and the iodides have two very intense bands in the ultra-violet which agree with those shown by an aqueous solution of iodine itself. Quantitative measurements were also obtained on the colour changes produced by concentration and heating. It was discovered that there are changes in nickel chloride and bromide in the violet analogous to but not so great as in the case of the cobalt salts, and so similar that any explanation of the cobalt colour changes must take account of them also.—Profs. Alex. **Smith** and A. W. C. **Menzies**: The vapour pressure of dry calomel. In a previous paper the authors showed that calomel vapour contained no measurable amount of Hg_2Cl_2 or of HgCl, and consisted wholly of the dissociation products mercury and mercuric chloride. According to chemical theory,

therefore, when, by removal of all moisture, dissociation is prevented, the vapour pressure of the dry substance should be negligibly small. Brereton Baker obtained results which indicated that dry calomel had a vapour pressure of about one atmosphere. Experiments were made to test this point directly. The final result was in accord with the theory, but only after a prolonged drying for five and a half months in an oven at 115° C.

PARIS.

Academy of Sciences, July 3.—M. Armand Gautier in the chair.—H. **Deslandres**: Ionisation of the gases of the sun. Relations between the radiation and rotation of the heavenly bodies.—J. **Boussinesq**: Calculation of the absorption, in translucent crystals, of a pencil of parallel rays.—A. **Haller** and Edouard **Bauer**: Some ketones of the type of benzyl-dimethyl-acetophenone. Trialkyl-acetic acids and the alcohols related to them. Ortho-, meta-, and para-xylene-dimethyl-acetophenones were prepared by the action of the corresponding bromo-xylenes on the sodium derivative of isopropyl-phenyl ketone. These ketones were converted into the xylyl-dimethyl-acetamides, and these latter into the xylyl-dimethyl-acetic acids. The amides were reduced to the corresponding alcohols by sodium and absolute alcohol. The analogous para-methoxybenzyl compounds were also made.—L. **Mangin**: The existence of right- and left-handed specimens of certain Peridinia.—Ch. **Depéret**: The discovery of a large anthropoid ape of the genus Dryopithecus in the Miocene of La Grive-Saint-Alban (Isère).—A. **Perot**: Solar spectroscopy.—Alphonse **Berget**: A new apparatus for taking soundings:—J. **Clairin**: Bäcklund's transformations of the first kind.—E. **Delassus**: The linear integrals of the equations of Lagrange.—Marcel **Brillouin**: Surfaces of slip. Generalisation of the theory of Helmholtz.—D. **Montesano**: The linear congruences of conics.—J. **Pionchon**: Effect produced by the relative displacement of a metal and electrolyte in contact. The E.M.F. between two electrodes alters if one of them be moved or set in vibration. For example, if two zinc plates are placed in a solution of zinc sulphate, the E.M.F. between them is zero, whereas if one of them is shaken it becomes positive to the other. Analogous effects are produced with other electrodes and electrolytes. The E.M.F. of a Daniell's cell was 1·0944 volt. When the copper was shaken it became 1·0990, and when the zinc was shaken the value changed to 1·0754 volt.—Gustave **Le Bon**: The variations in transparence of quartz for ultra-violet light, and on the dissociation of matter.—A. **Leduc**: The expansion of vapours and the variation, with temperature and pressure, of γ, the ratio of their specific heats.—A. **Blondel** and J. **Rey**: The perception of light signals of short duration at the limit of their reach.—H. **Malosse**: Specific rotatory power of camphor dissolved in acetone. Tables showing the specific rotatory power of camphor in acetone solution at various concentrations, and at different temperatures.—J. H. **Russenberger**: Extension of the laws of capillarity to the case in which the elements of the capillary system are movable in regard to one another.—Marcel **Delépine**: Some supposed chlorides of iridium; condensed chlorides. The hexahydrate of chloroiridic acid, H_2IrCl_6, analogous to chloroplatinic acid, may be obtained by drying the product of the action of chlorine on chloroiridate of ammonium with sulphuric acid of not more than 70 per cent. strength. This crystalline substance, on being heated at temperatures between 100° and 250° C. in a current of air, slowly loses water, chlorine, and hydrochloric acid, leaving black amorphous residues, of which the compositions are not expressible by simple formulæ. The supposed lower hydrated chloride, $IrCl_3,4H_2O$, could not be obtained, nor could the author prepare the anhydrous chloride, $IrCl_3$, of Claus, by the action of sulphuric acid on chloroiridites.—Œschner **de Coninck** and M. **Raynaud**: The dihydrate of uranium trioxide. The substance $UO_3,2H_2O$, when gently heated, produces the monohydrate; the second molecule of water is only lost at a higher temperature with a slight loss of oxygen. The molecular weight of UO_2 was found to be 270·46 (mean of five determinations) by heating the dihydrate in hydrogen.—M. **Portevin**: Chromium steels.—Ed. **Chauvenet**: The carbonates of thorium. Hydrated thorium dioxide, $Th(OH)_4$, absorbs carbon dioxide at the ordinary pressure until it has the composition $CO_2,2ThO_2,4H_2O$. If the pressure be increased to 30 or 40 ats., the substance $CO_2,ThO_2,2H_2O$ is formed. The anhydrous oxide, ThO_2, if prepared by strong ignition, will not combine directly with carbon dioxide, but if it has not been heated above 430° C., the substance $CO_2,7ThO_2$ is produced. In the wet way, by the action of an alkaline carbonate upon a salt of thorium, $CO_2,ThO_2,8H_2O$ is precipitated; this easily loses water, producing the above-mentioned hydrated carbonate, $CO_2,ThO_2,2H_2O$.—G. **Vavon**: The hydrogenation of carvone. Carvone, in presence of platinum black, takes up two, four, or six atoms of hydrogen to form carvotanacetone, tetrahydrocarvone, and carvomenthol respectively.—E. E. **Blaise**: The keto-glutaric acids and the aldehyde acids of the succinic series.—Maurice **Lanfry**: The oxythiophenes.—H. **Colin** and A. **Senechal**: Catalytic oxidation of phenols in presence of iron salts.—Jules **Amar**: The law of output after work. Correction of a former note.—Louis **Roule**: Some peculiarities of the Antarctic fauna, from the collection of fish recently obtained by the expedition in the *Pourquoi-Pas?*—C. **Delezenne** and Mlle. **Ledebt**: Formation of hæmolytic and toxic substances by the action of cobra venom on yolk of eggs.

CONTENTS.