THURSDAY, NOVEMBER 23, 1899.

## THE APPLICATIONS OF THERMODYNAMICS TO CHEMISTRY.

*Traité élémentaire de Mécanique chimique, fondée sur la Thermodynamique.* Par P. Duhem. 4 vols. Vol. i. pp. viii + 299; vol. ii. pp. 378; vol. iii. pp. 380; vol. iv. pp. 381. (Paris: Librairie scientifique, A. Hermann, 1897–1899.)

PROF. DUHEM'S treatise on the thermodynamic potential is so well known that little or nothing need be said in introducing another work from the pen of the same writer dealing with thermodynamical considerations.

The study of the laws of combination and dissociation is intimately connected with that of such physical processes as evaporation, liquefaction and solution. To this subject the not over-appropriate title of "chemical mechanics" (*mécanique chimique*) has been given in France. While Berthollet sought an explanation of the fundamental phenomena in the laws of motion combined with the Newtonian hypothesis of molecular attractions and repulsions, Sainte-Claire Deville referred the principles of "chemical mechanics" to thermodynamical considerations, and thanks to the labours of Hortsmann, Moutier, Gibbs, Helmholtz and a large number of other physicists, there has sprung up that wide field of investigation which has given the present book its title of "chemical mechanics founded on thermodynamics," or more briefly, chemical thermodynamics.

It is not with special applications alone that Duhem deals. The greater portion of the first volume and part of the second are occupied with thermodynamics proper, and constitute, to our mind, the best treatise on thermodynamics that we have seen. An introductory section contains a summary of the more important mathematical and dynamical theorems and principles required at the outset, and this should be helpful to students.

In his preface the author calls attention to the great difficulty of giving a perfectly rigorous and logical exposition of the laws of thermodynamics, and claims only to have attained the degree of precision usually adopted in treatises on physics. A comparison of Duhem's work with the heterogeneous mixtures of experimental results, mathematical formulæ and veiled assumptions which commonly have to do duty as text-books on thermodynamics, will show that the author has really advanced a long way in making the subject clear and intelligible. No better illustration of this can be cited than the careful precautions taken to avoid premature assumptions with regard to thermometric scales in the treatment of perfect gases. In these days of widespread education in "general elementary science" such terms as "a perfect gas" and "absolute temperature" bid fair to become by-words; but how many B.Sc.'s either of London or of our provincial universities can give correct definitions of them? If this point were tested, we venture to predict that in the vast majority of cases the first term would be defined by reference to the second, and the second by reference to the first, and if the circular nature of this reasoning were pointed out, the graduate under examination would have to take refuge in considerations respecting molecules, about whose nature and mode of motion he knew nothing. Moreover, apart from Charles's law and the difficulties connected with it, comes the question as to whether or not the definition of a perfect gas is to include Clausius's hypothesis as to the constancy of one (and therefore both) of the specific heats. Here again the question is considered most explicitly.

Another feature of Duhem's treatment is that while the old familiar $p$, $v$, $t$ trio receives full consideration, generalised coordinates are introduced from the very outset, and the significance of such coordinates is explained by illustrative examples as far as possible. To one feature, however, we must take exception, and that is the retention in Duhem's equations of the useless E (synonymous with the English J) standing for the "mechanical equivalent of heat," as it was once, and unfortunately often still is, called. This quantity is nothing more or less than the work measure of the specific heat of water at a certain temperature, and the equations of thermodynamics in no way depend on the specific heat of water. The absolute unit of heat is the unit of work, and with this unit E must be replaced by unity. As Prof. Poynting remarked in his address to Section A at Dover, "the real superiority of the work measure of specific heat lies in the fact that it is independent of any particular substance, and there is nothing whatever hypothetical about it."

In this respect the work unit of heat stands on a much more rational footing than the universally adopted dual systems of so-called "absolute units" of electricity and magnetism, which are not independent of the medium, and whose dimensions moreover are incompatible.

As regards Duhem's two chapters on stability, we can only wish they had been before us when first learning thermodynamics, as we should have been saved the trouble of thinking out for ourselves conclusions similar to those here expounded, after vainly attempting to follow the arguments of the text-books and to apply them to a Tripos rider; now the whole matter appears before us in a clearer light than it ever did previously.

The last part (Book ii.) of volume i. deals with false equilibria and explosions. By "false equilibria" (*faux équilibres*) are meant states of equilibrium which can be realised experimentally, although the conditions of equilibrium of conventional—or, as Duhem calls it, "classical"—thermodynamics are not satisfied. They are analogous to the equilibrium of rough bodies in statics, in configurations which, in the absence of friction, would have been impossible. This analogy has led, in Duhem's hands, to the development of an extremely elegant mathematical theory of false equilibria and explosions based on the introduction of a function which the author calls the "friction" (*le frottement*) of the system. This function is entirely distinct from that which represents viscosity, but when it is introduced into the equations of the system, along with the thermodynamic potentials, Clausius's inequality for irreversible cycles $\int dQ/T > O$ is satisfied. In a diagrammatic representation, the line of true equilibrium is bordered on either side by a region of false equilibrium. When the representative point just falls outside this region the conditions required for the occurrence of an explosion admit of a simple geometric interpretation.

In the second volume, Book iii. deals with change of state, dissociation, and the triple point; much of the latter matter will be familiar to those who have read the author's "Thermodynamic Potential." Book iv. deals with the critical point, the principle of James Thomson, Van der Waals's and allied formulæ, and the principle of corresponding states, specific heats of fluids, and adiabatic expansion of vapours. Book v. treats of dissociation in mixtures of perfect gases. In the third volume, Book vi. deals with the thermodynamic potentials of a homogeneous mixture, solution, osmotic pressure, the hypotheses of Van 't Hoff and Arrhenius, and the law of Guldberg and Waage. Book vii. contains a full investigation of the general problem of solution, the chapter dealing with double salts being of much interest, especially the graphical representations. In the fourth volume Book viii. is devoted to the consideration of double mixtures, including the thermodynamic theory of distillation, while an account of Willard Gibbs's theory of the statics of heterogeneous systems in Book ix. concludes the treatise. In this last book the law of phases is established, and the different degrees of variance of a system are considered separately, actual instances of the systems in question being cited. A separate chapter is devoted to the properties of univariant and bivariant systems. As Duhem points out, the whole of this theory is based on "classical" thermodynamics where "friction" is left out of account, as is also capillary action.

The treatise, taken as a whole, shows what vast progress has been made in expressing the laws of mixture, combination, dissociation, and chemical transformation generally, in terms of a single potential function of generalised coordinates, and thus placing chemistry and chemical physics on a similar footing to dynamics. The essentially mathematical treatment is not the least valuable feature of Duhem's work. Thermodynamics is quite as capable of being regarded from a purely mathematical standpoint as dynamics or hydrodynamics, but hitherto its mathematical aspect has not been exhibited so prominently as it ought to be. The inclusion of descriptions of details of experiments would have broken the continuity of the theory, and such details can be far better studied in the original papers to which abundant references are given in footnotes. Indeed, the present work appears to be in many respects a model of what such a treatise ought to be. In any special problem certain hypotheses are first made; these should be clearly pointed out, and attention specially drawn to them. From these hypotheses certain conclusions are drawn by mathematical reasoning, and lastly we have references to the evidence derived from experiment as to the accordance of these conclusions with observed facts. So long as a substance is regarded as a purely mathematical abstraction, it may be defined by any hypotheses whatever as to the form of its thermodynamic functions, and a Thermodynamics based on hypotheses convenient for purposes of calculation would possess the same interest to mathematicians as a Hydrodynamics which ignores viscosity and capillarity or a Geometry of any particular non-Euclidian space. But it would appear that the conclusions *do* largely represent, either exactly or as approximations, the results of experiment; and the subject thus assumes a physical reality.

It is difficult in writing on such a subject as the present to avoid, quite unintentionally, "smuggling" doubtful assumptions into the midst of an argument without declaring their nature. As we all know the late Clerk Maxwell was much addicted to this practice, the gaps in his reasoning having afforded fruitful material for later investigators. When we consider the variety of sources from which the subject-matter of the present treatise has been compiled, we can only congratulate the author on the measure of success he has achieved in admitting only perfectly rigorous deductions based on explicitly stated hypotheses.

We cannot close this work without some reflections as to the relative progress that has been accomplished by the two schools in explaining the properties of matter, the one by means of the thermodynamical potential, and the other by the application of dynamical principles to the individual molecules of bodies. Molecular dynamics has given us equations representing, under certain conditions, the fact that $dQ/T$ is a perfect differential; but there is still a something we have not got to the bottom of in every kinetic theory of matter, as applied to thermodynamics. We have as yet discovered no dynamical theorem of sufficient generality corresponding to the uniqueness of temperature, or establishing the fact that under the most general possible conditions the entropy of a system tends to a maximum. The question—Can the irreversible phenomena of thermodynamics of a body of finite size be accounted for by applying the equations of a conservative and reversible dynamical system to its individual molecules without making *some* special assumptions?—has never been completely answered. To deduce the second law from the equations of the kinetic theory imposes restrictions on the systems to which the conclusion applies where no such restrictions exist in the law itself. Even the very question of applying statistical methods at all to systems of molecules endowed with the property of perpetual motion requires careful consideration, since our statistical theories are so largely based on our experience of every-day phenomena—events by their very nature irreversible. One may thus be led to wonder whether Prof. Duhem's "friction" may possibly involve the existence of some molecular property which prevents molecular motions from being represented by the equations of what in the author's own nomenclature may be styled "classical" dynamics, and which introduces irreversibility into the motions even of individual molecules.

From a mathematical point of view the theory of the thermodynamic potential has attained far greater perfection than any theories based on molecular hypotheses that have been suggested up to the present; whatever the future may bring forth is another question. While thermodynamics originated in this country from the discoveries of Joule, it now hardly receives so much attention from Englishmen as it deserves. Prof. Duhem's treatise, by showing the wide range of phenomena which come under its scope, even omitting (as he does) thermo-electric phenomena and thermo-elasticity, cannot fail to attract students to this fascinating branch of mathematical physics. G. H. BRYAN.

## THE CONTINUITY OF THE ERYTHREAN RIFT VALLEY.

*Seconda Spedizione Bottego. L'Omo. Viaggio d'Esplorazione nell' Africa Orientale.* By L. Vannutelli and C. Citerni. Pp. xvi + 650; 11 plates, 9 maps, and numerous illustrations. (Milano: Hoepli, 1899.)

THE Erythrean Rift Valley has been proved continuous across forty degrees of latitude from the Jordan to the south of Kilima Njaro, except for a possible break of about 250 miles between Lake Rudolf and the basin of the Hawash. Whether the valley is broken in that district depends on the course of the Omo and its relations to the river known as the Nianam, which flows into the northern end of Lake Rudolf. The name Omo was introduced into geography by Léon des Avanchers in 1858, for a river which drains part of the southern slope of Abyssinia, a little to the west of Menelik's capital at Addis Abeba. The river had been known long before, for it is the Zebé of the seventeenth-century Jesuit missionaries. The upper part of its course was described by Ludolf in his "New History of Ethiopia" (1681) from information supplied by the Abba Gregorius. But the lower course of the river was quite unknown. Ludolf believed that it flowed eastward and entered the Indian Ocean near Mombasa.

Bruce in the following century accepted this hypothesis and called the river the "Zebé or Quilimancy," the latter being an old name for the Ozi, a river which is a parasite of the Tana.[1]

But in the present century Frederick Ayrton and Antoine d'Abbadie claimed the Zebé as one of the head-streams of the Nile. This view was supported by Petermann, who held the Zebé to be a tributary of the Sobat, and by Bonala, who believed that it flowed into the Victoria Nyanza, and was therefore the remotest source of the Nile. Harris, McQueen, Schweinfurth and Cecchi on the contrary supported the theory that the Zebé belonged to the Indian ocean drainage, and rendered this view more plausible by identifying the Omo as one of the sources of the Juba. In 1889 and 1890 a fresh explanation was introduced by Teleki and von Höhnel's discovery of Lake Rudolf, and Borelli's descent of the Omo towards that lake, into which native rumour asserted that the river flowed. The work of these travellers seemed to disprove both the old theories; but Dr. Donaldson Smith, after his important journey to Lake Rudolf in 1895-6 again advocated the connection of the Omo and the Juba. What was known of the levels of the three rivers seemed fatal to this idea, and in a review of Donaldson Smith's book in NATURE (July 1, 1897) it was maintained that the Omo and the Juba could not be connected, and that "the Omo must continue as the Nianam and flow into Lake Rudolf."

[1] Bruce is quoted on p. 4 of the present work as having regarded the Zebé as one of the head-streams of the Nile; but that was only the view of some of his editors. Bruce himself did not reach the Zebé; he does not appear to mention it in his narrative, and his map marks it as separated from the Nile tributaries.

In order to settle this long controversy Vittorio Bottego, an explorer well known from his work in the Juba basin in 1891–2, proposed an expedition which was fitted out under the auspices of the Italian Geographical Society. Thanks to the energy of this Society, Bottego started in October 1895 from Barawa on the Somali coast at the head of a powerful caravan of four European officers, 250 natives, 120 camels, and 300 mules.

The expedition left Barawa in October 1895, and marched across Italian Somaliland, along a route parallel to the river known to geographers as the Juba. The authors, however, speak of it as the Fiume Ganana, which being interpreted is the "River River."

The first long halt was at Logh, the principal commercial centre in the Juba valley. After building a fort and a trading station at that town the expedition crossed the "Fiume Ueb" (which also means "River River"), and marched north-westward up the course of the principal tributary of the Juba. The explorers found that this river dwindled rapidly, and long before they reached its head found that it could have no connection with the Omo. Leaving the Juba basin, the expedition carefully explored Lake Abbaia, which it is proposed to call Lagho Regina Margherita, and then proceeded to its main objective the Omo. The river was reached near the point to which Borelli had tracked it from the north. Bottego, after his former expedition, inclined to the view that the Omo was one of the Nile tributaries; but after following the river for some distance westward it suddenly bent southward, became the Nianam of von Höhnel, and entered Lake Rudolf. The Omo problem was settled.

While resting in the food country at the northern end of Lake Rudolf, the expedition mapped its western shores, and collected much fresh information regarding the Reshiat, who are described under the name of the Gheleba. This interesting tribe was first described by von Höhnel. From the facts and figures given by Vannutelli and Citerni it appears probable that the people are Nilotic negroes, allied to the Njempsians, and altered by Galla intermixture.

After mapping the western shores of Lake Rudolf the expedition proceeded up the second river, which von Höhnel had described as entering the northern end of the lake. The existence of this river has, however, been denied. Bottego's party followed the river, which it is proposed to rename the Fiume Maurizio Sacchi, to the north-west; but its course is short, and the expedition climbed the water-shed into one of the tributaries of the Sobat. For this tributary the authors propose to restrict the name of Juba. They followed this river to the north-west until it left the Ethiopian highlands near its junction with the group of rivers that unite to form the Sobat. They traversed the swamps of this region to a point some forty miles from the old Egyptian station of Nassur. Having thus settled the relations of the Sobat-Juba, the expedition returned to the Abyssinian highlands on the home trail. They entered the Sajo country, which is ruled by one of Menelik's governors. Bottego sent a polite request for permission to return to Massowah either across the Amhara province around Lake Tsana, or through Shoa, or by any route which might be suggested. The expedition was invited to visit the

Abyssinian chief at Jellem, where it was received with great state; but two days later Bottego's Abyssinians were invited to desert, and in the night twelve men escaped, taking away two cases of cartridges. At daybreak the Italians found their camp surrounded; they attempted to cut their way to open country, and were attacked. They fought with desperate courage against overwhelming odds. Bottego was killed, Citerni was wounded and captured, and Vannutelli compelled to surrender. Fortunately Major Nerrazzini was then in Addis-Abeba arranging the final details of the peace which had been concluded between Italy and Abyssinia. At his intervention the two officers were promptly released, and they returned to Europe through Addis-Abeba, where they were courteously and sympathetically received by Menelik.

Meanwhile the second part of the expedition had fared as disastrously. Dr. Sacchi had left the main party at Lake Stefanie, and crossed the Borana country, intending to reach Lake Abbaia by a new route. But his party had a fight with a force of Abyssinians a little to the south of that lake. Sacchi was killed, apparently on February 7, 1897. Part of his diaries have been recovered, and they contain many interesting notes on the geology of the country traversed.

In spite, however, of these disasters, the results of the journey were of great importance, and they are admirably summarised in the present volume, which has been written by the two survivors Vannutelli and Citerni. The book is interestingly written; the incidents are graphically related; and the details are sufficiently full to be of great scientific interest. Geographically the main achievement of the expedition was the final solution of the Omo problem, and proof of the unity of the northern and southern parts of the Erythrean Rift Valley. The basins of lakes Stefanie, Abbaia and Zuai connect the well-marked depressions of Lake Rudolf and the Hawash. The atlas that accompanies the volume is not only a complete revision of the geography of the region, but contains extensive new surveys. Ethnographically, the expedition has collected much new information regarding the little-known Somali and Galla clans of the Juba country and of the mixed Nilotic-Hamitic races around the northern part of Lake Rudolf. The zoological collections, in spite of losses, were very large, and have been previousiy described in a series of reports by specialists, and in the present volume there is a general summary of results by Prof. Gestro.

The geological collections made by the expedition are described by d'Ossat and Millosevich, who from Dr. Sacchi's notes have been able to prepare a geological map of the Omo and Upper Juba. The meteorological records, which seem to have been very carefully taken, are edited and discussed by Dr. Peyra. The present volume is therefore not only a narrative of an adventurous expedition, but a most important contribution to the geography and natural history of Eastern Africa. It not only confirms Bottego's reputation as one of the most daring and successful of Italian African explorers, but shows him to be a man of wide scientific sympathies and attainments. His friends have at least the consolation of knowing that his life has not been laid down in vain.

J. W. G.

## *MODERN SURGERY.*

*Surgery: a Treatise for Students and Practitioners.* By Thos. Pickering Pick, Consulting Surgeon to St. George's Hospital. Pp. xix + 1176. (London: Longmans, Green, and Co., 1899.)

IT is always a matter of satisfaction when a senior member in any profession writes a text-book, for the seniors who have attained to a high position have had unrivalled opportunities of practice which renders their opinions of the greatest value. Mr. Pick is therefore to be highly commended for the completion of his self-imposed task. The book contains, he tells us, the substance of the lectures which he has delivered at St. George's Hospital for fifteen years, and is the outcome of his experience as a hospital surgeon and teacher of surgery for nearly thirty years. It is worthy of comparison with the world-renowned text-book of surgery written by Erichsen, which has hitherto been the most satisfactory of all the English surgical works, and it bears the comparison well, for it is written on very similar lines. Mr. Pick's treatise has the advantage of being an original work, whilst Sir John Erichsen's has been adapted repeatedly to present needs, and however skilfully such adaptations are made they lack somewhat of the savour which first gives a successful book its vogue. Mr. Pick's work, too, is contained in a single volume, whilst Sir John Erichsen's, by a process of incorporation and the requirements of successive editions, has become two bulky volumes.

Mr. Pick has brought his book to a most successful issue. It contains a clear and concise account of modern surgery, not overweighted by detail, and yet sufficiently full to be an accurate guide both to the student and to the medical practitioner who can only afford a single work in each department of his profession. Mr. Pick is old enough to have been educated in the days of suppurative surgery, but his actual practice has been carried out in the modern operating theatre and wards where antiseptic surgery reigns supreme. He is able, therefore, to contrast the old with the new systems, and one of the charms of his book is the skilful manner in which he selects the good points in the practice of the older surgeons and adapts them to the present *régime*.

Where all is good it is difficult to select one article more than another for praise, but the influence of the great surgical school attached to St. George's Hospital is perhaps best marked in the chapter on diseases and injuries of the head; whilst Mr. Pick's acknowledged eminence in connection with the surgical diseases of children, and in fractures and dislocations renders his remarks on these subjects of especial value.

The surgical pathology throughout the work is quite consonant with modern teaching, and such errors as may be present are rather errors of omission than of commission. The recent summer has shown how large a part gnat bites may play in the production of cellulitis amongst the poorer and less healthy inhabitants of towns. There is no mention of ossifying sarcoma of bone, or of Pirrie's fracture; whilst in describing the diatheses or "complexions" it would be more accurate to speak of them as being characteristic of persons predisposed to tubercle rather than of the tuberculous individual.

The sections on actinomycosis and syphilitic disease of joints might be advantageously recast and made somewhat fuller, whilst "tensing" as a synonym for "tighten," and "sorbefacient" for "causing resolution" are certainly as ugly as they are unwarranted.

The book is illustrated by 440 drawings, of which the majority have been executed by Dr. Harvey Goldsmith, some from preparations or drawings in the museum of St. George's Hospital, others from rough sketches made by Mr. Pick himself. The drawings for the most part fulfil their purpose of illustrating the text, but in Fig. 6 the veins appear to be situated external to the skin; whilst the drawings of the mocmain and lever trusses in Fig. 338 are too diagrammatic to be useful.

The book has a good index, and concludes with an appendix containing a description of the various methods of amputation. This appendix might have been rendered additionally serviceable by the introduction of a section upon prothetic appliances. D'A. P.

## OUR BOOK SHELF.

*Elements of Precise Surveying and Geodesy.* By Mansfield Merriman, Professor of Civil Engineering in Lehigh University. Pp. 261. (London: Chapman and Hall, Ltd. New York: Wiley and Sons, 1899.)

THIS book will be useful not only to undergraduates attending Prof. Merriman's classes at the well-known Lehigh University, but to all who may be engaged in carrying out accurate or geodetic surveys. It is clearly written, methodically arranged, and well illustrated; and the problem at the end of each section seems well designed to test the student's knowledge.

In Chapter i. the laborious method of least squares is explained, and the most important processes for the comparison of observations are described. Chapter ii. deals with precise plane triangulation, the measurement of horizontal angles, the adjustment of the angles of a triangle and the computations. Chapter iii. is devoted to base lines, their measurement and reduction to sea-level. A steel tape, from 300 to 500 feet long, is recommended as a convenient apparatus for the measurement of base lines, and instances are given of the excellent results that have been obtained with it in the United States. In its favour are its portability and the moderate cost at which accuracy of measurement can be secured by its use. Chapter iv. contains useful sections on accurate levelling and the adjustment of "a level net." In Chapter v. the field operations necessary for the determination of azimuth, latitude and longitude are well described, and it may be noted that a good sextant is held to be preferable to a transit theodolite for taking altitudes of a star. In Chapter vi. there is a slight sketch of the attempts to determine the form and size of the earth from that of Eratosthenes to the measurement of the Lapland and Peruvian arcs by the French Academy. This is followed by sections on the solution of geodetic problems on the supposition, first, that the earth is a sphere, and then, Chapter vii., that it is an oblate spheroid. In the latter case Clarke's elements of the spheroid are used for the calculations. Chapter viii. deals with projections, including the polyconic projection adopted in the United States; and Chapter ix. is a brief but clear account of the various operations connected with the practical work of geodetic triangulation. In Chapter x. there are short discussions on the figure of the earth considered as a spheroid, an ellipsoid, an ovaloid and a geoid; and in Chapter xi. there are tables sufficient for the solution of the problems given in the volume.

Prof. Merriman's book contains frequent references to the valuable publications of the United States Coast Survey, which are not always easily accessible, and the American meter is used in the tables and calculations. But this does not lessen its value as a treatise on the elements of precise surveying and geodesy that may be profitably used for instructional purposes in this country. C. W. WILSON.

*Experimental Science (Physiography: Section I.).* By R. A. Gregory and A. T. Simmons, B.Sc. Pp. viii + 332. (London: Macmillan and Co., Ltd., 1899.)

THIS is one of the school books called into existence by the alterations which have been made by the Department of Science and Art in the syllabus for elementary physiography. A clear perception of the needs of both pupils and teachers is evident throughout, and the high standard which the authors have set themselves in previous works of a similar character is thoroughly maintained. The book is so planned that it is well adapted for the new arrangement whereby the subject may be taken in three stages, by candidates for engagement as pupil teachers, and pupil teachers in their first and second years; and it also includes most of the subjects of the Oxford and Cambridge Junior Local examinations in experimental science. Though treating a considerable range of subjects, and keeping examination requirements well in view, the book is by no means sketchy, but indicates very clearly the significance of the progressive series of experiments described. Many of the experiments are suitable for performance by the pupils themselves. The illustrations are both numerous and good.

*Tito Nenci.* I. Bachi da Seta. 3a edizione con note e aggiunte di Francesco Nenci. Con 47 incisioni e 2 Tavole. Pp. xii+300. (Milano: Hoepli, 1900.)

THIS is a compact little manual which seems to have first appeared in 1883, and has now arrived at its third edition. The portrait of Prof. T. Nenci forms the frontispiece, and the other plate illustrates the ventilation of a silkworm establishment. The text illustrations are good, some of them occupying a whole page. The book is divided into seven parts, dealing with the natural history of the silkworm; the "bacheria," or silkworm-breeding establishment; races and rearing; diseases of the silkworm; degeneracy and regeneration; outlay; properties of silk, &c.; and other silk-producing Lepidoptera. But the book is chiefly intended as a practical manual; and the last chapter gives little more than the names of a few of the best-known silk-producing Saturniidæ, though the cocoons of two of these are illustrated. W. F. K.

*Types of British Animals.* By F. G. Aflalo. Pp. xx + 290. (London: Sands and Co., 1899.)

THIS well-illustrated and very readable addition to the "Library for Young Naturalists" is likely to become a favourite with boys. Technical terms are reduced to a minimum, though room has been found for necessary explanatory paragraphs. The first eight chapters describe types of British quadrupeds and whales, and are followed by eight chapters on birds. After single chapters on British reptiles and amphibians, with six on British fishes, invertebrate life is considered in the concluding six chapters. Spiders and insects are described by Mr. C. S. Colman. The familiar and chatty style which is adopted throughout will be sure to capture a boy's attention, and eventually set him observing for himself. We hope the author's appeal to his readers to burn their catapults may prove successful, but we have our doubts. The eight full-page plates and thirty-one illustrations by Mr. Caldwell not only add to the attractiveness of the volume, but will prove useful in enabling the reader to recognise living specimens.

## 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.*]

### Stockholm International Conference on the Exploration of the Sea.

THE publication of a portion of the report of the Stockholm Conference in NATURE of November 9 (p 34) shows, I suppose, that the matter is now open for discussion by scientific men; and it is certainly desirable in that case that marine biologists and others interested in Fisheries investigation should express their opinions on the resolutions, and especially the recommendation, of the delegates. I feel sure that those gentlemen who attended the Conference and took part in drawing up the report will not consider such discussion ungracious, or that we who criticise are in any way wanting in appreciation of their labours. It is because we recognise the great importance which this report, with its series of resolutions, ought to have that we think it worth while to urge that some parts of it should receive careful re-consideration.

Although one may cordially approve of many of the resolutions passed by the delegates, still the report is certainly in some respects a disappointing document; and there is internal evidence to show that this is the result of compromises which were perhaps inevitable, but which have probably led to the omission of what might have been a valuable programme of work.

Last summer, when the arrangements for the Conference were announced, hopes ran high, and it was very naturally and confidently anticipated that the report, when issued, would contain strong recommendations to the Governments concerned involving the use of sufficient boats and men to carry out a definite scheme of biological investigation during a definite period. For surely what we need most at the present time in the interests of more exact fisheries knowledge is the nearest possible approximation to a census of our seas—beginning with the territorial waters. Most fisheries disputes and differences of opinion are due to the absence of such exact knowledge.

If anything approaching a census or a record of trustworthy fisheries statistics had been taken fifty years ago, it would now be invaluable to fisheries inspectors, superintendents and local authorities, as well as to biologists. Our successors will justly reproach us if with our increased knowledge and opportunity we let the twentieth century commence without inaugurating a scheme of practical work which will give us the desired statistics.

The Stockholm report unfortunately says nothing to the point in regard to all this. In place of asking for boats and men, it urges—in the only recommendation of the Conference (" Résolutions textuelles," p. 12, C)—the establishment of a " central bureau," in which the work will apparently in large part be that of a physico-chemical laboratory.

I hope I shall not be misunderstood in this. I do not undervalue the importance of hydrographic work in its connection with the fisheries (and I am only considering it in that connection at present) as carried on of late years, chiefly by the Scandinavians; but it is curious how in this report the obvious, primary, biological investigations are passed lightly over and the secondary physico-chemical work in the central bureau is strongly recommended. Part of the report is called a programme of work, but it contains no definite programme of biological work. I suppose it may be said, all that will be arranged in time at the central bureau, but in the meantime an opportunity is lost. If nothing but an International Committee and a central bureau is asked for, probably that (at most) is all that will be obtained, and *it is not all that is necessary*. In my opinion, what we want at the present time is not conferences, or committees, or a central bureau, so much as boats and men, *and work at sea*.

W. A. HERDMAN.

Croxteth Lodge, Liverpool, November 16.

P.S.—I see Mr. Allen's letter in to-day's NATURE. On the whole he seems to regard the report with more favour than I do; but on most points we are in agreement. It is certainly curious to omit the English Channel and the Irish Sea from an investigation in the interests of the British fisheries.

### The Meteors of Biela's Comet.

WITH your permission I should like to call attention to the possibility of a return of the Andromedes meteors on or about November 23. A consideration of the period of the shower, as deduced from all its known returns, had some time back led me to the conclusion that this year was more likely to be favoured with it than last. The fact that it was not seen last year is, as far as it goes, in support of my contention. But, of course, the stream may take less than a year to pass the point of the intersection of the orbits, in which case the earth may very possibly not pass through it at this return of the meteors.

E. C. WILLIS.

South Radwello, Norwich Lodge, Ipswich.

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MR. WILLIS's inference that some Bielan meteors may be visible this year seems quite in accordance with the historical facts of the stream. The parent comet was observed between 1772 and 1852, and its mean period from twelve revolutions was 6·71 years. If this also represents its mean orbital time since 1852, perihelion would occur in September 1899. But the last four observed returns from 1826 to 1852 averaged 6·62 years, which would indicate perihelion at the end of January 1899. On the whole it seems highly probable that when the earth crossed the comet's orbit in November 1898 it was too far in advance of the cometary nucleus for any meteoric shower to result. It also appears likely that at the meeting, now imminent, of the earth and cometary orbit, the former will encounter a section of the stream too far in the wake of the comet for it to be very thickly strewn with its material. However, this remains to be seen. The apparition of a fine shower of these meteors on November 23, 1892, sufficiently proves that the period of thirteen years intervening between the rich displays of 1872 and 1885 did not exactly represent two returns of the same part of the meteoric group. In 1872 the earth passed through a section of the stream following the comet, while in 1885 it encountered a part preceding the comet. Intervals of twenty years (equivalent to about three periodical revolutions of the comet) seem favourable to recurrences of the meteoric shower as it was observed in 1798 and 1838 (including two periods of twenty years) and in 1872 and 1892. I think the next brilliant return of the meteors will certainly occur in 1905, and that a minor display is very likely to be visible in 1899. If so, the meteors will appear in the early evening of November 24 next, the longitude of the node being 242°·2.

According to the investigations of Schulhof and Abelmann, the planet Jupiter will greatly disturb this meteoritic stream in about March 1901 and cause a minus displacement of the node to the extent of 6°·2. This means that in 1905 the shower will make its apparition on about November 18.

November 15. W. F. DENNING.

## RECENT DEVELOPMENTS OF WIRELESS TELEGRAPHY.

THE efficiency of the system of wireless telegraphy developed by Mr. Marconi has recently been put to some striking tests, with results which are in every respect satisfactory. During the yacht races for the America Cup, descriptive reports of progress were sent by wireless telegraphy from the *Grande Duchesse*, on which Mr. Marconi had his apparatus installed; and as many as four thousand words were transmitted by this means over distances up to thirty miles in the course of a single afternoon.

The method of sending the reports of the yacht races is described by the *Scientific American* to have been as follows:—"The foremast of the *Grande Duchesse* carried an auxiliary mast of sufficient length to give the desired vertical height of 120 feet to a wire, which reached from a short yard on the mast to the table of the operating room below, on which the sending and receiving apparatus was placed. A similar wire was suspended from the foremast of the Bennett-Mackay cable steamer, which was anchored near the Sandy Hook lightship, the starting and finishing point of the races, and also from a mast at the Navesink Highlands. The cable ship and the Highlands had temporary cable connections with New York.

The *Grande Duchesse* accompanied the yachts over the course, and the momentary details of the race, as observed from her decks, were flashed to the cable ship, from which they were sent over the cable to New York, and thence telegraphed throughout the world."

Before leaving the United States Mr. Marconi gave some demonstrations of his system to naval officers and technical experts appointed to report upon its value in naval warfare. With the instruments he had available, perfect communication was kept up between the cruiser *New York* and the battleship *Massachusetts* when the vessels were thirty-five miles apart; and messages were exchanged over a distance of ten miles with a torpedo boat travelling at full speed.

An even more striking demonstration of the utility of wireless telegraphy was given as we went to press last week. It appears from a letter communicated by Major Flood Page to the *Times*, that when Mr. Marconi left New York he cabled to the office of his company in London that he would speak to the Needles from the steamship *St. Paul* on their arrival in English waters. The vessel was expected to pass the Needles about 10 or 11 o'clock on Wednesday morning, and Major Flood Page arrived there on the previous evening, when all arrangements for communication were made. On Wednesday morning, he writes:

"We sent out our signals over and over again, when, in the most natural and ordinary way, our bell rang. It was 2.45 p.m. 'Is that you, *St. Paul?*' 'Yes.' 'Where are you?' 'Sixty-six nautical miles away.' Need I confess that delight, joy, satisfaction swept away all nervous tension, and in a few minutes we were transcribing, as if it were our daily occupation, four cablegrams for New York, and many telegrams for many parts of England and France, which had been sent fifty, forty-five, forty miles 'wireless,' to be despatched from the Totland Bay Post Office."

Upon the vessel itself a *Transatlantic Times* was printed by the ship's compositor, and the subjoined extract from this novel newspaper is of interest in connection with that given above:

"Through the courtesy of Mr. G. Marconi, the passengers on board the *St. Paul* are accorded a rare privilege—that of receiving news several hours before landing. Mr. Marconi and his assistants have arranged for working the apparatus used in reporting the yacht race in New York, and are now receiving despatches from their station at the Needles. War news from South Africa and home messages from London and Paris are being received. The most important despatches are published on the opposite page. As all know, this is the first time that such a venture as this has been undertaken. A newspaper published at sea with wireless telegraph messages received and printed on a ship going 20 knots an hour! This is the 52nd voyage eastward of the *St. Paul*. There are 375 passengers on board, counting the distinguished and extinguished. The days' runs have been as follows:—November 9, 435; November 10, 436; November 11, 425; November 12, 424; November 13, 431; November 14, 414; November 15, 412; 97 miles to Needles at 12 o'clock, November 15. Bulletins:—1.50 p.m. . . .—. First signal received, 66 miles from Needles. 2.40.—'Was that you, *St. Paul'?* 50 miles from Needles. 2.50.—Hurrah! Welcome home! Where are you? 3.30.—40 miles. Ladysmith, Kimberley, and Mafeking holding out well. No big battle. 15,000 men recently landed. 3.40.—At Ladysmith no more killed. Bombardment at Kimberley effected the destruction of one tin pot. It is felt that period of anxiety and strain is over, and that our turn has come. 4.0.—Sorry to say the U.S.A. cruiser *Charleston* is lost. All hands saved."

In addition to the messages above-mentioned, the *Times* states that passengers availed themselves of the instruments to send greetings to friends in England and America, and when the *St. Paul* was forty miles from shore in one case arrangements were completed by a passenger for a supper party in town upon the night of the arrival of the American Line express at Waterloo Station.

This interesting development of wireless telegraphy solves the problem of the communication of a ship with the shore, so far as ocean liners are concerned; for there should be no difficulty in installing the necessary apparatus, or in training officers to work it. Now that such results have been obtained, advantage should be taken of the system as a means of communication whenever opportunity affords.

## *SOME RECENT WORK OF THE MARINE BIOLOGICAL ASSOCIATION.*

ONE of the most important tasks which can be undertaken by the staff of a sea-side laboratory is the exact description of the relations between the fauna of the neighbourhood and the external conditions. Excellent anatomical work can be performed, as it is habitually performed in all the various marine stations which now exist, by naturalists who are unable to live continuously at the sea-side. In many cases a short visit to a suitable locality will enable an anatomist, aided by the knowledge and experience of skilled residents, to collect in a short time material for the most complete study of a species from the anatomical point of view. But many complicated problems connected with the breeding of marine animals, and others, equally complex, which arise from even the most superficial study of their distribution, can only be solved by continued observation extending in many cases over years; and such observations can only be conducted by resident naturalists, with the resources of a properly equipped laboratory at their command.

It is well known that officers of the Marine Biological Association have for years been engaged in the study of questions connected with the breeding of fishes and other marine animals. The last number of the Association's *Journal* contains a report of some 180 pages, illustrated by sixteen charts, which shows that Mr. Allen, the Director of the Plymouth Laboratory, is fully alive to the need for continuous and careful study of the way in which the fauna of the neighbourhood is distributed.

The report deals with the strip of sea-bottom which runs from a point just west of the Eddystone Lighthouse to the Start, at a depth of from about 28 to about 35 fathoms.

A careful description of the nature of the sea-bottom throughout this area is given, and a useful suggestion is made as to the possibility of a uniform nomenclature, by which descriptions of the character of a sea-bottom may be made more clearly intelligible than they are at present.

The bottom deposit is washed through a series of sieves, with apertures varying from 15 millimetres to 0·5 mm.; and a distinct name is given to the material which rests upon each of these sieves, if the deposit is washed through them in order. Six kinds of material are thus recognised, from "stones," which will not pass through a sieve with perforations of 15 mm. diameter, to "medium sand" which remains on a sieve with a mesh of 0·5 mm. The material which passes through apertures of 0·5 mm. diameter is separated into two portions by being shaken up in sea-water. Anything which settles in one minute is spoken of as "fine sand," anything which remains in suspension after one minute is spoken of as "silt."

When a deposit has been separated in this way into constituents of different degrees of fineness, the various constituents are dried and weighed, and the weight of each, expressed as a percentage of the total weight of the sample of deposit, is given for each locality.

This method of describing the texture of a sample of the sea-bottom is simple, and not very laborious. The general adoption of such a method would certainly make it easier than it is at present to compare descriptions by various writers.

A short geological account of the various sands and gravels obtained is given by Mr. R. H. Worth, together with a determination of the $CaCO_3$ (which in these deposits is nearly all of organic origin) in deposits of varying degrees of fineness. Several partial analyses of silts are also given.

Mr. Allen clearly appreciates the great importance of the character of the silt, which forms so large a part of the food of many creatures living on the sea-bottom, and it is to be hoped that in course of time he may be able to attempt a systematic survey of the silts in the neighbourhood of Plymouth, so as to tell us not only more about their chemical composition, but more about their physical character, and about the organisms they contain. He has already made an important advance in our knowledge by showing that "coccoliths" occur in shallow water deposits very much more frequently than has hitherto been believed; but many other organisms, such for example as the the various bacteria which exist in these deposits, are likely to be of considerable importance as part of the biological environment; and of these we know practically nothing.

Having given a detailed description of the nature of the sea-bottom at eighteen selected places in the small area dealt with, Mr. Allen gives a complete list of the species obtained at each locality as the result of a number of dredgings, together with an estimate of the relative abundance of the various species. This complicated information has been admirably digested, and it is so tabulated that the reader can see with very little trouble the relation between the abundance of any species and the character of the bottom deposits or of the fauna of adjacent localities.

The work is deliberately limited to a small area, where the conditions of life are tolerably uniform throughout, and statements are made which lead one to hope that this is only a first instalment of a more extended survey.

Every one who cares about the problems of marine zoology will hope that Mr. Allen may be able before very long to publish his promised account of the region between the thirty-fathom line and the shore, so that the relation between the littoral fauna and the fauna he has now described may be determined. As it stands, however, his work is a solid and valuable contribution to a kind of knowledge which must be largely increased before we can hope to understand the bionomics of the sea.

## THE OLD RED SANDSTONE OF SHETLAND.

THOUGH abounding in ill-preserved plant remains, the Old Red Sandstone rocks of Shetland have hitherto yielded none of those characteristic fossil fishes which would enable us to compare them with rocks of similar age elsewhere in Scotland. On the general evidence of lithological features and the supposed identity of their respective floras, they have been regarded usually as a northward extension of the "Orcadian" beds of Caithness and the Orkneys. Two years ago Mr. John S. Flett, M.B., B.Sc., of Edinburgh University, was able to report that he had found certain obscure fish remains in Shetland, and, this summer, assisted by a grant from the Royal Society of London to defray the expenses of quarrying, he has succeeded in obtaining a number of undoubted fish-remains from the flag-stones of Brissay, near Lerwick. In this collection, which consists mostly of broken and detached plates, Dr. R. H. Traquair, F.R.S., has recognised fragments of an *Asterolepis* (probably a new species) and of *Holonema*, a fish new to Britain, but occurring in the Chemung (Upper Devonian) of North America. A full description of these will, no doubt, shortly be forthcoming. In the meantime, it seems certain that the fauna of these beds is distinct from any fauna of Old Red age at present known in Britain, and, until more fully investigated, its horizon remains open to question; but Mr. Flett inclines to believe that its real position will turn out to be intermediate between the John-o'-Groat's beds (the highest of the Orcadian series of the Orkneys) and the true Upper Old Red of Moray and Elgin. The genus *Asterolepis*, so characteristic of the Upper Old Red, was shown by him two years ago to occur also in the Thurso beds of the Orkneys, and the general forms of the Shetland flora would indicate a connection with the Orcadian. Nevertheless, the whole aspect of the fauna is Upper Old Red; not one of the commoner Orcadian fishes has been obtained in Shetland. An interesting problem is opened up by these discoveries, to which it is to be hoped further investigations will furnish a definite solution.

## SIR J. WILLIAM DAWSON, C.M.G., LL.D., F.R.S., &c.

NEWS has been received of the death of Sir William Dawson, Emeritus Principal and Chancellor of McGill University, Montreal, and the most distinguished of Canadian geologists. He was the son of James Dawson, of Picton, a town on the northern shores of Nova Scotia, where he was born in October 1820.

Coming to this country in early youth he studied at the University of Edinburgh, and gained a knowledge of geology and allied sciences from Robert Jameson, then Regius Professor of Natural History. Returning to his native land, Dawson became Superintendent of Education in Nova Scotia from 1850 to 1853; and later on Professor of Geology and Principal of McGill College and University 1855 to 1893.

On his return to Nova Scotia he directed his attention with the greatest enthusiasm to the study of geology, for as early as 1845 we find him communicating to the Geological Society of London papers on the Coal-formation of the country. To this formation for many years he gave especial study. In company with Sir Charles Lyell he made in 1852 a detailed examination of the fine succession of "fossil forests" of the Coal-period in the cliffs of South Joggins. Together they obtained also the first remains in the Coal-measures of an "air-breathing reptile," named *Dendrerpeton*, which was found in the interior of one of the erect Sigillariæ; a single species of land-shell, *Pupa vetusta*, was found in the same situation.

Zealously pursuing his observations, Dawson was enabled to issue in 1855 his well-known work entitled "Acadian Geology: an account of the Geological Structure and Mineral Resources of Nova Scotia." A third edition of this work was published in 1878.

In 1854 he became a Fellow of the Geological Society of London, and it is noteworthy that all his leading discoveries, before and afterwards, were brought before this Society. His contributions to geological science were many, and though dealing largely with fossil plants, with footprints and impressions of various animals, he also wrote concerning the higher forms of life, and devoted much attention to the phenomena of the Glacial period.

In 1862 Dawson was elected a Fellow of the Royal Society. Two years later his name was rendered familiar to every student of geology by the announcement of the discovery of an organism in the oldest known rocks, the Laurentian of Canada. As early as 1859 Sir William Logan had expressed his opinion that traces of organic structure were to be found in Laurentian limestone; but it was not until 1864 that Dr. Dawson determined by the aid of the microscope that the structure was that of a Foraminifer. He then gave to the "fossil" the name *Eozoon Canadense*, and his opinion was strongly supported by Dr. W. B. Carpenter and Prof. T. Rupert Jones. It is needless here to refer more particularly to the controversy that took place regarding this supposed organism; suffice it to say that for many years the fossil was figured as an organism in most text-books, and was considered to be the oldest evidence of life on the earth. If we turn to Prof. Lapworth's "Intermediate Text-book of Geology, 1899," p. 182, we still find a figure of "Eozoon"; but the author remarks: "the organic nature of *Eozoön* is discredited by most geologists, and the preponderance of scientific opinion has long been in favour of regarding it as a peculiar mineral structure, imitative of the organic." Dawson himself, however, in the *Geological Magazine* for 1895, still boldly upheld the animal nature of Eozoon.

In 1881 the Council of the Geological Society awarded to Dr. Dawson the Lyell Medal, the President (Mr. Etheridge) remarking on the value of his researches on the fossil flora of the Carboniferous and older rocks of Canada. In 1884 Dr. Dawson published a series of articles, and afterwards a small volume, on the geology of Egypt and Syria, but for the most part his original contributions relate to Canadian geology.

In addition to his Acadian Geology, he was author of several other more or less popular volumes, including "Archaia; or Studies of the Cosmogony and Natural History of the Hebrew Scriptures" (1860); "The Story of the Earth and Man" (1873, and many later editions); "The Dawn of Life" (1875); "Fossil Men and their modern Representatives" (1880); "Geological History of Plants" (1888); "Relics of Primeval Life" (1897).

Dr. Dawson was appointed C.M.G. in 1881, and he was knighted in 1884 on the first occasion when the British Association paid a visit to Canada. He was elected President of the Association for the Birmingham meeting in 1886.

He died November 19, in his eightieth year. His son, Dr. G. M. Dawson, C.M.G., F.R.S., is the distinguished and energetic Director of the Geological Survey of Canada.

H. B. W.

## *THE LEONIDS.*

THE following communications have reached us with reference to the Leonid meteors observed last week:—

### MR. DENNING'S REPORT.

It may be safely said that no meteoric display was ever so generally looked for and awaited with so much interest as the one which has just occurred. That the character of it should have proved disappointing is to be regretted, and especially so after the previous failures in 1897 and 1898. The astronomical world had been eagerly anticipating the event for many months, and the curiosity of the general public had been excited by articles in the newspapers pointing out, perhaps too confidently, that the meteors would appear in such amazing numbers that the event would form one of the most striking spectacles of a lifetime. Every one therefore sat up to see the shooting stars, but all more or less failed to realise the expectations they had formed. Some people saw nothing, for clouds or fog hid the moon, stars and meteors on the nights of November 14 and 15. Others had a clearer sky and a dazzling moon, but the grand display of meteors was entirely wanting. The constellation of Leo could be distinctly seen as it rose higher in the east, but meteoric stars only shot at intervals from the familiar "sickle." We had expected that the whole firmament would be furrowed with these "Leonids," as it was in 1799, 1833 and 1866; but instead of a heavy bombardment, there was only weak, desultory firing, and when, in the grey dawn of November 16 observers discontinued their vigils, it was with a feeling of regret; moderated, however, by the knowledge that better success might attend similar efforts in 1900 and 1901.

A large number of reports have been received from observers in different parts of the country. Observations were commenced on November 6 by Prof. A. S. Herschel, at Slough, and in three hours he counted twenty-eight meteors after 14h. on that night, but there was no sign of the Leonids. On November 8 he watched for two hours after 13h. 45m., and saw seventeen meteors, but still no indication of radiation from Leo. On the same night Mr. Besley, at Clapham, watched between 10h. 55m. and 13h. 10m., and counted twenty-two meteors, including seven Taurids and possibly two Leonids.

On November 10 further observations were secured by Prof. Herschel and Mr. Besley, as well as by Mr. T. H. Astbury, at Wallingford, and by the writer at Bristol. An aggregate of seventy-two meteors was seen, including perhaps two Leonids; but it is often very difficult to identify true Leonids from the same swift, streak-leaving meteors directed from other radiants in the neighbouring region of sky.

On November 11, in two hours between 14h. 30m. and 16h. 30m., the writer at Bristol noted ten meteors, including two certain Leonids. One of these at 14h. 52m. was a well-observed foreshortened path from $158°+15°$ to $160°+12°$, and would, in combination with the other Leonid, indicate the radiant at $152°+23°$. If this position is correct the radiant would appear to be a stationary one like that of the October Orionids.

On November 12 the sky was much clouded, but on November 13, between 17h. 8m. and 17h. 50m., Mr. J. E. Clark, at South Croydon, saw nine meteors (seven Leonids). At Bristol the S.W. sky was partly clear from 17h. 15m. to 18h., and five meteors (one Leonid) were counted. At Marlborough between 17h. 20m. and 18h. 30m. twenty-one meteors (eighteen Leonids) were seen by Mr. H. Savory. At Cambridge between 17h. and 18h. 25m. twenty-three meteors were counted by Mr. Hinks.

On November 14, Mr. T. H. Astbury, at Wallingford, registered twenty-five Leonids, and saw about a dozen more between 16h. 3m. and 17h. 53m. Sir W. J. Herschel, at Littlemore, Oxford, saw ninety-eight meteors (sixty-six Leonids) during the night. At Yeovil the sky was generally cloudy, but between 17h. and 18h. 30m. six meteors were seen crossing breaks in the clouds. Both at Littlemore and Yeovil a very fine non-Leonid was seen at 17h. 40m. At Worthing, Sussex, between 15h. and 18h. more than 200 Leonids were counted by Mr. A. R. Schulz. At Cambridge four observers watching from 12h. 5m. to 16h. 35m. observed forty-five meteors. At Brighton between 14h. 30m. and 18h. twenty-eight meteors (twenty-four Leonids) were noted by Dr. R. J. Ryle.

On November 15, 16 and 17, further observations were made, but meteors fell in very moderate numbers. They appear, in fact, to have been no more numerous than on mid-November nights in ordinary years when the comet is not far from aphelion.

Reports from foreign stations may possibly modify our present views and show that a fairly bright shower was observed elsewhere and during the daytime in England. But from a few descriptions already to hand from America and various parts of Europe it appears that the meagreness of the display formed a common experience even among observers situated in widely different longitudes.

There is every reason to suppose that though the shower has managed to elude us this year it must confront us next year, and possibly in 1901. It will be remembered that there were rich displays in 1866, 1867 and 1868. The one in 1866 occurred ten months after the parent comet of Tempel had passed through its perihelion (January 11), while the shower of 1868 appeared nearly three years after the return of the comet. The latter object probably reached perihelion last spring (though it was not observed anywhere), and we are clearly entitled to expect from the great extension of the meteor stream visibly encountered from 1866 to 1868 that exhibitions of the finest kind will be presented in the two ensuing years. Whether or not the phenomenon will be favourably perceptible in England is uncertain, but it ought to be seen in one of the two years.

In 1833 there was a magnificent display. In 1866 the earth passed through a section of the orbit three months in advance of the part we encountered in 1833. There was a very rich shower in 1866, but it was nothing like the preceding one. In 1899 the earth intersected a region of the stream six months in advance of that of 1833, and where the meteors are thinly distributed. Everything supports the view that observers will not watch in vain for these meteors in 1900 and 1901.

When we consider the circumstances affecting the visibility of the Leonids, we must readily concede that it will often evade notice at a given place. In England, November nights are rarely clear and clouds may hide the meteors, or the earth may traverse the swarm at some time during the 15 hours in a day when it possibly could be seen, for from 7 a.m. to after 10 p.m. either daylight or an invisible radiant places it beyond reach. But many of us will hope to find compensation for the disappointments of recent years in observing a brilliant return of the meteors in one of the two ensuing years, and certainly before the denser region of the stream gets too far on its outward journey to aphelion.

W. F. DENNING.

### CAUSE OF THE NON-APPEARANCE OF THE SHOWER.

None of the Leonid meteors are visible until and unless some out of their vast number chance to plunge into our atmosphere and are extinguished after a second or two of intense brilliance. We cannot accordingly follow their motions by observations in the open sky, and can only tell where they are when we can compute where they must be. This has become possible with reference to station A in the stream, that portion through which the earth passed in 1866, and of which Adams determined the osculating ellipse as it existed in that year. Any change either in form or position which it has since undergone has been due to perturbations. The meteors occupying that portion of the stream have nearly completed another revolution since 1866, November 13. The perturbations they have suffered in the latter part of their course have been computed in Germany by Dr. Berberich, and the perturbations over the whole of the revolution have been computed in this country by Dr. Downing and the present writer, with the aid of the skilled computers of the Nautical Almanac, and at the expense of the Royal Society. These more full computations enable us to follow all the motions of this portion of the stream. It will reach its descending node, where it comes nearest to the earth's orbit, on the 27th of next January, and is accordingly at present advancing towards the earth, along an osculating ellipse of which the present form and position can be determined. This has been done, and it has been thus ascertained that the earth passed the descending node of this orbit last Thursday morning at about 6 a.m. In 1866 this orbit intersected the earth's orbit, but unusually intense perturbations have since acted on it, and have so shifted its position that the point when it pierced the plane of the earth's orbit last Thursday, and which we may call point P, lay at a disrance from the earth towards the sun which was 0·0141 of the mean distance of the sun, that is, it lay about five times farther from the earth than the moon is. A subsidiary investigation, which will shortly be published, makes it almost certain that the point P indicated above is situated within the stream which was passing the earth last Thursday. This is the only point in the stream which was passing us last Thursday of which we actually know the position; and it was at the great distance from us which is above stated.

Now comes in another consideration. A separate dynamical investigation into the conditions under which the Leonids were drawn into the solar system by Uranus, has shown that when that planet advanced along his orbit and left them behind, they found themselves moving nearly with the same speed and nearly in the same direction, but not quite. They were in fact scattered over a very small cone of dispersion. This occasioned small differences to exist between the vast elliptic orbits round the sun, upon which they then entered. Some of the meteors found themselves in planes slightly more inclined to the ecliptic than others, some started along ellipses of slightly greater ellipticity, and so on; but all when they had travelled along the inward part of their new elliptic journeys would cross the plane of Uranus's orbit (which is nearly the plane of the earth's orbit) at points which lay along the line of nodes, measured in the plane of Uranus's orbit, a line which nearly coincided with the radius of the earth's orbit, which lay along the line of nodes in the plane of the ecliptic. Hence the stream became a ribbon-shaped stream at its descending node, where the earth encounters it, the width of the ribbon lying very nearly along one of the radii of the earth's orbit. The position of this ribbon has been somewhat altered by the perturbations to which it has been exposed during the seventeen centuries and threequarters which have since elapsed. Its width accordingly no longer lies quite perpendicular to the earth's orbit. We know that the stream has this ribbon shape, but we do not know its width further than that it is considerable, nor do we know where in the width of the ribbon the point P lies whose position we have been able to determine. That we have not had one of the great Leonid showers this year conclusively proves that the part of the width of the ribbon which lies outside the point P has not been able to reach the whole way out to the earth's orbit—a distance of about 1,300,000 miles.

G. JOHNSTONE STONEY.

### GREENWICH OBSERVATIONS.

The Astronomer Royal reported to the *Times* on the 16th inst., that the preparations made at Greenwich for observing the Leonid meteors were rendered abortive by cloud and fog on the nights of November 14-15 and 15-16. During a short break in the clouds on the morning of the 16th only 16 Leonids were noted (by four observers) in 42 min. from 5h. 34min. to 6h. 16min. A.M. November 16. No photographs could be obtained.

### REPORT FROM THE SOLAR PHYSICS OBSERVATORY.

To take advantage of the meteor shower that was expected at the earlier part of last week, the whole staff of the Solar Physics Observatory took part in a carefully-prepared programme. The observers were divided up as follows: The six-inch Dallmeyer camera for photographing the radiant point, and a siderostat with three small cameras mounted on its polar axis for obtaining spectra were worked by Dr. Lockyer and Mr. Howard Payn, who was a volunteer. Mr. Fowler took charge of an integrating spectroscope and a small visual spectroscope mounted equatorially to examine bright trails. The large 6-inch prismatic camera was used by Mr. Baxandall and Mr. Shackleton on alternate nights, while a 9-inch prismatic reflector and another battery of small cameras was worked by Mr. Butler and Mr. James.

On all the four nights (9 p.m. to 6 a.m.) during which a watch was kept, the weather was very unfavourable, and it was only for short periods of time on Wednesday and Thursday that a glimpse of the sky was at all possible. In fact, fog and cloud seemed to alternate or combine at the expense of a clear sky. To take advantage of a clear sky at some distance from the observatory, such as at Hampstead, several volunteers took up their positions there with advantage. At the observatory itself no photograph of any meteor trail or spectrum was obtained, and it was practically only for a short period on Thursday morning that plates were actually exposed with any prospect of success. Eye observations indicated, however, that if the shower had arrived on Wednesday or Thursday, at least some trace of its presence would have been seen during the period of observation, in spite of the fog, if the display had attained anything like its grandeur of 1866.

Tuesday night was apparently very clear at Hampstead, and one of our keen amateurs reported that between 10 p.m. and 4 a.m. the next morning, there was an absolute dearth of meteors. Another observer on Banstead Downs also saw no signs of the shower, for between 2.28 a.m. and 3 a.m. on the Wednesday morning, he counted only ten meteors, and these might not all have been Leonids. Brighton had a clear sky on the morning of Wednesday, and an observer there who watched between midnight and 4 a.m. saw no evidence of a display but sixteen Leonids and a few sporadic meteors. Several other observers who observed from Hampstead Heath on the Thursday morning early also reported no shower, but simply a meteor or two.

It must be concluded therefore that the expected shower did not arrive, or rather that the earth has not passed through any very dense portion of the swarm. It may be recollected that in the two preceding Novembers the Leonids were conspicuous by their absence, and this may practically be said of the recent display.

In addition to the above reports, the communications printed below have been received :—

Mr. E. C. Willis, of Ipswich, reports as follows :

*November* 14 :—

| Time. | Meteors seen. Leonids. | Others. | Remarks on weather. | |
|---|---|---|---|---|
| 12 5 – 12 45 | 1 | 0 | Thick mist | Moonlight. |
| 13 0 – 13 20 | 0 | 0 | Very thick mist | |
| 14 0 – 14 25 | 1 | 0 | Thick mist | |
| 16 45 – 17 0 | 10 | 4 | Fine | No moon. |
| 17 0 – 17 15 | 4 | 1 | Fine, with some cloud | |
| 17 15 – 17 30 | 8 | 3 | Fine | |
| 17 30 – 17 45 | 12 | 6 | Fine | |
| 17 50 – 18 5 | 2 | 2 | Fine, sky much lighter | |

*November* 15.—Observed occasionally from 11h. to 18h. The clouds at times covered the entire sky, while at times they were much broken up. No meteors were seen. The conditions were such that a brilliant shower could not have passed unobserved.

*November* 16.—Observed from 11.40 till 12.10. The sky was mostly covered with cloud. No meteors were seen.

The following notes by the Rev. Martin Wall, Fort Augustus, N.B., have been received from the Meteorological Office :—

"Great meteor" seen at 8.20 p.m., November 15. Flying with tremendous velocity south-east to north-west. Described, by an engineer, as a mass of flame of between 2 and 3 feet square ; in brilliancy like the arc-light ; leaving a trail of flame in its course, and lighting up the sky with a white light. It was seen by a second person to explode, over hill to north-west.

[N.B.—Indoors, where the electric light was burning, the diffused light of the meteor was distinctly noticeable.]

Two or three Leonid meteors were seen on the night of November 14 (one or two at 2 a.m., and one at 5.45) ; but the 15th and 16th were totally clouded over ; hence photographic preparations were of no avail.

[N.B.—Numerous ordinary meteors were also seen on the 14th.]

## NOTES.

THE scientific lessons of the war are crowding upon us. We have already referred to the blunder made by our military authorities, in not sending Marconi apparatus to South Africa among the first equipments. We now learn indeed, after the investment of Ladysmith is drawing to a close, that Marconi apparatus is being sent out. The silence of Ladysmith during the last eventful weeks will point the moral, which is not likely to be forgotten in the future ; and it may well be that in the movements about to take place, in which the Ladysmith and the relieving force should be able to work in concert, the absence of a sure and rapid method of signalling, the absence of the Marconi apparatus, may render this difficult if not impossible. We have been informed on good authority that some time ago the importance of a locomotive search-light in operations of war was strongly represented to the military authorities ; but they would have none of it. Fortunately, however, the naval force in Natal has now provided the army with one. It is certain to do good service.

THERE can be little doubt that the presence of another scientific instrument, the balloon at Ladysmith, has saved the situation. A moment's consideration of what this touch of science can do for us will indicate that the above expression is well grounded. Imagine two identical maps of Ladysmith and its surroundings, including the region dominated by our guns, carefully marked with squares, so that the position of any patch can be exactly defined by the rectangular coordinates shown at the side. A1, A20, &c., X6, Z30, Z40, &c. Imagine one of these in the hands of an officer who knows the ground thoroughly well, in the car of the captive balloon. He telephones the position of the enemy to the officer commanding the artillery down below, who is possessed of an identical map. From this he can at once determine the azimuth and range, and in a few minutes the shell may be fired in the required direction. The telephone of the balloon will inform the gunners how the shell has been dropped, and any directions regarding range can be given. It will therefore be impossible for the rebels, thanks to the balloon, to form in daylight in any large numbers for an attack on the camp, without rendering themselves liable to the searching fire of the guns. May we hope therefore that the balloon will also be used along the chief line of advance? During a calm day it is possible that this scientific instrument may be far more valuable than an army of scouts, though the difficulties attending its working are fully recognised. Seeing then how important scientific instruments are in this struggle, in which millions are freely spent, we return to our question, how is it that there is no scientific committee to advise the Government in such matters, even if only to anticipate scientific applications? and how is it that from the Grand Council of the nation, the Privy Council, men of science are rigorously excluded?

A CONFERENCE of representatives of electric railway and electric tramway enterprises on the one hand, and representatives of the Government interested in the Greenwich and Kew Observatories on the other, was held at the Board of Trade on Wednesday in last week. The object of the conference was to ascertain the best means of dealing with the interference with the delicate instruments in the observatories by the leakage which there is reason to believe will follow from the introduction of large systems of electric traction. After Sir Courtenay Boyle had opened the proceedings, Prof. Rucker and the Astronomer Royal showed that magnetic instruments are seriously affected by the proximity of systems of electric traction ; but Sir Douglas Fox and Major Cardew would not admit that any interference with observatory instruments had at present been proved. As a result, a committee was appointed "to investigate the amount of magnetic disturbance produced in the neighbourhood of electric tramways and railways constructed and worked under the Board of Trade regulations ; and to report as early as possible." The committee consists of Profs. Rucker, Ayrton and Perry, representing the laboratories ; Prof. Kennedy, Mr. H. F. Parshall, Major Cardew and Mr. Brousson, for the electric traction companies ; and Mr. A. P. Trotter for the Board of Trade.

THE Paris correspondent of the *Chemist and Druggist* makes the following announcement :—The Professorship of Inorganic Chemistry at the Paris School of Pharmacy, vacant by the retirement of Prof. Riche, has been given to M. Henri Moissan. The latter's appointment as professor of toxicology at the School, which he already held, was perhaps due more to a very natural desire to attach the brilliant professor to the teaching staff than to poisons being his *forte*. He will now lecture on the subject that has practically been his life study. His first lesson on

Thursday afternoon of last week produced quite a little ovation, M. Moissan being loudly cheered by the large number of students present. He gave a short address on the career of Prof. Riche, and touched on the subject of electro-chemistry.

THE *Cecil Rhodes*—the first iron steamer designed for service on Lake Tanganyika—was launched at Wyvenhoe on Saturday. The steamer is to be employed primarily in laying the wires of the Cape to Cairo telegraph line along the shores of the lake. After the trial trip the boat will be dismantled and taken to pieces for shipment to Chinde, on the East Africa coast, whence she will be taken up the Zambesi and Shiré rivers by the Sharrers Zambesi Traffic Company, thence by native porters through Blantyre to Mpimbo, where she will be again shipped and carried across Lake Nyassa to Karonga, and finally taken overland along the Stephenson road to the south end of Lake Tanganyika, at which point she will be reconstructed and launched for the second time.

PROF. FERDINAND TIEMANN, honorary professor of chemistry in Berlin University, died on November 7.

DR. HENRY HICKS, F.R.S., the distinguished geologist, died on Saturday last, at the age of sixty-two.

THE death is announced, at Southport, of Mr. Alexander McDougall, who was widely known about sixty years ago in connection with the invention of the atmospheric railway, and has been associated since then with a long succession of mechanical and chemical appliances of public utility.

WE regret to see the announcement of the death of Dr. Camara Pestana, chief of the Bacteriological Institute at Lisbon. It was his verdict on specimens sent to him from Oporto for examination that conclusively established the existence of the plague there in August last. Dr. Pestana caught the plague while studying it at Oporto, and his death was due to that disease.

FROM the *Cape Times* we learn with regret that Prof. Francis Guthrie, until the end of last year professor of mathematics in the South African College, died on October 19. Prof. Guthrie was a brother of the late professor of physics at the Royal College of Science, South Kensington. He was born in 1831, and went out to Cape Colony in 1861 as professor of mathematics in the then newly-established Graaff-Reinet College. In 1875 he resigned his appointment at this college, and went to Cape Town. After a brief visit to England in 1876, he was appointed to the chair of mathematics in the South African College, then vacant by the retirement of the Rev. Prof. Childe. This appointment he held for twenty-one years, retiring from it in 1898. The Council of the college marked their appreciation of his long and honourable term of service by according a pension of double the amount to which he was legally entitled. Prof. Guthrie was deeply interested in botany; and he had the advantage of attending the lectures of John Lindley, an English botanist of high reputation. In Graaff-Reinet he gave, outside the college course, a series of public lectures; and on his removal to Cape Town, took up again more assiduously his botanical pursuits. Finally, he undertook, in conjunction with his life-long friend, Mr. Harry Bolus, the enormous task of a revision of the Order of the Heaths, for the next volume of the "Flora Capensis," now in course of preparation at Kew. Into this work he threw himself with all the ardour and enthusiasm of youth, and was engaged upon it up to a short period before his death.

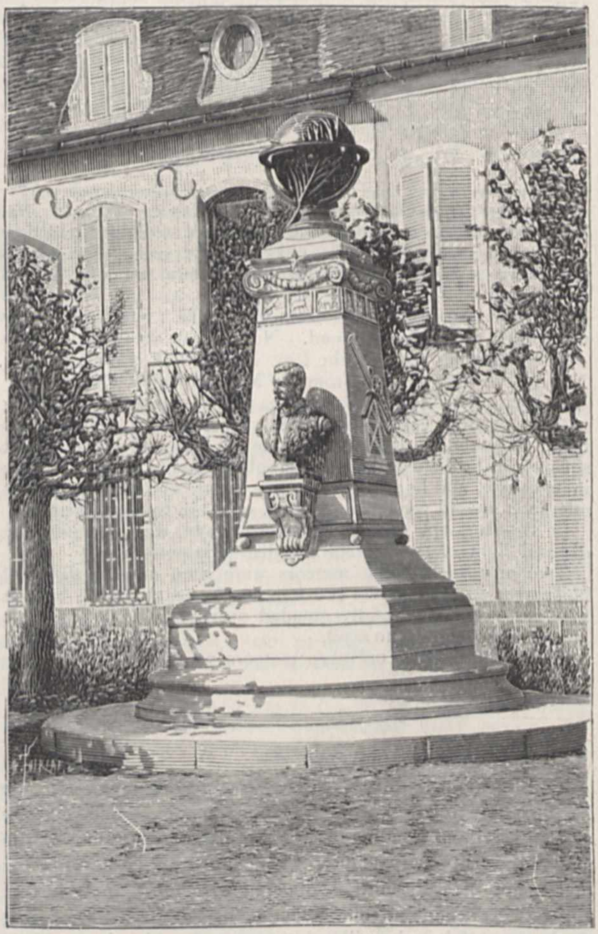
FELLOWS of the Physical Society, and their guests, dined together at the Hotel Cecil on Friday evening, November 17. The president of the society, Prof. O. J. Lodge, took the chair, and the guests included many distinguished men of science.

MR. STEWART CULIN, of the University of Pennsylvania, is preparing a memoir on the late Dr. D. G. Brinton, at the request of the family of the deceased anthropologist. He will be glad to receive letters and other literary materials bearing upon the subject of his memoir.

THE *British Medical Journal* states that Mr. J. W. Stephens and Dr. R. S. Christophers, members of the Royal Society expedition on malaria, have returned home, but they may possibly at a subsequent date proceed to the West Coast of Africa.

AS a proof of his cordial sympathy with the cause of bird protection, the Poet Laureate, Mr. Alfred Austin, has written a special poem for the Christmas card which the Society for the Protection of Birds is issuing this year. It is entitled "Peace and Goodwill to the Birds," and is illustrated by a coloured picture of that much persecuted bird the tern, designed for the purpose by Mr. A. Thorburn.

A MONUMENT erected, by public subscription, to the memory of the lamented astronomer, M. Felix Tisserand, late director of the Paris Observatory, was unveiled at Nuits-Saint-Georges on



October 15, in the presence of a distinguished company of men of science. The accompanying illustration of the monument is given in *La Nature* with an account of the inauguration ceremony. Général Bassot, speaking on behalf of the Academy of Sciences, referred to Tisserand's scientific work. M. Poincaré spoke as the representative of the Bureau des Longitudes; M. Baillaud reminded the company of Tisserand's work at Toulouse; M. Callandreau spoke on behalf of the Société Astronomique;

M. Tannery in the name of the École Normale; M. Bigourdan for old pupils; and M. Lœwy, the director of the Paris Observatory, as the representative of the Government and the Observatory. The French delight to honour their men of intellect; but it is not often that a memorial of the kind erected to Tisserand is unveiled in honour of a man who has devoted his life to science in England.

FOUR years ago a scheme was drawn up by the late Dr. E. von Rebeur-Paschwitz for the organisation of the study of earthquakes over the whole globe. He obtained for it the support of all the leading seismologists, but his early death unfortunately delayed its execution. Prof. Gerland, on whom Von Rebeur's mantle has fallen in Germany, continues to support the scheme, and, having secured the approval of the Geographical Congress at Berlin, has issued a pamphlet in which he suggests the foundation of an international seismological society. The objects of the society would be to diffuse as far as possible the study of earthquakes in all countries, and especially in those which do not yet possess seismological stations; to create a methodical organisation of microseismic observations; and to centralise the publication of reports, which would appear in the form of supplements to the *Beiträge zur Geophysik.* It is also proposed that the Society should hold its general meeting conjointly with the International Congress of Geography.

MAJOR S. J. RENNIE describes in the *British Medical Journal* a grave case of snake-bite treated successfully with Calmette's antivenene serum. In concluding his account, he remarks: "That we have in Calmette's antivenene serum a most powerful remedy against the bites of venomous reptiles has been fully proved both in the laboratory, and also, in a few instances, in actual practice. In the year 1896 it fell to my lot to treat the first case in which this serum was used in India, and since then other successful cases have been reported. The case under consideration is, however, of especial interest, in that it proves, first, that no matter how acute the symptoms, or how far advanced the effects of the poison, it is never too late to use the antidote; for, as will have been noted, the boy, in this instance, was, to all intents and purposes, dead at one time; and, secondly, that the "antivenene" will keep for an almost indefinite period, and exposed to all vicissitudes of climate, as I had the serum used in this case in my possession in the plains of India for nearly four years."

THE annual report by the Board of Trade on their proceedings under the Weights and Measures Acts has just been issued as a Parliamentary paper. The report refers to the biennial meeting of the International Committee of Weights and Measures, which was held in Paris in April last, to consider the work undertaken at the bureau of the committee since the year 1897, and also to arrange the future proceedings at the bureau for the years 1899–1901. The committee was attended by representatives from various countries, including Great Britain, and was presided over by the president, Prof. W. Förster, director of the observatory at Berlin. The discussions at the numerous meetings of the committee, and the results of the inquiries by the committee into the administration of the bureau and the scientific investigations undertaken there by the director of the bureau, Dr. J. René-Benoît, have been published under the directions of the committee in the "Procès-Verbaux des Séances de 1899," and also in the "Travaux et Mémoires du Bureau International des Poids et Mesures." The report states that the Board of Trade are in communication with some Government departments with the view of ascertaining how far the metric system of weights and measures might be officially adopted in contracts. The Standards Department have in course of preparation, for the purpose of explaining the principles of the metric system in schools, a set of education models of metric weights, measures, and weighing and measuring instruments similar to those used in trade.

TWO papers, dealing with the construction and equipment of the Waterloo and City Railway, were read at last week's meeting of the Institution of Civil Engineers. The first paper, by Mr. H. H. Dalrymple-Hay, was devoted to a description of the general features of the line, and the methods used in its construction. The new line is one and a half miles long, and, with the exception of a short length at Waterloo consists of two iron tunnels with a station at each end, approached by stairs and inclines. The method of tunnelling in the London clay and in water-bearing strata was the well-known Greathead system, except in the case of a short length of tunnel which was driven by a new method not requiring the employment of a heading or timbers outside the shield. The average rate of working in the small tunnels was ten feet every twenty-four hours where the tunnels were in the clay. In the larger tunnels at the City Station, which were also in the clay, six feet was completed regularly in the same time. In water-bearing strata, however, the speed varied greatly, depending upon the character of the ground and the depth of ballast and head of water at the face.

THE second paper, referred to above, by Mr. Bernard M. Jenkin, gave an account of the electrical equipment of the line, which is the second underground railway that has been built to be worked electrically. The electric energy is generated at the Power Station, at the Waterloo end of the line, by high-speed engines coupled direct to two-pole dynamos. The energy is transmitted to the trains by feeders connected to an insulated rail, or conductor, placed between the two running rails of the permanent way. Experiments and tests were made on completion of the line to ascertain the time and power taken to drive a train from one station to the other under different conditions and with different limits of speed on the sharp curves. The time in which a train could traverse the whole of the distance from one station to the other depends mainly upon the maximum speed which could be allowed on the sharpest curves. There are some very sharp curves at the bottom of the dip in the line where it passes under the river, and it was originally intended that the speed on these curves should be limited to twenty-four miles an hour. Before the line could be opened it was inspected by the Board of Trade, and Sir Francis Marindin decided to limit the speed round the sharpest curves to fifteen miles an hour instead of twenty-four miles an hour, for which the whole of the electrical equipment of the line was designed. This alteration has had naturally a very great effect on the whole working of the traffic on the line, the brakes having to be applied to the train on the down gradients, as the speed which would be attained by gravity alone would very much exceed the limit of fifteen miles an hour by the time the curves were reached. The switchback principle of working the line cannot, therefore, be adopted as it might otherwise have been with the particular arrangements of gradients and the absence of intermediate stations which is the peculiarity of the line described.

IN the few years that have intervened since the water of Niagara was first turned into the wheel-pit of the Niagara Falls Power Plant, a large number of entirely new industries have sprung up around, or within easy touch of, the power station. That the tendency is for the industries to gravitate to the power rather than the power to be transmitted to the industries is shown in an account given in the *Scientific American*, from which it appears that out of a total of 35,000 horse-power delivered from the station, over three-fourths are consumed in its vicinity, as against less than one-fourth that is transmitted to a distance—the principal long distance transmission being that of 8000 horse-power to Buffalo, for the use of the Cataract Power and Conduit Company. It must not, however, be concluded that long distance transmission will not enter largely into the ultimate utilisation of the energy of Niagara. The remarkable installation recently opened in Southern California, where a transmission of eighty-three miles has been successfully accomplished, suggests that a large part of the 7½ millions of hydraulic horse-power available at Niagara Falls may yet be transformed and transmitted to the large cities of the eastern States. The present indications are, however, that for some time to come transmissions are not likely to be attempted for distances of over 100 miles.

THE success of the Naples Zoological Station in preserving marine animals for the purposes of both exhibition and study is so well known to all interested in museum work, that they will be prepared to welcome the translation by Mr. E. O. Hovey, which has recently appeared in the *Bulletin of the U. S. Museum* (No. 39), of Dr. Salvatore Lo Bianco's memoir on the methods employed in such preservation. It is to Dr. Lo Bianco himself that the exquisite results obtained are chiefly due; and the translator appends the following remarks on the secret of this success. "One reason for the beautiful appearance of the material sent out by the station is that it is properly caught in the first place; another is that, for the most part, the animals are alive when the process of preservation begins. With many forms it is indispensable that they be alive at the beginning of operations; with some it is not so necessary, but with all it is highly desirable. . . . The best methods have been determined for each species by itself, different species of the same genus often requiring different handling. . . . When new species are encountered, the best method of procedure must be determined by experiment." It is interesting to note that the author assigns to alcohol the first place as a preservative medium; adding that although formalin is a very useful liquid for keeping animals temporarily, it is less well suited for their permanent preservation.

LOCAL scientific societies often have a tendency to develop into societies for the promotion of penny readings and popular lectures; but the committees should always bear in mind that though interesting accounts of the scientific work of others may create a desire to know more of the facts of nature, the real value of a local scientific society must be judged by the facilities afforded for original observations, and the use the members make of them. The Preston Scientific Society, to judge by the annual report presented last week, not only encourages interest in science by means of lectures, but in each of its sections systematic studies and individual investigations are organised. A scheme for identifying and recording the flora of Preston and the neighbourhood was drawn up three years ago, and has been actively carried out during the past summer. Much new information has thus been gained, and in regard to the flowering plants it appears that the flora of the district was never so completely known as it is now. Mr. E. Dickson, who has been elected president for the ensuing year, pointed out in his address that this is the kind of work that can usefully be done by a local society, namely the investigation of local facts and phenomena. There is much to be done in the way of working out details of the natural history in every district, and the societies which stimulate activity in the required directions will assist in the advancement of scientific knowledge.

THE *Bulletin* of the Cracow Academy for July contains an important note of a mathematical character by Dr. Ladislaus Natanson on the thermokinetic properties of solutions. The present investigation appears to furnish a thermodynamical interpretation of Van 't Hoff's molecular theories of osmotic pressure.

WE have received the fourth report of the International Commission of Glaciers. The report is entirely devoted to records of glacier measurements made in various parts of the world during 1898; it forms a substantial addition to our knowledge of glacier movements and their periodic variations.

THE new *Bulletin de la Société de Géographie* contains a number of papers of more than average interest. Mr. F. J. Clozel contributes a historical paper on the Ivory Coast; Captain Chanoine writes on the Voulet-Chanoine Mission; Dr. Huguet describes the physical geography of Southern Algeria in a paper illustrated by some rough but suggestive sketches of sand-dunes. There is an account by Dmitri Klementz of travels in Western Mongolia in 1885 and 1897, and the first part of an important paper on the Meteorology of Palestine and Syria, by Father R. P. Zumoffen, S.J.

WE have received parts 1–3 of vol. xxi of the *Transactions and Proceedings* of the Botanical Society of Edinburgh (1897–1899), which contain several interesting articles, especially on the structure and microscopical examination of woods, recent and fossil, viz.:—On the histological structure of fossil woods, by Mr. R. A. Robertson; on a method of injection-staining plant vascular systems; on contact negatives for the comparative study of woods; and on the histology of some fossil woods, by the same writer. Mr. R. Stewart McDougall has a paper on the bacteria of the soil, with special reference to soil inoculation; Mr. R. Turnbull, one on *Apodya lactea*, a fungus belonging to the Saprolegniaceæ; Mr. Percy Groom, one on the fusion of nuclei among plants, and Mr. R. A. Robertson, one on abnormal conjugation in *Spirogyra*.

OUR German contemporary *Globus* is always interesting, and it is a great pity that there is no journal on similar lines in the English language. The following articles in recent numbers are well worth reading: "The Philipponens of Ostpreussen" (vol. lxxvi. No. 12) gives an account of the houses, mode of life, and religious beliefs of a strange Christian sect that was established about 1700 by Philip Pustoswiät. "The Onondaga Indians of New York State, and the Sagas of the foundation of the confederation of the five nations by Hiawatha" (Nos. 13, 14). "Indian and Singhalese Children and their Games" is a welcome addition to a neglected subject; there are several illustrations (Nos. 14, 15). R. Schumacher gives (No. 15) an illustrated ethnographical account of a recent travel among the uncivilised Tschin-huan who live in the high and hard-to-reach mountains of Formosa; the author does not believe that they are an aboriginal population (No. 14). "Folk-lore among the Huzulen" (Nos. 15, 16, 17). Dr. H. Jansen gives (No. 17) a valuable illustrated *résumé* of recent ethnographical, anthropological, and archæological work in Portugal. We would call attention to the illustrations of existing pile dwellings.

MESSRS. WILLIAM WESLEY AND SON have sent us a catalogue of books and pamphlets on modern astronomy, which is a model of clear and orderly arrangement. The catalogue is limited to astronomical literature of the nineteenth century, and includes 2240 titles, arranged under thirty-three heads and subheads. The classification adopted is particularly convenient, and it enables an astronomer to find at once the works in the list bearing upon the branch of celestial science in which he takes special interest.

THE additions to the Zoological Society's Gardens during the past week include a Diana Monkey (*Cercopithecus diana*, ♂) from West Africa, presented by Mr. E. F. Martin; a Spotted Ichneumon (*Herpestes auro-punctatus*) from Busreh, presented by Mr. B. F. Ffinch; two Dusty Ichneumons (*Herpestes pulverulentus*), a Cape Crowned Crane (*Balearica regulorum*) from

South Africa, presented by the Trustees of the South African Museum; two Schalow's Touracous (*Turacus schalowi*), four Cape Turtle Doves (*Turtur capicola*) from South Africa, presented by Mr. W. L. Sclater; a Vulturine Eagle (*Aquila verreauxi*) from South Africa, presented by the Rev. D. Kolbe; a Tawny Eagle (*Aquila noevioides*) from South Africa, presented by Mr. Claude Southey; a White-tailed Gnu (*Connochaetus gnu*, ♂) from South Africa, presented by Mr. C. D. Rudd; two Mandrills (*Cynocephalus mormon*, ♂♂), two White-collared Mangabeys (*Cercocebus collaris*, ♂♀), a Tantalus Monkey (*Cercopithecus tantalus*, ♂), a Lucan's Crested Eagle (*Lophotriorchis lucani*) from West Africa, a Spring-Bok (*Gazella euchore*, ♂) from South Africa, a White-tailed Ichneumon (*Herpestes albicauda*) from the Atbara River, a Yellow-headed Conure (*Conurus jendaya*) from South-east Brazil, four Lesser Pin-tailed Sand-Grouse (*Pterocles exustus*), a Black-headed Partridge (*Caccabis melanocephala*) from Arabia, deposited; a Roi Rhe-Bok (*Cervicapra fulvo-rufula*, ♂) from Maryland, Schombie Station, Cape Colony, a Gannet (*Sula bassana*), British, purchased.

## *OUR ASTRONOMICAL COLUMN.*

HOLMES' COMET (1899 *d*).

*Ephemeris for 12h. Greenwich Mean Time.*

| 1899. | R.A. h. m. s. | Decl. ° ′ ″ |
|---|---|---|
| Nov. 23 | ... 2 13 55·17 | ... +47 40 0·2 |
| 24 | ... 13 6·67 | ... 32 36·4 |
| 25 | ... 12 20·16 | ... 25 1·7 |
| 26 | ... 11 35·67 | ... 17 16·9 |
| 27 | ... 10 53·25 | ... 9 22·5 |
| 28 | ... 10 12·94 | ... 47 1 19·5 |
| 29 | ... 9 34·75 | ... 46 53 8·4 |
| 30 | ... 2 8 58·72 | ... +46 44 50·0 |

COMET GIACOBINI (1899 *e*).—Several observations of this comet having been obtained, Herr S. K. Winther continues his ephemeris in the *Astronomische Nachrichten* (Bd. 150, No. 3600):—

*Ephemeris for 12h. Berlin Mean Time.*

| 1899. | R.A. h. m. s. | Decl. ° ′ | Br. |
|---|---|---|---|
| Nov. 23 | ... 17 52 33 | ... +10 17·6 | |
| 24 | ... 54 12 | ... 10 34·0 | ... 0·50 |
| 25 | ... 55 52 | ... 10 50·5 | |
| 26 | ... 57 32 | ... 11 7·0 | |
| 27 | ... 17 59 12 | ... 11 23 6 | |
| 28 | ... 18 0 52 | ... 11 40·2 | ... 0·48 |
| 29 | ... 2 33 | ... 11 56·9 | |
| 30 | ... 18 4 13 | ... +12 13·7 | |

During the week the comet passes from the northern part of Ophinchus into Hercules, about 6° east of α Ophinchi.

REFRACTION EFFECT OF COMET SWIFT (1899 I).—Prof. C. D. Perrine, during May and June 1899, made several attempts to determine if any appreciable refraction was caused by the body of Swift's comet on a ray of light passing through it, and contributes his conclusions to the *Astronomische Nachrichten* (Bd. 150, No. 3602). The observations were made with the 36-inch Lick refractor, and consisted of determining accurately the position angle and distance of two stars, (1) when one or both of them were seen enveloped in the mass of the comet; (2) when quite free from the cometary matter. The diameter of the head of the comet was computed to be about 174,000 miles, and the extent of matter traversed by the light from the stars about 163,000 miles. The greatest range of variation in the measured distance of the stars was 0″·26, which the author thinks in all probability accidental, as no systematic variation was detected; so that from these experiments the conclusion is that the mass of a comet causes no appreciable effect of refraction on light passing through it.

PREDOMINANCE OF SPIRAL NEBULÆ.—In the *Astronomische Nachrichten* (Bd. 150, No. 3601), Prof. J. E. Keeler describes the preliminary results of his inquiry into the structure of nebulæ. The discussion is based on photographs obtained with the Crossley reflector of the Lick Observatory, and the author finds that in addition to confirming the spiral structure of the nebulæ catalogued by the Earl of Rosse, so many others possess the same characteristic form that their being put in a special category loses its significance; in fact, any small compact nebula not showing evidence of spiral structure, appears exceptional. He finds gradations leading to the belief that the elongated spindle-shaped nebulæ of Herschel also really belong to this class. The author concludes by stating that if numerous exceptions prove that spirality in nebulæ is not an universal law, it may perhaps be regarded as the usual or normal accompaniment of contraction in cosmical masses, and any departure from it may be explained as the result of special conditions, tending to suspend or weaken causes which are generally in operation.

BULLETIN ASTRONOMIQUE.—The *Bulletin Astronomique* for November 1899 contains an illustrated article by M. Camille Flammarion on the "Eclipses of the Twentieth Century visible at Paris." Forty-three eclipses of the sun will be visible, two of them being total, and thirty-three presented in good positions for observation. The particulars of each are given, with a diagram showing maximum phase. The same author describes the observations of 339 Perseids made at Juvisy from 10–13 August 1899, with illustrations showing the plotted paths. The mean position of the radiant was RA = 3h. 3m.; Decl. + 56°.—M. Souleyre concludes his article on the "Distribution of rain on the earth's surface."—M. A. Benoit contributes a very interesting article on "Transneptunian planets," giving particulars respecting a proposed instrumental equipment for a systematic search for such bodies.

## *THE FITTING OF THE CYCLE TO ITS RIDER.*[1]

THE present time is opportune to notice some points in cycle riding which have received our attention during the last three years. Every intelligent rider of a cycle must have at some time compared his powers as a human motor with the motors that drive the motor-cars which he now so frequently meets in the streets. He naturally wishes to study the question of most efficient propulsion, including that of his own mechanical efficiency as a motor driving his cycle. The design of the modern cycle was so far developed by 1896 that a standard type then became the rule, most cycles having a 45-inch wheel base, two wheels of equal diameter 28 inches, cranks 6½ inches long, and a ratio of gear varying between 59 to 80 inches, the sole difference made between cycles intended for tall riders and those for short ones consisting in varying the height of the frame. In 1896 the writers, being urged thereto by Mr. Otto Blathy, the well-known engineer of Budapesth, had their attention called to the necessity of varying the crank length to suit the varying length of leg of the rider. A series of experiments was carried out for cranks up to 9½ inches long, and the results obtained were very remarkable. It may now be taken as admitted that a very large proportion of the riders who have tried cranks of increased length have found great benefit from their use, but although they feel strongly how tangible these advantages are, some difficulty has been felt in satisfactorily explaining them.

All that has been written on cycle riding in the past has been confined to the style of riding which has been gradually elaborated on cycles fitted with the standard 6¼-inch to 6½-inch cranks, but this is little or no assistance to us when we attempt to investigate the subject through wider limits of muscular movement.

When mechanical engineers measure the efficiency of any form of mechanical motor they confine themselves generally to the consideration of the fuel that it consumes, but do not, as a rule, when considering its efficiency, take into consideration the cost of keeping it in repair, or include with it the cost of feeding and maintaining the driver; but the food which is the fuel of the cycle rider has not only to perform the same duties as the fuel of the mechanical motor, but has in addition to supply the nerve waste and repair the muscle waste which answers to the repairs to the mechanical motor, and from the same supply to maintain the brain power of the driver. The food energy of the cyclist has, therefore, to be distributed through three distinct channels: the first in importance is that which is required

[1] Abstract of paper read before the Cycle Engineers Institute at Birmingham, by R. E. Crompton and C. Crompton.

to repair brain waste, and which we hereafter call "Brain Waste"; second, that required to supply the nerve action, which energises the muscles when ordered to do so by the brain, and which we hereafter call "Nerve Waste"; and third, that for the upkeep of the muscles themselves, and which we hereafter call "Muscular Waste." Hitherto writers have, we believe, given too much prominence to the last-named of these. We think that, instead of being the most important of all and taking the largest share of food, it is probably the least important of the three. Dr. E. Turner has shown a method of estimating, with considerable scientific accuracy, the proportions of the food supply required by the above three sources of waste. He has noticed that the proportions of uric and phosphoric acids present in the human urine after exertion give the measure of the brain and nerve wastes relatively to the urea present, which is a measure of the muscle waste. A long series of experiments have made us feel reasonably certain that the nerve waste is practically proportional to the number of times that the nerve centres energise the muscle in order that it may make a stroke; in other words that the nerve waste is proportional to the number of revolutions of the crank shaft of the cycle, and it is doubtless this fact that has led to the craving for high gears, which allow of a reduced number of crank revolutions, as riders have found that by pedal during the entire revolution of the crank shaft in order to drive his cycle at the required speed. We measure the total resistance or pull of the cycle on the road in lbs., and call it total resistance expressed by our symbol "R," the power exerted by the cyclist, that is, the rate of doing work in foot pounds per minute by the symbol "P," and the work done in foot pounds per hour by the symbol "W." So long as the crank lengths are kept constant, or nearly so, the term geared to 60 or 70, as the case may be, give a sufficiently accurate idea of how far the pedal pressure "F" is influenced by the ratio of revolutions of the crank shaft to that of the driving wheel, but immediately the crank length is varied this term gear leads to confusion. We think a better term is multiple, which we denote by the symbol "M." "M" is the figure by which the angular speed of the feet or pedal is to be multiplied in order to get the lineal speed of the cycle moving along the road, consequently R multiplied by M gives F. We have prepared several tables which give the value of "R" for speeds varying from 5 to 20 miles an hour. It will be seen that "R" consists of three parts, $r1$, $r2$, and $r3$. $r1$ is the mechanical friction of the cycle, $r2$ is the road rolling and tyre resistance; these two first are functions of the weight of the machine and its rider, $r3$, the most important of all, is that due to air resistance. In a second table we have the

TABLE I.—*Giving Values of R for a Rider and Cycle weighing* 190 *lbs. at Speeds from* 5 *to* 20 *miles an hour.*

| V = miles per hour | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wind pressure in lbs. per sq. ft. = ·00241$V^2$ | ·0602 | ·0867 | ·118 | ·154 | ·195 | ·241 | ·291 | ·347 | ·407 | ·472 | ·542 | ·616 | ·696 | ·780 | ·870 | ·964 |
| $R^3$ = ·00241$V^2$ × 5·5 sq. ft. when area is 5·5 sq. ft. | ·353 | ·48 | ·653 | ·85 | 1·08 | 1·33 | 1·64 | 1·92 | 2·25 | 2·61 | 3·00 | 3·41 | 3·85 | 4·32 | 4·81 | 5·33 |
| $R^1 + R^2$ = ·0008 $WV^{\frac{2}{3}}$ when W = 190 ... | ·94 | 1·07 | 1·2 | 1·3 | 1·4 | 1·52 | 1·61 | 1·72 | 1·82 | 1·9 | 1·98 | 2·10 | 2·16 | 2·25 | 2·3 | 2·4 |
| $R_1$ $R_2$ $R_3$ = R ... | 1·293 | 1·55 | 1·853 | 2·15 | 2·48 | 2·85 | 3·25 | 3·64 | 4·07 | 4·51 | 4·98 | 5·51 | 6·01 | 6·57 | 7·11 | 7·73 |

TABLE II.—*Giving Values of F for a Rider and Cycle weighing* 190 *lbs. at Speeds from* 5 *to* 20 *miles an hour.*

| Miles per hour = V | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M = 4½ ... ... ... | 5·82 | 6·95 | 8·32 | 9·65 | 11·18 | 12·8 | 14·6 | 16·4 | 18·3 | 20·3 | 22·4 | 24·8 | 27·0 | 29·5 | 31·9 | 34·8 |
| M = 5 ... ... ... | 6·45 | 7·75 | 9·25 | 10·7 | 12·4 | 14·25 | 16·23 | 18·2 | 20·3 | 22·5 | 24·8 | 27·5 | 30·0 | 32·7 | 35·5 | 38·6 |
| M = 5½ ... ... ... | 7·1 | 8·5 | 10·2 | 11·8 | 13·6 | 15·65 | 17·85 | 10·0 | 22·4 | 24·75 | 27·3 | 30·3 | 33·1 | 36·1 | 39·2 | 42·5 |
| M = 6 ... ... ... | 7·75 | 9·3 | 11·1 | 12·9 | 14·9 | 17·05 | 19·5 | 21·8 | 24·5 | 27·0 | 29·8 | 33·1 | 36·2 | 39·4 | 42·9 | 46·4 |

reducing the number of crank revolutions they can economise their nerve waste so as to leave a greater reserve of food energy to supply brain and muscular waste. Our attention was directed to this at a very early stage in our experiments; but we found that a limit was soon reached to the raising of the gear, as if the crank length is kept constant the crank pressure necessary to drive the cycle increases just as the gear is increased, so that a strain is brought on the muscles at times of facing high winds or climbing steep hills, which is greater than the muscles can stand without muscular soreness setting in; in fact, the limit of strain is surpassed, which it will be convenient to call the "elastic limit" of the muscles, and whenever this "elastic limit" is passed for more than a few minutes the muscle is temporarily weakened for the remainder of the day's run; in fact, the repair of that muscle cannot be made until the rider rests and sleeps as well.

We have adopted this term "Elastic Limit" of the muscles because it corresponds very closely to a term well known to mechanical engineers when used to express the extent to which metals may be strained or stretched without taking permanent set; so long as they are subjected to strains within this limit no permanent injury is done to the metal, whereas if it is passed the structure of the metal is altered and becomes weaker and liable to fracture. This process of being strained, even to a small extent above the elastic limit, has been sometimes called the fatigue of metals, and is somewhat analogous to the fatigue of muscles strained above their elastic limit.

We use the term "Pedal Pressure" and symbol "F" to express the pressure in lbs. which the rider must apply at the

value of F worked out for various multiples, and in a third table we give the value of F under maximum conditions of hill climbing at a speed of 8 miles an hour. From

TABLE III.—*Values of F in lbs. on Various Hills with Different Values of M at* 8 *miles an hour.*

| Hill of | 1 in 30 | 1 in 25 | 1 in 20 | 1 in 15 | 1 in 10 |
|---|---|---|---|---|---|
| M = 4½ | 38·160 | 43·875 | 52·425 | 66·645 | 95·175 |
| M = 5 | 42·40 | 48·75 | 58·25 | 74·05 | 105·75 |
| M = 5½ | 46·640 | 53·625 | 64·075 | 81·455 | 116·325 |
| M = 6 | 50·88 | 58·50 | 69·90 | 88·86 | 126·90 |

these tables we are able to show that we have to deal with values of F varying from 18 lbs. to 130 lbs. It will be seen that the F required by an average rider using a multiple of 5 when he is maintaining a speed of 12 miles an hour on a calm day will vary between 18 lbs. and a maximum of 106 lbs. when he is climbing hills of 1 in 10 at a reduced speed of 8 miles an hour. These figures are representative as average conditions of the forces which have to be exerted by riders, although it is needless to say that far greater values of F are reached by riders when racing or in hill-climbing competitions.

We have endeavoured to give some approximate value of the elastic limit of muscles, and have made extended experiments to settle this point. In the case of one of the writers, the elastic limit of the quadriceps cruris at the point where soreness is usually felt, *i.e.* just above the knee, appears to be that corresponding to an F of 120 lbs., so that in this case with a multiple of 5, whether the arrangement be 6½-inch cranks, 65 gear, or 9½-inch cranks, 95 gear, a gradient of 1 in 10 can be ridden, and it is probable that this limit can be reached for three or four minutes without causing the muscular soreness. This of course varies greatly with the physical condition of the rider, but it is probable that this elastic limit is a function of the cross section of the muscle, and that the above value may be taken as an average one for men of average physique; with women it is probably somewhat less. It appears certain that the value of the elastic limit is a most important determining factor in designing a cycle to enable a rider to develop his physical powers when cycle riding in the most efficient manner. Once we determine it we can fix on the multiple M, and then, as we desire to keep down the nerve waste by reducing the crank revolutions for a given road speed, we can only do this, as M is a fixed quantity, by increasing the crank length. To what extent can this be done to give the best possible efficiency? The rider's thigh bones and the muscles that work them up and down may be looked upon as levers working on the hip joint as a fixed point, the outer ends being connected to the pedal by the shank bones, ankle joint and foot acting as a rather complicated connecting rod. The effective length of the thigh bone of riders varies between 15 inches for short men and 23 inches for tall men. The length of the standard 6½-inch cranks is therefore 43 per cent. of the length of the thigh bone on short riders, but only 28 per cent. of its length in tall men. In the case of the writers it is about 35 per cent. It was necessary to determine this proportion of the crank length to the thigh-bone length.

Our experiments, extending over three years, show that although we have gradually increased the crank length from 6½ inches to 9½ inches, in other words, from 35 per cent. up to 53 per cent. of the effective length of the thigh bone, we have not yet passed the point of greatest efficiency. Our proposals have of course been severely criticised, mainly by those who have not tried the system, and the following objections have been urged against increased crank length.

(1) Causing loss of power when hill climbing, or when riding against the wind, in fact at any time when the F required is considerable, and that this loss of power is caused by the excessive bending of the knee joint, which in its turn causes knee soreness.

(2) Militates against proper ankle action.

(3) Causing saddle soreness, bad steering, and other troubles.

(4) Causing extra strains on the parts and frame of the cycle.

Dealing with these questions in the above order, we have shown that the main object of increasing the crank length is to reduce the number of revolutions at a given road speed without increasing the value of F, and as it is practically certain that the knee soreness complained of entirely depends on this value of F not being exceeded, the only other way in which knee soreness could be produced is by excessive knee flexure. There are two ways in which this question of knee flexure may be considered. It has been said that when the knee is bent beyond a certain angle the muscles act at a disadvantage, and again that the extra flexure of the joints is the cause of the soreness which riders complain of, and that a rider having an 18-inch thigh bone can actually exert a greater pedal force at the half-stroke of 6½-inch cranks with its corresponding knee angle, than he can with 9 inch cranks and the correspondingly increased angle. We have, however, settled this question by careful experiments made in a testing machine, and we have shown that the knee angle at which the maximum pushing strain can be exerted is that which corresponds to a crank length of 18¾ inches; in other words, that the maximum force of the leg is obtained with a knee flexure far in excess of that required for any possible crank length that could be used on a cycle, so that this question of loss of power from excessive knee flexure is completely disposed of. Fig. 1 shows these results plotted on a curve.

TABLE IV.

| Distance between hip-joint and ball of foot in inches | Angle at knee between shank and thigh | Maximum push in lbs. |
|---|---|---|
| 22 | 75° 30′ | 325 |
| 23 | 79 36 | 370 |
| 24 | 83 31 | 390 |
| 24½ | 86 0 | 412 |
| 25 | 87 44 | 408 |
| 26 | 92 46 | 385 |
| 27 | 97 32 | 362 |
| 28 | 102 32 | 325 |

What writers mistake for knee soreness caused by excessive flexure is really due to the following cause. Any muscle which is constantly used throughout only a part of its stroke becomes developed and hardened into a condition which Sandow calls "a muscle-bound condition." It becomes shorter as it is never properly stretched out, the tendons which secure it also become shortened, and if this condition is not speedily remedied it becomes permanent. In the hard riding short crank cyclist, this applies to the quadriceps cruris, it being only called upon to work through a part of its stroke. When such a cyclist uses long cranks for the first time, he finds himself unable to properly flex his knee joints on account of this shortening of the quadriceps. The effort of stretching the muscle out to its full stroke causes the knee soreness complained of. There can be no question, however, that long crank riders benefit greatly by the extra knee flexure, compelled by the long cranks, and that this greatly increases their bodily activity and enables them to excel in exercises, such as running, walking, hill climbing and jumping, all of which require flexibility of the knee joint. Sandow points out that the best way to prevent the muscle-bound condition is to work the muscles in pairs throughout their full stroke; consequently, if we desire to develop the quadriceps cruris in a perfect manner to the full length of its stroke, we must also develop the muscles which form the pair to it on the underside of the thigh, *i.e.* the biceps cruris. It occurred to us, therefore, at an early period, that we ought to train these muscles to do their share of the work of propelling the cycle, hence arose what we call the pull stroke. Cyclists who use toe clips, or those who notch the soles of their cycling shoes, so as to get a better grip of their pedals, can use this pull stroke to a small extent; that is to say, they can claw or pull the pedal round

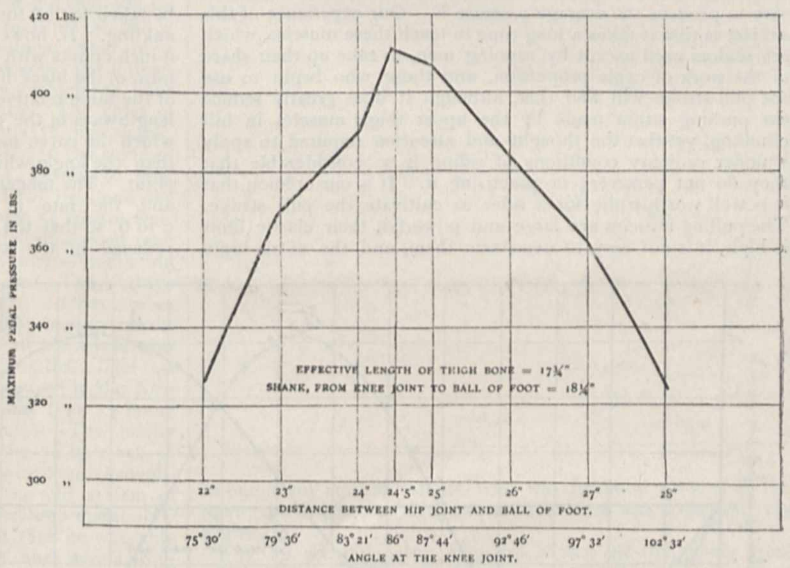



FIG. 1.—Curve showing relation between knee angle and maximum thrust on pedal.

during the lower portion of its circular path; but unless special devices are provided to enable them to draw the pedal upwards throughout a much larger arc, they cannot make use of the pulling muscles in a satisfactory manner. In order to do this we have bent our pedal plates slightly forward, as shown on Fig. 2, and we have prepared shoe plates of a form which enable them to hook into the back plate of the pedal.

It will be seen that our pulling device differs essentially from toe clips, which do not enable the upward pull being made unless the toe is pointing downwards. We find that this militates against good ankling action, and has a tendency to induce cramp in the calf muscles; on the contrary with our pulling device, the calf muscles may be quite inert during the upward stroke, the shank acting merely as a connecting rod in tension. It will be seen that the pull stroke enables us to reduce

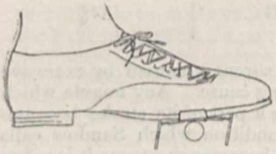


FIG. 2.

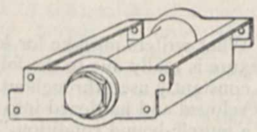


FIG. 3.—Crompton patent pedal.

the minimum pressure on the downward stroke, which is necessary to produce the average pressure F. Our experience of this subject is that it takes a long time to teach these muscles, which are seldom used except by running men, to take up their share of the work of cycle propulsion, and those who begin to use the pull stroke will find that, although it does greatly reduce the pushing strain made by the upper thigh muscles in hill climbing, yet that the thought and attention required to apply it under ordinary conditions of riding is so considerable that they do not persevere in practising it. It is our opinion that it is well worth while for a rider to cultivate the pull stroke. The pulling muscles are large and powerful, their elastic limit is high, it is not easy to overstrain them, and the extra brain

decreased, the force required to do this not coming from the muscles which move his leg, but from the calf muscles, which take a purchase, not against the saddle, as would be the case if he did not use ankle action, but against the pedal itself, so that the kinetic energy which is taken out of the leg in stopping its descending weight is usefully employed in propelling the cycle, and thus there is a great saving of energy by good ankle action.

If we take curve Fig. 4, the vertical lines of which represent velocity, the velocity downwards being represented by the vertical lines below the base line A B, and the velocities upward by the vertical line above it; if also we take the horizontal line to represent time when travelling with 60 gear and 6-inch cranks at 10·71 miles an hour, M being 5, a complete revolution is made in one second, and the upward and downward velocity of the leg at any moment is shown by the curve. Now rate of acceleration is change of velocity at a given time, and therefore the acceleration at any point is represented by change of velocity in a given time at that point. Suppose the acceleration to remain the same throughout that time as it is at the point P, the curve would describe a tangent to that curve at the point P and the acceleration—that is, the change of velocity divided by the time—would equal the tangent of the angle formed by the tangent of the curve with the base line.

You will notice that up to 90 degrees the tangent increases as the angle increases, therefore the steeper the curve at any point the greater is the acceleration at that point, and the greater the acceleration the greater the rate at which kinetic energy has to be taken out of the leg, and therefore the greater necessity for ankling. If, however, when riding at the same speed we use 9-inch cranks with 90 gear M is still 5, but the curve takes the form of the black line. You will see that the curve is obviously of the same relative shape as the red curve, but it is drawn out lengthways in the proportion of 6 to 9, and therefore the angles which the curve makes with the base line at any point is less than the angle which the red curve makes at a corresponding point. The tangents of the angle of steepness vary as 6 to 9, and the rate at which acceleration is reduced is also as 9 to 6, so that the necessity for careful ankling is in this case reduced in the same proportion, in other words, for equal

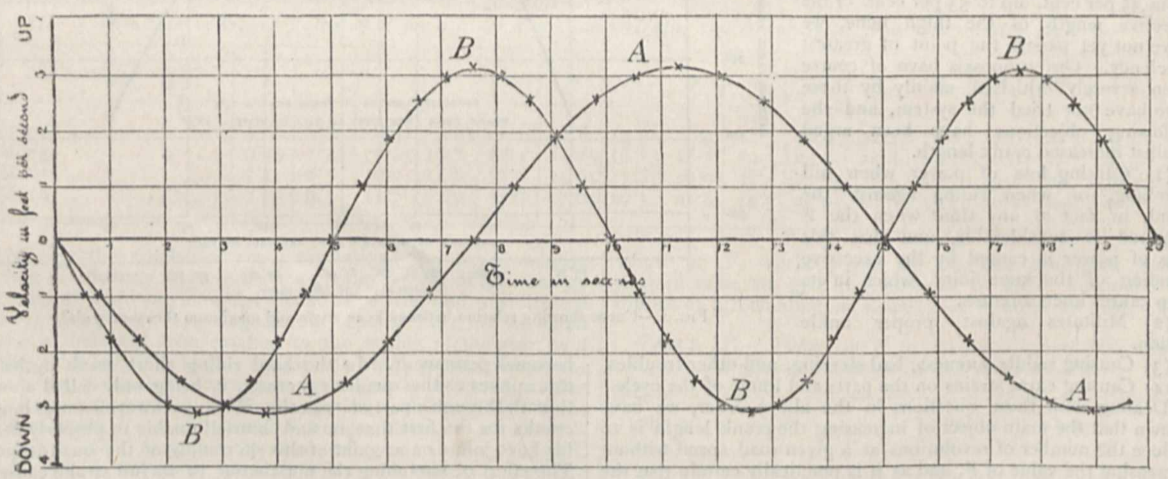



FIG. 4.—Curve B shows vertical velocity of pedal of 6 inch crank, 60 gear } Both at speeds of 10·71 miles per hour.
" A " " " 9 " " 90 "

waste that is required during the process of teaching these muscles is soon found to be reduced, as by practice these muscles automatically take up their share of the work.

It has been said that increased crank length militates against proper ankle action. The use of ankle action is not generally understood. The moving portion of a man's leg has considerable weight, when it is at the top of the stroke it possesses potential energy which is changed into kinetic energy as the leg descends, when it gets at the bottom of the stroke it stops going downwards and commences to rise, and the kinetic energy due to the downward movement of the leg has to be given up. What becomes of it? If the stopping of the leg is done by the same muscles which lift the leg there is a considerable waste of power, but if towards the lower end of the downward stroke the man begins to flex his calf muscles the velocity of his leg is gradually

efficiency long cranks do not require such careful ankling as short ones; although as more time is given in which to carry out such ankling, it is easier for the average rider to acquire it to a sufficient extent.

It is unnecessary to deal at any length with the question of saddle soreness. We cannot find that lengthened cranks have made any notable difference in this respect. Those who were liable to soreness with short cranks have not had this liability increased, but rather decreased by the new system. The position of the saddle has of course to be carefully attended to in riding with the lengthened cranks. As to the bad steering, this is an imaginary fault. We find that a well-designed machine will steer just as well, hands off, with long cranks as with short ones. It is true that the long cranks do introduce some extra strains into the cycle. The cranks themselves have to be carefully designed and made of special material. The use of nickel steel has enabled us to make the long cranks of ample strength, although they weigh very little more than short ones. The strains introduced into the frame are mainly those due to chain pressure, and are not influenced by crank length but entirely by the speed of the chain. The speed of the chain can be increased by enlarging both the sprocket and back pinion wheels. Summarising our results it appears—

(1) That when we talk of designing the cycle to suit any individual rider, so as to develop his powers as a motor to the greatest extent, we have first to consider how we can best economise his nerve waste by enabling him to reduce the number of revolutions and increase the stroke through which his legs can travel. Our experiments have shown us that these conditions are best fulfilled in the great majority of cases by giving to the rider a length of crank equal to half the length of his thigh bone.

(2) That the value of M the multiple, in other words the gear, is then to be determined by the maximum strains which his muscles will stand, and we believe in most cases this corresponds to a pedal pressure F not exceeding 100 lbs. for weak individuals up to 140 lbs. for strong ones.

(3) That the crank length determines the shape of the frame and the length of the wheel base, and that the extra long wheel base necessitated by the long cranks renders the cycle pleasanter to ride and does not materially increase its weight.

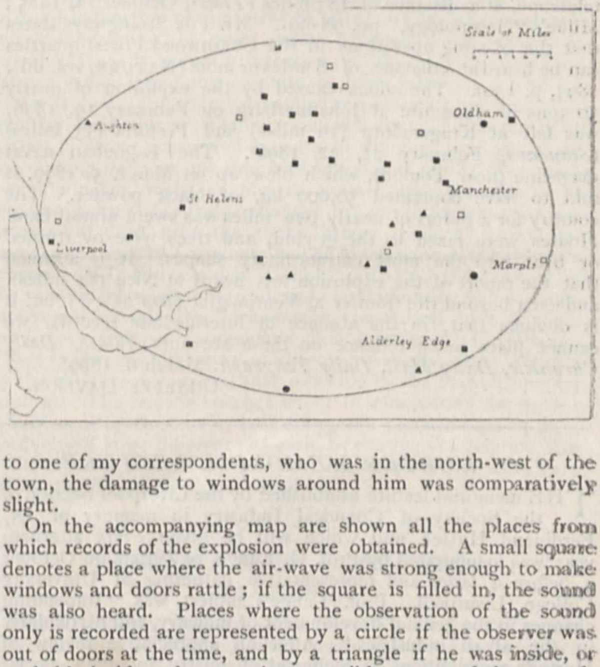
(4) That considering how important it is to reduce the number of crank revolutions in order to economise nerve waste, the cultivation of the pull stroke enables a greater average F to be obtained without straining the muscles beyond their elastic limit, and, consequently, allows of a higher multiple M and a correspondingly reduced number of revolutions. Out of a number of carefully made test runs we have selected the following as representative of the increased efficiency which we have obtained from the use of the lengthened cranks. The elder of us, aged 54, height 5 feet 10 inches, thigh bone 18-inch shank, from knee to ball of foot 21 inches, made a trial in the summer of 1896 with a cycle having $6\frac{1}{2}$-inch cranks, geared to $99\frac{1}{2}$. The total weight of rider and cycle was then 195 lbs., and the surface exposed to the air, including cycle, was $5\frac{1}{2}$ square feet. The maximum distance that could be travelled on a good road with an average wind was 78 miles in ten hours, including rests, or in an actual riding time of $7\frac{1}{4}$ hours. The average foot pounds per minute in this case was 2917. In September 1898 R. E. Crompton made a test on a cycle having cranks 9·1 inches long, geared to 102. The weight of the cycle and rider was, as in the former trial, made up to 195 lbs. The test run was from Kensington Court, London, to Romsey in the New Forest and back; total distance 156 miles, total time 13 hours 28 minutes, riding time 10 hours 54 minutes. The bodily fatigue on this day was no greater than on the 78-mile run in 1896. In this ride the average foot pounds per minute throughout the day was 6650, so that whereas with the old system of short cranks in 1896, R. E. Crompton was able to maintain P at 2917 for $7\frac{1}{4}$ hours, with the new system in 1898 he was able to maintain 6650 for 10 hours 54 minutes; in other words, from a given amount of food or, what is the same thing, a given amount of bodily fatigue, R. E. Crompton was in 1898, on the long-crank machine, able to do three times as much work as he did on the short-crank machine in 1896. Many other similar runs have been made, and other long-crank riders can produce equally satisfactory results.

The theory we have formed as to the nature of bodily fatigue induced by cycle riding, in which we have endeavoured to show the extreme importance of the part played by the brain and nerve systems, and that probably the major portion of the energy of the human body considered as a motor passes through the brain and nerve tissues to energise the muscles, is a matter which merits the careful attention of physiologists. Writers on this subject have hitherto considered the human or animal motor as a heat engine, all the useful energy being obtained by corresponding chemical work done on the muscles. We believe that the greater part of the energy-yielding processes goes on within the brain itself or in the nervous system directly connected with the brain. Many facts observed by cyclists and other athletes when carrying out feats of endurance show that brain and nerve nourishment is to be aimed at rather than the repair of muscle waste, and that certain foods and drinks have to be avoided on account of their action in producing temporary slackness; in fact, on account of their preventing the brain from effectively energising the muscles.

## *NOTE ON THE DISTANCES TO WHICH EXPLOSIONS ARE FELT AND HEARD.*

ST. HELENS being situated in a thickly populated district, the disaster at Messrs. Kurtz's works (belonging to the United Alkali Company) seemed to offer a good opportunity for determining how far a great explosion may be felt and heard. Isolated observations, as will be seen below, have been made on other occasions; but, to feel confidence in the results, we require a fairly continuous series of records extending from near the centre of disturbance to the boundary of the affected area. I therefore wrote letters to all the more important newspapers in the south of Lancashire and north of Cheshire, in request of observations either of the sound or of the movement of windows by the air-waves. In reply to them, I received more than fifty accounts, which, in addition to several which appeared in the local press, gave a total of 61 records from 47 different places.

The immediate cause of the explosion was the firing of one of the vessels used in crystallising the chlorate of potash, the vessels being made of wood lined with lead. It is computed that eighty tons of chlorate exploded. The whole of Messrs. Kurtz's buildings were razed to the ground, and nine out of ten great vitriol chambers on the other side of an adjoining road were destroyed. Within a few hundred yards of the chemical works there are many streets of workmen's cottages; the doors, windows, chimney-stacks of whole rows were dismantled, and, in some cases, the roofs fell in. Within a radius of a mile or so, hardly a window seems to have escaped;[1] but according




to one of my correspondents, who was in the north-west of the town, the damage to windows around him was comparatively slight.

On the accompanying map are shown all the places from which records of the explosion were obtained. A small square denotes a place where the air-wave was strong enough to make windows and doors rattle; if the square is filled in, the sound was also heard. Places where the observation of the sound only is recorded are represented by a circle if the observer was out of doors at the time, and by a triangle if he was inside, or probably inside, a house. A perceptible tremor of the ground, strong enough to be mistaken for an earthquake, was felt at some distance from St. Helens, but how far cannot be definitely ascertained.

It will be seen that the area over which the sound was heard is practically the same as that in which the air-wave was strong enough to make windows rattle. The bounding curve is elliptical in form, $39\frac{1}{2}$ miles in length from east to west, $27\frac{1}{4}$ miles in breadth, and includes an area of about 850 square miles. St. Helens lies close to the longer axis of the curve and nine miles to the west of the centre. Towards the east, the sound was heard at Alderley Edge ($24\frac{1}{2}$ miles from St. Helens) and at Oldham (27 miles). Windows were observed to rattle at Alderley Edge and also at Marple (28 miles). To the west of St. Helens the sound was heard at Liverpool (10 miles) and Aughton (10 miles). I have tried in vain to ascertain the direction of the wind at the time of the explosion at different places

1 The above particulars are obtained from the account given in the *Manchester Guardian* for May 13.

within the sound-area, but the observation above recorded from the north-west quarter of St. Helens is worthy of notice in connection with the easterly elongation of the area of disturbance.

For the sake of comparison it may be worth while to refer briefly to the results obtained from previous explosions. At the conclusion of Sir John Moore's retreat, a great Spanish powder magazine, containing, it is said, 1500 barrels, was blown up near Corunna. The ground rocked sensibly for miles, and at a distance the shock was felt before the sound was heard (R. Mallet, *Irish Acad. Trans.*, vol. xxi., 1848, pp. 63–64). In the great Erith explosion (October 1, 1864) two barges, a large magazine and a small one blew up in succession. They contained respectively about 9, 33, and 4 tons of gunpowder. Everything within a distance of half a mile—trees, houses, barns—was utterly destroyed, except two haystacks on the south side of the river. Windows were shattered within a radius of at least five miles. The explosion was heard and felt at Teddington (21 miles), Uxbridge (27 miles), and Windsor (32 miles), and the concussion is said to have been felt near Ashford, which is distant about 40 miles (*Times*, October 3–6, 8, 1864). The catastrophe in the Regent's Canal (October 2, 1874) was caused by the explosion of about five tons of gunpowder. The shock and sound were observed as far as Chiselhurst (13 miles), and the vibrations were felt at Aveley (18 miles) and Gravesend (23 miles) (*Times*, October 3, 5, 1874). To effect the removal of the Flood Rock in Hell Gate, New York Harbour, about 130 tons of dynamite, &c., were exploded; and the vibrations were perceived, with the aid of a mercury bath and telescope, at a distance of 183 miles (*Times*, October 12, 1885; Milne's "Seismology," pp. 98–99). Mr. Fox Strangways states that the blasting operations in the Charnwood Forest quarries can be heard at a distance of 18 miles or more (NATURE, vol. liii., 1895, p. 130). The shock caused by the explosion of nearly 50 tons of dynamite at Johannesburg on February 19, 1896, was felt at Krugersdorp (19 miles) and Pretoria (33 miles) (*Standard*, February 21, 22, 1896). The Lagouban naval magazine (near Toulon), which blew up on March 5, 1899, is said to have contained 50,000 kg. of black powder. The country for a radius of nearly two miles was swept almost bare. Houses were razed to the ground, and trees were overturned or bent into the most extraordinary shapes. It is affirmed that the report of the explosion was heard at Nice (84 miles), and even beyond the frontier at Ventimiglia (100 miles); but it is obvious that, in the absence of intermediate records, we cannot place much reliance on these accounts (*Times*, *Daily Chronicle*, *Daily Mail*, *Daily Telegraph*, March 6, 1899).

CHARLES DAVISON.

## *THE HURTER MEMORIAL LECTURE.*

THE memorial lecture established by the Liverpool Section of the Society of Chemical Industry in memory of Dr. Ferdinand Hurter, and which will be given every alternate year, was inaugurated by Prof. G. Lunge, of Zürich, on October 4, before a large and representative gathering at University College, Liverpool. Prof. Lunge's subject was "Impending changes in the general development of industry, and particularly in the alkali industries." After an appreciative review of Hurter's contributions to technical chemistry, in which special reference was made to his remarkable mathematical power and to the manner in which he employed it side by side with the highest branches of chemical science for the investigation and elucidation of technical problems, Prof. Lunge turned to the more immediate subject of his address. In contemplating the general features of chemical industries as carried on to-day, the question of the supply of fuel and of other sources of power was first considered; it was pointed out that the superiority which many countries, notably Great Britain, enjoy in many industries on account of their wealth of coal is limited in time, and that the increasing consumption of coal with a decreased source of supply as the result, must lead to the employment of other sources of energy. The economical use of coal in the blast-furnace, the adoption of closed coke ovens which, in addition to allowing the recovery of by-products, also increase the yield of coke, and recent improvements in the production of gaseous fuel are likely to postpone the time and force of the competition of those other sources of energy of which water-power stands foremost, but such postponement is restricted essentially to certain industries. From a general standpoint the total energy of the fossil fuel of the world is an infinitesimal fraction of the energy which the sun expends daily on the evaporation of water, and which is transformed to a great extent into the kinetic energy of falling water. The transformation of water-power into electrical energy, with its easy and cheap power of transmission, is likely to lead to revolutionary changes in chemical industries, not only in respect to the conditions of manufacture, but also in regard to the centres of production. Countries possessing great water-power will in the future carry on all those manufacturing processes in which electricity is either essential or an advantage, subject to certain limitations regulated by the cost of carriage of both raw materials and products. Prof. Lunge detailed the present position of electrical processes applied to chemical industries, dealing especially with the alkali trade and the manufacture of bleach and chlorate; the next generation will in all probability, in his opinion, obtain its chlorine by electrolytic methods, but the accompanying alkali will not form more than one-eighth or one-tenth of the world's demands The bulk of the latter must therefore be derived from other sources—these, in Dr. Lunge's opinion, will be the ammonia-soda process and naturally occurring soda. In regarding the future of these industries the modern developments of the manufacture of sulphuric acid by the catalytic process, in which sulphur dioxide and oxygen are passed over platinised asbestos, were discussed; the success of this method, especially for the manufacture of strong acid, is thoroughly established, and the lead chamber is threatened with extinction in consequence. Prof. Lunge pointed out, however, that this old apparatus has still certain claims of efficiency in the manufacture of weak sulphuric acid. Incidentally, in considering the economical use of fuel, Prof. Lunge gave a most interesting description of the Dellwik-Fleischer water-gas process, the efficiency of which he had himself examined with the result that he found that it gave no less than 82 per cent. of the fuel value of the coke against the 45 per cent. of the older processes. The characteristic of the process is the formation of carbon dioxide during the "blow" instead of carbon monoxide, a fact which reduces the time of the blow from 10 minutes to $1\frac{3}{4}$ minutes.

In looking back upon the industry with which Hurter's life-work was associated, Prof. Lunge dwelt upon the fact that the very processes Hurter had helped so ably and successfully were without doubt doomed, if not to complete extinction, still to a most serious crippling. Like other earnest workers, Hurter had but tilled the soil from which others will reap a harvest; and although there is a feeling of sorrow in the thought that so much genius, inventive talent and honest labour had been expended in what seemed now a transient aim, still

Der wer den Besten seiner Zeit genug gethan
Der hat gelebt für alle Zeiten.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

CAMBRIDGE.—Mr A. Hutchinson, of Pembroke College, has been reappointed Demonstrator in Mineralogy and Assistant-Curator of the Museum of Mineralogy for a term of five years.

Sir Walter Gilbey and Mr. Austin Keen have been appointed additional members of the Board of Agricultural Studies.

Mr. H. Woods, of St. John's College, is to be appointed a University lecturer in Palæozoology. He has hitherto held the post of demonstrator in this subject at the Woodwardian Museum.

The awards of entrance scholarships have been made at the two groups of Colleges, the first comprising Trinity, Clare and Trinity Hall, the second Pembroke, Caius, King's, Jesus, Christ's, St. John's and Emmanuel. One hundred and seventeen scholarships and exhibitions have been given; of these 23 are for mathematics, 28 for natural science, and 49 for classics. The value of these scholarships varies from 80*l*. to 40*l*. a year, that of the exhibitions from 50*l*. to 20*l*. a year.

NEGOTIATIONS have been proceeding with the authorities of Mason College and King Edward's Foundation relative to the provision of a remodelled system of commercial education in Birmingham. It is expected that the charter of the new University for Birmingham will be granted early next year, and that there will be a faculty of commerce in connection therewith.

Speaking at the Birmingham Chamber of Commerce last week, Mr. Neville Chamberlain said they were on the eve of a new departure in the educational life of Birmingham. They were looking forward to the rise of a University which would take up new and special lines, including commercial education. That was a great experiment, and it seemed to him to be the duty of that chamber, as representing the commercial life of Birmingham, to do what it could to ensure the success of the experiment.

## SCIENTIFIC SERIALS.

*Bulletin of the American Mathematical Society*, October.—The number opens with a partial analysis of the papers communicated at the sixth summer meeting of the Society, held at Columbus, Ohio, in August last, by Prof. Holgate.—The President, Prof. Woodward, congratulated the Society on the manifest interest in mathematical study and investigation as evidenced by the large number (twenty-three) of communications presented.—A report on the recent progress in the theory of linear groups is an interesting and thorough report by Dr. L. E. Dickson, which was made before Section A of the American Association for the Advancement of Science at its meeting at Columbus, previous to the above gathering of the Society. It is a supplement to the previous report, drawn up by Dr. G. A. Miller, which appeared in the February (1899) number of the *Bulletin*. The author restricts himself to finite linear groups, and of these he considers first the finite collineation groups and afterwards the linear congruence groups and the more general groups in Galois fields. These reports are very useful to students of the subject.—A few shorter notices (small reviews) follow.—The "Notes" contain many items of interest, but two of them are not quite accurate. For instance, the London Mathematical Society has *not* decided to issue its *Proceedings* in two volumes per annum. The resolution, as stated in the appendix to Volume xxx, says "in future the volumes of *Proceedings* shall contain as nearly four hundred pages as may be found convenient, provided that each volume shall begin with the report of proceedings at a meeting, not necessarily an annual general meeting." This may sometimes result as in the "Notes," but not necessarily so. A statement on p. 40 would lead one to infer that Dr. Graves was professor at Trinity College, Dublin, at the time of his death, and had been so ever since 1843.

*American Journal of Science*, November.—March weather in the United States, by O. L. Fassig. If the earth's surface were uniform, the normal circulation of air would produce two belts of high pressure at a latitude of about 30° north and south. The presence of continents breaks up these areas. The author shows that the "permanent" high pressure areas have a great determining influence upon weather in its general aspects, and that a considerable advance in forecasting work may be expected to result from their study. The March weather of the United States is determined by the relative extent of three such areas, and the course of the March storms lies along the gap between them.—Some new minerals from the zinc mines at Franklin, N.J., by S. L. Penfield and C. H. Warren. The minerals include "hancockite," which has the general formula of epidote, but having lead and strontium isomorphous with calcium; "glaucochroite," $CaMnSiO_4$, closely allied to monticellite, $CaMgSiO_4$; and its matrix "nasonite," the empirical formula of which is $Pb_6Ca_4Cl_2(Si_2O_7)_3$. The authors also investigate the chemical composition of ganomalite, and show that the acid, $H_6Si_2O_7$, of which nasonite and ganomalite are salts, is intermediate between orthosilicic acid, $H_4SiO_4$, and metasilicic acid, $H_2SiO_3$, and may be regarded as their algebraic sum, or as derived from two molecules of the former by abstraction of water.—Action of acetylene on the oxides of copper, by F. A. Gooch and D. Baldwin. While metallic copper may at comparatively high temperatures induce the polymerisation of acetylene, it is an oxidising action which starts at moderately low temperatures the formation of the peculiar "acetylides." Thus it is found that ferric oxide heated in acetylene at temperatures varying from 150° to 360°, according to circumstances, darkens, glows, and gathers with evolution of heat a dark carbonaceous deposit. In the products of such action the content of iron varies from 2·8 to 5·8 per cent. Silver oxide also acts upon acetylene.—A new mode of occurrence of ruby in North Carolina, by J. W. Judd and W. E. Hidden. Corundum occurs in North Carolina in three different forms. In the ordinary schists of the district, long prismatic crystals, usually of grey, pink and blue tints, occur. In the peridotites, crystals are found, some of very great size and of great variety of colour, but seldom or never clear and translucent. In certain garnet-bearing basic rocks at Cowee Creek, small tabular and short prismatic crystals are abundant, and these very frequently exhibit the transparency and colour of true ruby.

*Wiedemann's Annalen der Physik und Chemie*, No. 10.—Explosions in air, by W. Wolff. The effect of an explosion in air is propagated by a process analogous to the propagation of sound, except in the immediate neighbourhood of the source, where a bodily translation of the air is superadded. But that translation does not extend further than about 25 m. Up to that point the propagation of the wave is more rapid than the propagation of sound.—Glow-light phenomena with high-frequency alternate currents, by H. Ebert. There is a residual effect of the positive charge in the glow-light, which persists for a short time after the glow has ceased. This produces a repulsion between the two electrodes.—Influence of impurities upon a gaseous spectrum, by P. Lewis. The addition of very small quantities of mercury vapour to hydrogen gives rise to the green mercury line, which only disappears at −20 degrees. When oxygen is added to hydrogen in increasing quantities, the maximum of emission is shifted towards lower pressures.—Resistance to projectiles in air, by R. Emden. The resistance offered by air is jointly proportioned to the square of the velocity, $v^2$, and to another function of the velocity, $f(v)$. The latter quantity is constant up to the point where $v$ becomes the velocity of sound. Then it abruptly increases to about three times its former value, remaining constant at high velocities. The increase is due to the energy expended in producing and maintaining the head wave.—Electric pictures, by L. Fomm. The author produces pictures of sections of different kinds of wood by covering them on one side with tinfoil and on the other with bromide paper, with the film in contact with the wood. A metallic point negatively charged by an influence machine, mounted at 5 cm. from the paper surface, produces a good impression in about half a minute.—The Macfarlane-Moore vacuum vibrator, by J. Elster and H. Geitel. To avoid the sticking of the vacuum interrupter the authors keep it vibrating by a separate interrupter outside the vacuum tube, in unison with the one inside.—A fault in Lippmann's photography, by O. Wiener. There is always a difference of phase between the wave reflected by the gelatine surface and that reflected by the first elementary stratum. The remedy consists either in eliminating the surface reflection altogether, as by immersing the plate in benzol, or in producing a large difference of path, by coating the gelatine with a film of collodion. With a suitable thickness of the latter, very brilliant and true effects are obtained.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, June 15.—"On the Resistance to Torsion of certain forms of Shafting, with special reference to the Effect of Keyways," by L. N. G. Filon, M.A., King's College, Cambridge, Fellow of University College, London.

In this paper solutions of the torsion problem are obtained for cylinders whose cross-sections are bounded by confocal ellipses and hyperbolas. The method employed is that of conjugate functions, suggested by Saint-Venant, Thomson and Tait, Clebsch, Boussinesq and MacDonald, and applied by them to other cases.

The strains and stresses are obtained in the form of infinite series of circular and hyperbolic functions. There are two types of sections specially studied.

The first is bounded by an ellipse and by the two branches of a confocal hyperbola. The solution is worked out numerically for various values of the eccentricity of the ellipse and of the angle between the asymptotes of the hyperbola.

The position of the fail-points, or points of maximum strain and stress, is investigated at length.

It is shown that the maximum stress does not always occur, as is usually assumed, at the point of the boundary nearest to the centre of the section, but that in some cases there are four fail-points symmetrically distributed round the contour, on the broad sides of the section.

An example of this kind has already occurred in Saint-Venant's edition of Navier's "Leçons de Mécanique." This is compared with the present results. The paper also investigates the critical sections when the two cases of four and two fail-points pass into one another. It is shown in particular that when the angle between the asymptotes is less than 73° the greatest stress always occurs at the neck of the section.

The second type of section is bounded by one ellipse and one branch of a confocal hyperbola.

The case in which the confocal hyperbola reduces to a straight slit or thin keyway is specially studied.

For the first type of section this case gives two thin keyways; for the second only one.

The manner in which the reduction of the torsional rigidity, due to cutting such slits into the material, varies with the depth, is very striking. This reduction, which is as great as ·23 per cent. when the depth of the keyway is 0·6 (semi-major axis) falls to about 1 per cent. when this depth is 0·12 (semi-major axis). This would account for such keyways not always giving in practice the reduction in torsional rigidity which we should expect from Saint-Venant's results for the circle. Keyways of only moderate depth will affect the torsional rigidity very little.

Finally, the effect on the torsional rigidity of two such equal and opposite slits is shown to be about twice the effect of a single slit.

**Chemical Society**, November 2.—Dr. W. H. Perkin, Vice-President, in the chair.—The following papers were read: On methods for determining the relative proportions of gaseous chloroform and air in a mixture of the two, and on a method for producing a mixture of air and chloroform in any desired proportion, by A. Vernon Harcourt.—The theory of saponification, by J. Lewkowitsch. It is demonstrated that partially hydrolysed fats contain di- and mono-glycerides, and that the hydrolysis of triglycerides constitutes a bimolecular reaction.—Note on the action of dilute nitric acid upon oleic and elaidic acids, by F. G. Edmed. Dilute nitric acid converts oleic acid quantitatively into elaidic acid.—Formation of tetrazoline, by S. Ruhemann and H. E. Stapleton. A good yield of tetrazoline, $CH\langle{NH.N \atop N.NH}\rangle CH$, is obtained by heating monoformylhydrazide. — Asymmetric optically active nitrogen compounds. Dextro- and lævo-benzylphenylallylmethylammonium iodides and bromides, by W. J. Pope and S. J. Peachey. On heating $\alpha$-benzylphenylallylmethylammonium iodide with silver dextrocamphorsulphonate and acetone, a mixture of the camphorsulphonates of the dextro- and lævo-quaternary ammonium derivates is obtained. From these salts the corresponding and optically active iodides and bromides may be prepared. It is thus proved that dissolved substances may owe their optical activity to asymmetric nitrogen.—Camphoroxime. Part III. Behaviour of camphoroxime towards potassium hypobromite, by M. O. Forster. Camphoroxime yields, when treated with potassium hypobromite, a nitroso-derivative, $C_{10}H_{16}BrN_2O$, which is converted into a compound of the composition $C_{10}H_{14}BrNO$ by sulphuric acid; on treating either substance with soda, a nitrite, $C_9H_{13}N$, and an amide, $C_9H_{15}NO$, are produced. The latter seems to be campholytic amide.—Optical influence of an unsaturated linkage on certain derivatives of bornylamine, by M. O. Forster.—The interaction of sodium hydroxide and benzaldehyde, by C. A. Kohn and W. Trantom. Electrolytic preparation of induline dyes, by E. C. Szarvasy. On electrolysing a fused mixture of aniline and its hydrochloride, the following substances are formed: induline, anilidoinduline, induline 6 B, and azophenine.—The heat of combination of copper with zinc, by T. J. Baker.—The action of sulphuric acid on fenchone, by J. E. Marsh. 1:2:4-Acetorthoxylene is produced by the action of sulphuric acid upon fenchone.—On glucosides, by H. Ryan.—Note on polyazo-compounds, by R. Meldola and W. A. Williams. — On ethyl dibromobutanetetracarboxylate and the synthesis of tetrahydrofurfuran-$\alpha\alpha'$-dicarboxylic acid, by B. Lean.—The application of powerful optically active acids to the resolution of externally compensated basic substances. Resolution of tetrahydroquinaldine, by W. J. Pope and S. J. Peachey.—The application of powerful optically active acids to the resolution of feebly basic substances. Resolution of camphoroxime, by W. J. Pope.—The application of powerful optically active acids to the resolution of externally compensated basic substances. Resolution of tetrahydroparatoluquinaldine, by W. J. Pope and E. M. Rich.—Homogeneity of dextrolævo-$\alpha$-phenethylamine dextrocamphorsulphonate, by W. J. Pope and A. W. Harvey.—The characterisation of racemic liquids, by F. S. Kipping and W. J. Pope.—A method for discriminating between "non-racemic" and "racemic" liquids, by W. J. Pope and S. J. Peachey.—On two hydrated cobalt oxides, green- and buff-coloured, by W. N. Hartley.—A method of separating isomeric xylidines from the commercial product, by W. R. Hodgkinson and L. Limpach.—Action of hydrolytic agents on $\alpha$-dibromocamphor and the constitution of bromocamphorenic acid, by A. Lapworth.

**Entomological Society**, November 1.—Mr. G. H. Verrall, President, in the chair.—Mr. J. J. Walker exhibited two living specimens of *Bostrychus cornutus*, Fab., obtained from a wooden stool which was brought from Zanzibar.—On behalf of Mr. W. Purley, of Folkestone, Mr. C. G. Barrett exhibited the following species of Lepidoptera:—*Stigmonota trauniana*, *Lozopera beatricella*, *Peronea cristana*, *Cledeobia angustalis*, *Crambus inquinatellus*, var., *Eudorea dubitalis*, var. *ingratella*, and *Endotricha flammealis*.—Mr. McLachlan showed four examples of *Deilephila lineata*, taken by Mr. E. W. Hainworth at Victor, Colorado, at an elevation of 9000 feet, on July 23, 1899; also an ash-twig which had been girdled by hornets, the observation of this curious fact having been made by Mr. W. C. Boyd, of Cheshunt, from whom he received the twig.—Dr. T. A. Chapman exhibited specimens of *Erebia flavofasciata* taken at Campolungo at an elevation of 7000 feet. He stated that the species occurred only in those places where there was an outcrop of dolomitic strata belonging to the crystalline schists, and was not met with elsewhere at that elevation, nor was it to be found in association with the same strata at lower levels.—Mr. H. J. Elwes exhibited and gave a brief account of a collection of Lepidoptera made by Mrs. Nicholl and himself in a part of Bulgaria which had not previously been visited by entomologists. *Lycaena eroides*, *L. anteros*, *L. zephyrus*, *Melittaea cynthia*, *Erebia gorge*, and *Coenonympha typhon* were a few of several interesting forms to which he directed attention.

**Linnean Society**, November 2.—Dr. A. Günther, F.R.S., President, in the chair.—Prof. Stewart, F.R.S., exhibited and made remarks on a preparation of the leaves of *Mimosa pudica* showing the diurnal and nocturnal positions. He also exhibited the embryo and egg-cases of *Cestracion Philippi*.—Rev. G. Henslow read a paper on the proliferous state of the awn of Nepal barley. After describing the two varieties *Hordeum coeleste*, vars. *Aegiceras* and *trifurcatum*, he showed that the inverted flower-buds (which constitute the peculiarity of the monstrosity) were different in the two varieties.—Dr. W. G. Ridewood read a paper on the hyobranchial skeleton of the new aglossal toad, *Hymenochirus Boettgeri*. The hyoidean cornua of this animal was shown to be ossified, a fact unique among tailless amphibians.—Mr. Harold Wager read a paper on the eye-spot and flagellum in *Euglena viridis*.

**Mathematical Society**, November 9.—Lord Kelvin, G.C.V.O., President, in the chair.—The President stated that the Council, as announced at the June meeting, had awarded the De Morgan medal to Prof. W. Burnside, F.R.S. After Major MacMahon, R.A., F.R.S., on behalf of the Council, had stated the grounds of the award, the President presented the medal to Prof. Burnside, who suitably thanked the Council for the honour they had conferred upon him.—The following gentlemen were elected the Council for the ensuing session: President, Lord Kelvin; Vice-Presidents, Prof. Elliott, F.R.S., Lieut.-Colonel Cunningham, R.E., Prof. Lamb, F.R.S.; Treasurer, Dr. J. Larmor, F.R.S.; Secretaries, R. Tucker and Prof. Love, F.R.S.; other members, Prof. Burnside, Dr. Glaisher, F.R.S., Prof. Hill, F.R.S., Dr. Hobson, F.R.S., A. B. Kempe, F.R.S., Dr. F. S. Macaulay, H. M. Macdonald, Major MacMahon and E. T. Whittaker.—Prof. Burnside communicated a short note by Dr. L. E. Dickson on the abstract groups isomorphic with the symmetric group on $k$ letters.—Major MacMahon spoke on the fundamental solutions of the indeterminate relation $\lambda x \geqq \mu y$.—The following papers were read in abstract. Certain correspondences between spaces of $n$ dimensions, by Dr. E. O. Lovett. (1) On the form of lines of force near a point of equilibrium; (2) the reduction of conics and quadrics to their principal axes by the Weierstrassian method of reducing quadratic forms; and (3) on the reduction of a linear substitution to a canonical form; with some applications to linear differential equations and quadratic forms, by T. J. I. Bromwich: (1) on Ampère's equation $Rr + 2Ss + Tt + U(rt - S^2) = V$, and (2) the theory of automorphic functions, by Prof. A. C. Dixon.—Note on Clebsch's second method for the integration of a Pfaffian equation, by J. Brill.

**Zoological Society,** November 14.—Dr. A. Günther, F.R.S., Vice-President, in the chair.—Mr. Sclater gave an account of his recent journey to the Cape, and made remarks on the animals he had obtained there for the Society's collection. He also called attention to the desirability of the establishment of a Zoological Garden at Capetown.—Mr. A. Smith Woodward read a communication from Señ. F. Ameghino containing some further notes on *Neomylodon listai* (*Grypotherium*). Mr. A. Smith Woodward also exhibited, on behalf of Dr. Moreno, the skull and other specimens of this animal lately discovered in the cave in Southern Patagonia where the original pieces of skin had been obtained, and made remarks on them.—Mr. Lydekker exhibited and made remarks on a remarkably fine head of the swamp-deer (*Cervus duvauceli*), obtained by Major C. B. Wood in the Central Provinces of India.—The Secretary exhibited, on behalf of Mr. C. Pole Carew, some malformed horns of the Sambur Deer (*Cervus aristotelis*), obtained by him in the southern province of Ceylon, and read some notes on them sent by Mrs. Carew.—A communication was read from Mr. F. Vaughan Kirby, containing field-notes on the blue-buck of the Cape Colony (*Cephalophus monticola*).—A communication was read from Mr. R. I. Pocock, containing an account of the collections of Arachnids made by Mr. G. L. Bates in French Congo. To this was added a complete list of the species of the same group represented in the British Museum, and descriptions of the new genera and species.—A communication was read from Mr. Stanley S. Flower containing notes on a second collection of Batrachians made in the Malay Peninsula and Siam from November 1896 to September 1898. Forty-nine species, of which fifteen had not been previously recorded from these countries, were enumerated, and the tadpoles of several of them were described for the first time.—Mr. R. Lydekker read three papers dealing with (1) the specific characters of the Chilian Guemal (*Cariacus chilensis*), which previously, from the absence of good specimens of the animal, had been inaccurately given; (2) the skull of a Shark-toothed Dolphin (*Prosqualodon australis*) from Patagonia, in which he pointed out the characters of distinction between that species and the genus *Squalodon*; (3) the results of recent investigations on the dentition of the Marsupial and Placental Carnivores.—A communication was read from Mr. Ernest Gibson, containing field-notes on the Wood-Cat of Argentina (*Felis geoffroyi*), two specimens of which animal had recently been presented to the Society by Mr. William Brown, of Buenos Aires.

CAMBRIDGE.

**Philosophical Society,** October 30.—Mr. J. Larmor, President, in the chair.—The following were elected officers for the ensuing year: President, Mr. J. Larmor; vice-presidents, Mr. F. Darwin, Prof. A. R. Forsyth, Dr. W. H. Gaskell; treasurer, Mr. Newall; secretaries, Mr. Baker, Mr. Shipley, Mr. Wilberforce; members of Council, Mr. Harker, Mr. Hutchinson, Prof. Liveing, Mr. Skinner, Mr. Gadow, Mr. Sharp, Prof. J. J. Thomson, Mr. Berry, Sir G. G. Stokes, Mr. Bateson, Mr. Seward, Mr. G. T. Walker.—The following communications were made to the Society: On semi-convergent series, by Mr. W. McF. Orr.—An experiment on the condensation of clouds, by Mr. C. T. R. Wilson. The author gave an experimental demonstration of the production of cloud by the contact of layers of moist air of different temperatures.—On the conductivity of gases from arcs and from incandescent wires, by Mr. J. A. M'Clelland. The first part of this paper contains an account of experiments on the conductivity of gas through which an arc discharge has passed; the second part deals with the conductivity of gas near an incandescent wire. Experiments have been made with an arc between platinum terminals and with an incandescent platinum wire in air, oxygen and carbonic acid gas. The conductivity is shown to be produced by ionisation, and the nature of the carriers, their velocity under an electric force, and other points are investigated. With the arc in air, or oxygen, there is a small excess of positive electricity in the gas taken from the neighbourhood of the arc, and this excess is very great in $CO_2$; the greater velocity of the negative carriers under electric force causes more of them to be discharged to the terminals of the arc. The velocity of the carriers under electric force is not a constant quantity, but varies with the nature of the arc and the temperature of the incandescent wire. The velocity diminishes as the temperature is raised; this may be caused by the carriers coming from the wire itself or the arc terminals at these higher temperatures, or by the disintegration of the wire or terminals affording material to condense on the carriers already formed in the gas.—On the secondary Röntgen rays, by Mr. J. S. Townsend. This paper contained an account of experiments made with the rays given out when Röntgen rays fall on metals and other bodies. These rays are of two kinds. The first are rapidly absorbed by the air, and at a distance of one centimetre from the radiating body their power of ionising the air is reduced to one-thousandth of its value at the surface. The rays of the second kind are more penetrating, and extend to a distance of several centimetres from the radiating body. They cannot be considered part of the first kind of rays, as these would only have an effect of $\frac{1}{10^{18}}$ of their initial value at a distance of 6 centimetres, which would be too small to detect.

MANCHESTER.

**Literary and Philosophical Society,** November 14.—Prof. Horace Lamb, F.R.S., President, in the chair.—Mr. W. E. Hoyle exhibited a series of flint implements, &c., from Egypt, forming part of a large collection obtained by Prof. Flinders Petrie during the past winter in excavating about twenty miles of cemetery in the western desert between Hu and Dendereh, and since presented to the Manchester Museum. These belonged to various periods, from prehistoric to Roman. Certain types of knives with very finely notched edges and forked lance-heads are very characteristic of the prehistoric age. One cemetery dates from the Libyan settlements in Egypt at the close of the Middle kingdom, about 2400 B.C. Here the graves were all shallow pits of the form known as "pan graves," in which the bodies were laid in a contracted position, but not all in the same direction. From this were obtained several of the strings of beads exhibited. The shell bracelets are very characteristic of this period. Another large cemetery at Hu began in the sixth dynasty, and contained, besides pottery, a large quantity of beads. One large necklace of five strings was of amethyst, others were of cornelian and garnet, whilst in the other sets were metal beads, which, from their not having corroded, were presumed to have contained a considerable proportion of gold. The collection included a large number of pieces of engraved bone, apparently prepared for inlaying, as well as two beautiful diorite saucers, one circular and the other in the shape of a large *Unio* shell. A block of stone about six inches square, with a circle and two cross-lines on the top, once formed the upper part of a short stone pillar, and is believed to have been a surveyor's mark.

PARIS.

**Academy of Sciences,** November 13.—M. van Tieghem in the chair.—Observation relating to researches on the diamines, by M. Berthelot. A correction to the paper published on this subject in the last number of the *Comptes rendus*.—The disease attacking carnations at Antibes, by MM. Prillieux and Delacroix. The primary cause of the disease is a fungus, a detailed description of which is given. Artificial cultures could be carried out either on potato or in a drop of nutrient fluid. The species appears to be new, and the provisional name of *Fusarium Dianthi* is given to it.—Researches on acute alcoholism; estimation of alcohol in the blood and tissues, by M. N. Gréhant. The alcohol was introduced into the stomach in measured amounts through a tube, and samples of blood taken at half-hourly intervals were submitted to distillation in vacuo, and the alcohol in the distillaters estimated by the bichromate method of Nicloux. In another experiment the animal was killed, and separate analyses made of the brain, muscles, liver, kidneys and blood. The amounts per 100 grams of material were nearly the same, varying between 0·325 and 0·41 c.c. of alcohol.—On congruences of circles and spheres which intervene in the study of cyclic and orthogonal systems, by M. C. Guichard.—On equations of the second order with fixed critical points, by M. Paul Painlevé.—On the generalisation of expansions in continued fractions given by Gauss and Euler, of the function $(1 \times x)^m$, by M. H. Padé.—A new mode of considering the propagation of luminous vibrations through matter, by M. G. Sagnac.—On the spectrophotometry of the electric light, by M. Fernand Gaud. A comparison between the intensities of different portions of the spectrum of incandescent and arc lights with sunlight was made by decomposing each light by screens of homogeneous colour, and measuring the intensity of the transmitted light with a simple Foucault or Bunsen photometer. The screens were previously carefully examined by Frauenhofer's method, and the wave-length of the light transmitted by the screen exactly determined.—On the atomic weight of the metal in radio-active barium chloride, by Mme. Sklodowska Curie. Fractional crystallisation of barium chloride obtained from uranium minerals gave a salt which concentrated the radio-activity in the least soluble portions. The atomic weight was found to increase with the radio-activity, the maximum value obtained being 145·8 as compared with 137·8 for the inactive barium. These results confirm the original view of the existence of a new element, radium.—On the preparation and properties of the crystallised phosphides of strontium and barium, by M. A. Jaboin. Crystallised strontium phosphide is prepared in a pure state by heating pure strontium phosphate with lamp black in the electric furnace. The phosphide has a dark colour, breaks with a crystalline fracture, and is rapidly attacked by moist air, or by chlorine, at about 30° C. At the temperature of the electric furnace carbon replaces the phosphorus slowly, giving strontium carbide. Barium phosphide is prepared in a similar manner and has corresponding properties.—On the estimation of phosphorus in organic compounds, by M. Ch. Marie. The organic material is destroyed by heating with nitric acid and potassium permanganate, and the phosphoric acid precipitated with molybdate, certain special precautions being necessary.—On some new asymmetric compounds of nitrogen obtained synthetically and possessing rotatory power, by MM. W. J. Pope and S. J. Peachey. α-Benzyl-phenyl-allyl-methylammonium iodide is heated with dextrocamphorosulphonate of silver, the silver iodide filtered off, and the resulting salt recrystallised from a mixture of acetone and ethyl acetate. From the less soluble fractions a dextrorotatory form ($M_D = +208°$) is readily isolated, the more soluble salt ($M_D = -87°$) being lævorotatory. From these salts a dextrorotatory iodide ($\alpha_D = 52°·4$), bromide ($\alpha_D = +68°·6$), and a lævorotatory iodide ($\alpha_D = -51°·4$) and bromide ($\alpha_D = -67°·3$) were obtained. In these compounds the rotatory power is clearly due to the asymmetrical arrangement of the groups round the nitrogen atom.—On the absorption of iodine by plants, by M. P. Bourcet. From a series of analyses of plants grown under identical conditions in soil containing iodides, it was found that certain plants absorb much more iodine than others, some absorbing none at all.—On the morphology and sexual evolution of a parasite of *Hemioniscus balani*, by MM. Maurice Coullery and Félix Mesnil.—On the absorptive power of seeds for moisture, by M. L. Maquenne.—On the origin of the symmetry in crystallised bodies and of polymorphism, by M. Fred Wallerant.—The relations existing between diuretic actions and osmotic properties of the sugars, by MM. E. Hédon and J. Arrous.—On lipase in pathological conditions, by MM. Ch. Achard and A. Clerc.—New experiments relating to the antiphylloxeric disinfection of vine plants, by MM. Georges Couanon, Joseph Michon and E. Salomon.

## DIARY OF SOCIETIES.

*THURSDAY*, NOVEMBER 23.

ROYAL SOCIETY, at 4.30.—(1) Note on the Spectrum of Silicium; (2) Preliminary Table of Wave-lengths of Enhanced Lines: Sir J. Norman Lockyer, K.C.B., F.R.S.—The Colour-Physiology of *Hippolyte varians*: F. W. Keeble and F. W. Gamble.—The Medusæ of Millepora: Prof. S. J. Hickson, F.R.S.

SOCIETY OF ARTS, at 4.30.—Old and New Colombo: John Ferguson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Cost of Steam Raising: John Holliday.—Influence of Cheap Fuels on the Cost of Electrical Energy: R. E. Crompton.

*FRIDAY*, NOVEMBER 24.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Openings for Mechanical Engineers in China: The Right Hon. Rear-Admiral Lord Charles Beresford, C.B.

PHYSICAL SOCIETY, at 5.—(1) On the Conductivities of certain Heterogeneous Media for a Steady Flux having a Potential; (2) On the Thermal Conductivities of Mixtures and of their Constituents: Dr. C. H. Lees.

*MONDAY*, NOVEMBER 27.

SOCIETY OF ARTS, at 8.—Enamelling upon Metals: H. H. Cunynghame.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Desert Sand Dunes: Vaughan Cornish.

INSTITUTE OF ACTUARIES, at 5.30.

*TUESDAY*, NOVEMBER 28.

ZOOLOGICAL SOCIETY, at 8.30.—On the Hatching-stage of the Land Pagurines: L. A. Borradaile.—General Account of an Expedition to the Gambia Colony and Protectorate in 1898–99: J. S. Budgett.—On the Relations of the Efferent Branchial Blood-vessels to the "Circulus Cephalicus" in Teleostean Fishes: Dr. W. G. Ridewood.—On the Reptiles, Batrachians, and Fishes collected by the late Mr. John Whitehead in the Interior of Hainan: G. A. Boulenger, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Papers to be further discussed*: The Waterloo and City Railway; The Electrical Equipment of the Waterloo and City Railway.——*And, time permitting, Paper to be read with a view to discussion*: Combined Refuse-destructors and Power-plants: C. Newton Russell.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Practical Three-colour Lantern Slide Making.

*THURSDAY*, NOVEMBER 30.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Bridges for Light Railways: L. H. Rugg.

*FRIDAY*, DECEMBER 1.

GEOLOGISTS' ASSOCIATION, at 8.—The Zones of the White Chalk of the English Coast. I. Kent and Sussex: Dr. A. W. Rowe.—A New Rhætic Section at Bristol: W. H. Wickes.

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