THURSDAY, MAY 31, 1894.

MATHEMATICAL THEORIES OF ELASTICITY.

A History of the Elasticity and Strength of Materials. Vol. II. Parts I. and II. By the late Isaac Todhunter, D.Sc., F.R.S. Edited and completed by Karl Pearson, M.A., Professor of Applied Mathematics, University College, London. (Cambridge: at the University Press, 1893.)

A Treatise on the Mathematical Theory of Elasticity. By A. E. H. Love, M.A., Fellow and Lecturer of St. John's College, Cambridge. Vol. II. (Cambridge: at the University Press, 1893.)

Introduction to the Mathematical Theory of the Stress and Strains of Elastic Solids. By Benjamin Williamson, D.Sc., D.C.L., F.R.S., Fellow and Senior Tutor of Trinity College, Dublin. (London: Longmans, Green, and Co., 1894.)

Theory of Structures and Strength of Materials. By Henry T. Bovey, M.A., D.C.L., F.R.S.C., Professor of Civil Engineering and Applied Mechanics, M'Gill University, Montreal. (New York: John Wiley and Sons. London: Kegan Paul, Trench, Trübner, and Co., 1893.)

PROFESSOR KARL PEARSON is to be congratulated on having brought his task, after nine years' hard work, to a conclusion; and the result would surprise Dr. Todhunter, the original projector of the treatise, could he see the three large volumes, of 2200 pages and 1800 articles, which have grown from the notes he made for a modest history of elasticity. The labour in the preparation of this history must have been enormous; it is the sort of work which is best left for a German to carry out; even the cutting of the pages is sufficient to give the reviewer a headache and mental indigestion.

The assistance of Mr. C. Chree is gratefully acknowledged in the preface, also of M. Flamant, Professor at the École des Ponts et Chaussées, Paris; and the Syndics of the Cambridge University Press are thanked for their financial assistance in the production of the book.

The part relating to St. Venant's writings, which forms the first half of part i., vol. ii., was issued separately some four years ago, and received notice in these columns in the number for March 20, 1890.

It is impossible within any reasonable limits to give an idea of the developments which the subject has received at the hands of the various mathematicians whose work is cited in the pages. A mere enumeration of the principal names—St. Venant, Rankine, Kupffer, Wertheim, Zöppritz, Neumann, Kirchhoff, Clebsch, Boussinesq, Thomson and Tait, &c.—and the list of chief elasticians given on p. xv., will show that the subject has attracted the attention of the principal analysts, who seek for the stimulus and directing influence of real physicial problems.

It must be allowed that the mode of attack of some of these problems is, by reason of their extreme difficulty, calculated to shock the mathematical prudery of certain pure analysts; and also that there is not yet complete accord among elasticians in the results they obtain; but then, to quote Rankine's eloquent words from his "Preliminary Dissertation on the Harmony of Theory and Practice in Mechanics": "The question in Practical Science is—*what are we to do?*—a question which involves the necessity for the immediate adoption of some rule of working. In doubtful cases we cannot allow our machines and our works of improvement to wait for the advancement of science; and if existing data are insufficient to give an exact solution of the question, that approximate solution must be acted upon which the best data attainable show to be the most probable."

"In Theoretical Science, the question is—*What are we to think?* and when a doubtful point arises for the solution of which either experimental data are wanting, or mathematical methods are not sufficiently advanced, it is the duty of philosophic minds not to dispute about the probability of conflicting suppositions, but to labour for the advancement of experimental inquiry and of mathematics, and to await patiently the time when these shall be adequate to solve the question."

So far as concerns the analyst who despises the stimulus that arises from the contemplation of the difficul ties of an actual problem, the above advice in Theoretical Science amounts very much to what King Paramount says to the wise men of Utopia—"Go and play in the corner."

A distinguished biologist once said to the editor of the present work, that he had for many years given up endeavouring to ascertain what others had done or were doing in his subject. To follow the great mass of contemporary work meant to expend his time in historical investigations rather than in original research (p. 488). But the present volumes on the history of elasticity will save this expenditure of time, and enable the investigator to start where others have left off.

The curious spiral lines, crossing at 45° the circles concentric with a punched hole, called Lüder's curves, and shown in the frontispiece of part ii., vol. ii., are interesting in confirming W. Carus Wilson's theory, that plastic yielding of an elastic metal takes place chiefly by shearing in directions inclined at 45° to the principal tension. The subject has recently been discussed in the *Comptes Rendus*, by M. Hartman, who brings out these curves more clearly by biting into the steel with acid.

Mr. Love's vol. ii. of his treatise on the mathematical theory of elasticity also completes the work, of which the first volume was noticed in NATURE, April 6, 1893.

A valuable historical chapter begins the volume, but we are puzzled to see the authors of a well-known treatise on Natural Philosophy given as Kelvin and Tait; it might as well be said that the Duke of Wellington commanded the British Forces in the Peninsula.

We learn incidentally that the battle over the theory of the curved plate is still raging, and that the rival theories of Lord Rayleigh and Mr. Basset do not yet meet with the author's complete acceptance; the investigations of Mr. Bryan and of the author on the wrinkling of the plating of a ship, and on the collapse of boiler flues, discussed in chapter xxiii., will do much to bring into focus the real points at issue.

The problem of the spiral spring, with Kirchhoff's kinetic analogue of the steady motion of a gyrostat, is treated in an interesting manner; what is the modification and the kinetic analogue when a helical wire is pushed into a helical tube, of a different curve?

A search through Clebsch's article in Crelle, t. 57, would reveal the clue to the construction of pseudo-elliptic cases of the general tortuous elastica, and thus also of its kinetic analogue in the general motion of a Top. The spherical catenary forms another analogue, and the special pseudo-elliptic case, devised by Clebsch, has been constructed in the series of models of Brill of Darmstadt, so that a string of beads can be placed on a plaster sphere in the appropriate curve.

Mr. Love has devoted careful attention to the examination of different cases of elastic stability, familiar instances of which are to be seen around us, in the waving of the cornstalks in the field, the vibration of a fishing-rod or of the mast of a steamer, or the whirling vibrations of a rapidly rotating shaft; an examination of the period of vibration at once assigns the limits of stability, as the place where the period of vibration becomes infinite, and afterwards imaginary. Thus the farmer can tell by the speed of the waves seen over the cornfield the appropriate time for the harvest.

The treatment of the wire generally, in chapters xiii.–xviii., is complete, and the graphical method of Fig. 30 is very elegant; but the period equation for lateral vibrations,

$$\cos m \cosh m = \pm 1,$$

is improved by being thrown into the equivalent form,

$$\tanh \tfrac{1}{2}m = \pm \tan \tfrac{1}{2}m, \text{ or } \pm \cot \tfrac{1}{2}m,$$

of which the solution by a geometrical construction is readily effected.

We miss the theorems of the elasticity of cylindrical bodies required nowadays in the construction of built-up ordnance and in the wire gun; the practical results can be exhibited very simply by geometrical constructions, merely requiring the drawing of a few straight lines.

Prof. Williamson's treatise of 130 pages will serve as a very good introduction to the study of Mr. Love's work. Great attention has been paid to the notation and nomenclature, and a suggestion of Prof. Townsend has been adopted which seems clear and simple; however, we must not wander far from the system laid down in Prof. Karl Pearson's history.

The work concludes with a description of the models, devised by Profs. Alexander and Thomson, for illustrating Rankine's ellipse of stress. This model was exhibited at the Munich Mathematical Exhibition, where it attracted great interest.

Prof. Bovey's theory of structures will provide for Canadian and American engineers the information and exercises which our engineers derive from Rankine's treatises; but Rankine's very condensed method of reasoning has been expanded for the benefit of the average student, so that the present work runs to over 800 pages.

It would be impossible to give a complete account of all the subjects discussed in the treatise within reasonable limits; but many elegant and novel theorems in the treatment of the theory of the beam and cantilever are to be found, illustrated numerically by an appeal to existing structures of the largest scale; in this respect the American engineer is at an advantage, as more bridge work of great dimensions comes under his notice.

Incidentally, Prof. Bovey provides his engineering students with a complete treatment of statics and dynamics, treated episodically as required for a problem in hand; and each chapter concludes with a large collection of examples, by which the student can test the soundness of his knowledge: these examples are based in general upon existing realities, and form a great contrast to the old-fashioned Cambridge mechanical problems, which were generally geometrical or trigonometrical theorems, with only a slight flavour of mechanics. One or two of these problems, for instance, 47, on p. 220, and 60, on p. 221, will doubtless receive revision in a future edition; and Mr. Macfarlane Gray's elegant constructions for the points of maximum piston velocity may then well find a place in p. 205. As the author writes for engineers, the gravitation unit of force is used throughout, and expressions such as $\frac{Wv^2}{2g}$ and $\frac{Wv^2}{gr}$ abound in consequence.

The confusion introduced by writing M for $\frac{W}{g}$ has been carefully avoided, with all its attempted *a posteriori* explanations; and for this mercy the engineering student owes a great debt of gratitude to Prof. Bovey.

A. G. GREENHILL.

LAW AND THEORY IN CHEMISTRY.

Law and Theory in Chemistry: a Companion Book for Students. By Douglas Carnegie, M.A. Pp. vi. 222. (London: Longmans, Green, and Co., 1894.)

THE object of this book is to help fairly advanced students "to recapitulate and co-ordinate the more important principles of chemistry before proceeding to more detailed and advanced works." The book makes no claim to be regarded as a text-book; it is intended to be read along with the text-book, which it is meant to supplement, especially in those parts of the subject that are sometimes overlooked, but are needed, in the opinion of the author, for "a liberal understanding of the science," and in some of those parts that are thought to present especial difficulties. In his preface, the author says that "the seven chapters are really short and independent essays on the subjects of which they severally treat"; he also adds that "the attempt has been made to indicate, with due appreciation of perspective, the trend of modern research in its relation to the science as a whole."

The first chapter, on "Alchemy and the birth of scientific chemistry," is evidently to be looked on as introductory to the study of law and theory in chemistry. The second chapter introduces the student to chemical laws and chemical theories by sketching the "Phlogistic period and the beginnings of chemical theory." The other parts of the science chosen for the display of the workings of law and theory are chemical classification, the atomic theory, isomerism, and chemical equilibrium.

The first and second chapters are chiefly historical; they present in a clear and interesting style the chief features in the development of the general conceptions regarding elements, and changes of properties, from the early days to the overthrow of the phlogistic theory by Lavoisier.

The distinguishing marks of this book are, in my opinion, clearness and suggestiveness. There are plenty of facts, and these are lucidly stated; but when the book has been read, the student is not left fact-stuffed to suffer from mental indigestion, but is incited to intellectual activity and imaginative action. Many works on chemistry convey stale truisms to the student; some preach the kind of truth that makes a man drunk when it is "stagnant inside him." This book suggests more than it asserts, and leaves the reader eager and hopeful. Take, for instance, the treatment of the well-worn subject of mixtures and compounds in chapter iii.: the many forms in which the differences between these classes of substances are stated, oblige the reader to think as he reads; and the admirable way in which illustrations of the differences are drawn from the processes of applied chemistry, give an air of reality to the matter, and withdraw it entirely from the sphere of mere academic discussion. The free use which is made of processes employed in manufactures to illustrate the laws and principles of the science, is much to be commended. The book deals for the most part with those portions of chemistry which require to be treated at once soberly and suggestively; and, on the whole, the author has succeeded in combining breadth of view with accuracy of detail. The chapter on "molecular architecture" well exemplifies the combination of these two qualities. But it seems to me that too much space is devoted in this chapter to Guye's views regarding optical activity. The reader is thrown somewhat off the main track, and he does not readily recover the path. The chapter on the classification of compounds is not, in my opinion, so happy as many of the others. The author seems to be too eagerly pursuing definitions, which Hunter said are the most accursed of all things on the face of the earth. Would chemistry be much better off were perfect definitions of acid, base, and salt to be found? I very much doubt it. Indeed, I think one of the great advantages of chemistry is its freedom from definitions. The last chapter, on chemical equilibrium, enables the careful student to grasp the bearings of the recent work in this department that has already profoundly changed the scope and aim of the science. It is just such an introduction to the study of chemical equilibrium as was wanted.

It would be easy to find fault; it is always easy to find fault. I have preferred to point out some of the excellencies of this work. It is exactly what the title-page describes it—a companion-book for students of chemistry. The want of an index, however, is a serious blemish in the book. M. M. PATTISON MUIR.

CLIMATE AND LUNG DISEASE.

Aero-Therapeutics; or, the Treatment of Lung Diseases by Climate. By Charles Theodore Williams, M.A., M.D. Oxon., F.R.C.P. pp. 186. (London: Macmillan and Co., 1894.)

THIS work affords valuable information, not otherwise easily attainable, concerning distant health resorts. Modern facilities of locomotion have brought the Andes and the Karoo within easier access than Montpelier or Penzance at the beginning of the Victorian era. The world is now at the feet of the health-seeker, and our ocean steamers and trans-continental railways are day by day carrying an ever-increasing number of convalescents. It is not necessary to have a yacht of our own if we would take a trip to the Fiords of Norway, the Grecian Archipelago, the West Indian Islands, or even to Japan; perfectly appointed steamers, with the comforts of a good hotel and the reliableness of an express train, are ever ready to convey us wherever we may desire.

Dr. Williams, who, as President of the Royal Meteorological Society, might be expected to fill his pages with statistics and tabular statements, gives also his own experiences of travel, together with a sketchy outline of cases of disease distributed amongst the varied and world-separated havens of health. It cannot be doubted that, in chronic disease, the wise selection of health stations is often of vastly greater import than physic or even diet, and in these lectures we find a comprehensive epitome of the claims of the most valuable resorts within our reach.

The description of the Riviera, given as it is by one with ample personal and acquired experience, is a valuable part of the work, and is summarised thus:—"The winter climate of the Riviera is clear and bright, with a good deal of wind but devoid of fog or mist; with a mean temperature of 8° to 10° higher than that of England, with half the number of rainy days and four or five times the number of bright ones."

Should the Riviera prove too stimulating, Ajaccio and Corsica are recommended.

Algiers is too rainy in November, December, and January, though the neighbouring desert converts what would be a moist into a dry climate.

Tangiers combines the warmth of the Mediterranean with the equability of the Atlantic, and is regarded as of value in some forms of phthisis.

Among the many attractions of South California (visited by the author in 1892) are the fruits of South Europe and of the tropics, as well as the apples, pears, and apricots of old England, and strawberries all the year round. In the large towns, however, the noise of the cable and electric cars detracts from the comfort and repose so desirable for the invalid.

The Australian health resorts are hot and dry; in inland regions are suited for young men with agricultural tastes, and threatened consumption.

The value of sea voyages is clearly shown, but the author rightly places in a clear light the cruelty of allowing unsuitable cases to start off alone on a long voyage.

The statistics of sea voyages come out well. It must be borne in mind, however, that patients sent to sea by a discriminating physician, and deemed fit to bear the vicissitudes and uncertainties of the voyage, are, on an average, of a more sturdy and hopeful type than those sent to Madeira, Egypt, or the Riviera.

The voyage to the Cape is described as sedative, that from the Cape to Australia as bracing. The voyage through the tropics to the Cape, followed by residence in the South African highlands, is unquestionably great.

It does infinite credit to Dr. C. T. Williams to have kept notes of his cases so systematically as to be able to arrange them as he has done. Among the interesting conclusions at which he arrives is this: that, in cases of cavity in the lung, the saline atmosphere of the ocean promotes antiseptic changes, and so encourages the arrest of disease.

In chapter iii., "On Barometric Pressure in Relation to Health," an interesting account is given of "Caisson Disease" and "Divers' Disease," due to too sudden exposure to change of atmospheric pressure, when working under deep water, as in the construction of the Forth Bridge. The disease begins with pain and sickness; paralysis of the lower limbs sets in, and death may occur speedily. A pressure equal to that of four or even six atmospheres is thus sometimes borne, and, if gradually attained, is not necessarily injurious.

In the "Compressed air bath," at the Brompton Hospital, the pressure rarely exceeds an addition of 10 lb. to the square inch, or $\frac{2}{3}$ of an atmosphere. Half an hour is given to reach this pressure, it is maintained for an hour, and half an hour is occupied in reducing it to the natural pressure; thus all danger of sudden change is taken away, and it is found that, in asthmatic cases, marked benefit is often secured by the compressed air.

The value of rarefied air, as at Davos, St. Moritz, or Denver is great; the analysis of cases thus treated shows an improvement in $\frac{3}{4}$ of the cases.

"In general results, the English home counties yield the smallest percentage of 'improvement,' and the largest of 'worse.' Next comes the Riviera, not much better; then, with a rise of 12 per cent. 'improved,' are sea-voyages, the percentage of 'worse' being still large. 'High altitudes' win easily in all categories, with their 83 per cent. 'improved,' and only 14½ per cent. 'worse.'"

It must be admitted there is strong evidence in favour of high altitude treatment. The value of such comparisons would be enhanced if we could be certain the patients pursuing different forms of climate treatment conformed to the same rules of hygiene and dietetics.

The concluding chapter of the book, "On the High Altitudes of Colorado," gives the results of Dr. Theodore Williams' recent visit to Denver, and is thus epitomised:

"The climate of Colorado is dry and sunny, with bracing and energising qualities, permitting outdoor exercise daily throughout the year. It has rescued many consumptives from a life of invalidism. Its exhilarating influence may be traced in the wonderful enterprise which the Colorado people have shown in developing their country. Thirty years ago Denver did not exist; it is now a well-built and well-organised city of 150,000 inhabitants."

This short survey must suffice to show that in the work before us facts are collected and arranged which cannot but prove of essential service to the public, and especially to the medical profession seeking the newest information concerning aero-therapeutics.

OUR BOOK SHELF.

Histories of American Schools for the Deaf, 1817–1893. Edited by Edward Allen Fay, Ph.D. In three volumes (Washington, D.C.: the Volta Bureau, 1893.)

FOUR hundred years ago the great double-continent of America was discovered, and almost contemporaneous with that event was a second discovery of, perhaps, less apparent but no less real importance. In the fifteenth century Rodolphus Agricola recorded the first instance of a deaf-mute who learned to read and write, and not long afterwards Girolamo Cardano, a fellow-countryman of Columbus, insisted that the instruction of individuals thus afflicted was possible though difficult, and, going farther, stated clearly the principle on which such instruction depends.

Like many another beneficent discovery, that of Cardano was long in finding recognition, and, although there were isolated cases instructed in Spain, England, Holland, France, and Germany, it was but a century and a half ago that the theory began to be put into practice. Paris claims the merit of giving the first start to the work of benevolence, Abbe de L'Épée there establishing his school in 1760, similar institutions rising in Dresden and Edinburgh about the same time. From such a beginning has sprung a work which, though carried on for the most part in silence, stands foremost in the philanthropic labours of the world—a work that must have brought light and happiness to many thousands of our less fortunate brethren, and been the means of developing valuable intellects which might otherwise have been lost to the community. Some idea of its quiet but steady progress may be gained from the following facts:—In 1836 there were 134 schools for the deaf in the world, in 1883 there were 397, and in 1893 the number had risen to 435. In the United States fifty years ago there were but six schools, in Canada and Mexico none, while in the three volumes before us are the histories of 79 schools in the United States, seven in Canada, and one in Mexico, which instruct, respectively, 7,940, 682, and 34 pupils.

True charity works, as a rule, in the dark; the outside world knows little as to its achievements, and seems to care as much. Here, however, can be learned something of its labours in one direction and its untiring energy appreciated. We hear little about similar institutions in this country, although they certainly exist, and a volume compiled on similar lines to the one at present under review would be welcome to all who have to do with deaf persons. This book, prepared for the Volta Bureau in commemoration of the four-hundredth anniversary of the discovery of America, contains, as we have said, the histories of eighty-seven schools for the deaf and dumb. These histories, which fill three large volumes, were nearly all prepared by the heads of the schools, and, many of them being written by the deaf and dumb themselves, they form a lasting monument of the excellence of the work done. By the help of excellent portraits and photographs the information to be gained is made exhaustive, and the reader becomes acquainted not only with the work done, but with the lives of many of the workers, lives which are worthy of a place among those who truly follow in the footsteps of Him who "made the deaf to hear and the dumb to speak."

P. MACLEOD YEARSLEY.

Monograph of the Stalactites and Stalagmites of the Cleaves Cove, near Dalry, Ayrshire. By John Smith, Vice-President of the Geological Society of Glasgow. (London: Elliot Stock, 1894.)

THE author has taken advantage of the opportunity afforded by the exploration of a cavern in the Lower Carboniferous Limestone, to study the various forms of deposit produced by the percolating waters. He appears, from his preface, to be under the impression that nothing has been previously written on the subject of stalagmitic deposits, and no references to any earlier literature occur in his pages. This is unfortunate, as a study of the writings of Cöhn, and others who have investigated the action of plants in promoting the deposition of calcium carbonate, would have helped him to solve some of the difficulties he has experienced.

The author classifies the different forms of deposit as "a stalactite" (when it is a pendent icicle-like mass), "a stalagmite" (when a similar mass, rising from the floor), "sheet stalagmite," "wall stalagmite," "tear-bands," "ribs" and "combs," all of which terms explain themselves. He would have done well to consult a botanist before applying the name *Gallionella* to the "confervoid filaments" found in the chalybeate water.

The 18 pages of text are illustrated by 36 plates, including 107 figures, roughly drawn, but characteristic. They show most of the common and seemingly capricious forms assumed by stalagmitic deposits. Certain of the observations are somewhat trivial, such as the reference to the "profile of Gladstone" in the centre of one stalactite, and the comparison with the "hind-quarters of an elephant" in another. The author has not availed himself of the assistance which would have been obtained by examining thin sections of the deposits under the microscope.

Botanical Charts and Definitions. By Miss A. E. Brooke and Miss A. C. Brooke. (London: G. Philip and Son, 1894.)

IT is notorious that examinations in elementary practical chemistry are frequently little more than tests of capacity for remembering analytical tables. This little book will serve the same purpose in botany that tables of analysis do in chemistry. In thirty-four pages the authors summarise the work required for the South Kensington (Elementary) and the Oxford and Cambridge Junior Local Examinations in Botany. Charts and definitions are given of sub-kingdoms, classes, orders, and floral whorls; of root, stem, leaf, inflorescence, and fruit. These, with definitions of terms of cohesion and adhesion, enable the student to classify a plant on the lines of the table of analysis with which the book concludes. We are afraid that the compilation will induce cramming for the examinations for which it is intended; but if this be avoided, and the charts are only used as supplementary to oral teaching and demonstration, they will help students to acquire a clear view of the relation and arrangement of the parts of a plant.

The Great Globe: First Lessons in Geography. By A. Seeley. (London: Seeley and Co., 1894.)

A SIMPLY worded and instructive primer of geography, printed in clear type, and illustrated with numerous cuts and diagrams. The book does not merely consist of lists of lengths of rivers, heights of mountains, populations of cities, and similar statistics, but is a compendium of facts calculated to interest the young reader, and, at the same time, to add considerably to his knowledge. There is a little too much of the goody-goody style of writing about missionary enterprises, but that is the only point we are inclined to criticise. Tales of the torturing of converts and murdering of missionaries are apt to create in children a morbid state not at all desirable, and they can very well be omitted without making a work on geography any the less interesting.

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.*]

Trituberculy and Polybuny.

IN all the speculations on the original type of the mammalian molar, beginning from Rütimeyer (1863), we find that a simple cusp or cone is, with perfectly logical reasoning, considered to be the primitive form from which all others are derived. The error, fatal in its consequences, consisted in the fact that all the teeth possessing such a simple form, whether recent or fossil, high or low in the system, have for a long time likewise been considered to be primitive; so that the only problem remaining to be solved, seemed to be to trace back the intermediate stages between the more or less complicated molars of recent mammalia and the "simple reptilian cone."

The cretaceous deposits having long failed to throw light upon the obscure relations between the comparatively scanty mesozoic mammalian teeth and the tertiary and existing forms, we were reduced to make the best of the oldest tertiary faunas. It is from the discovery of the lower eocene Puerco beds that the establishment of the tritubercular theory dates, Cope having traced the superior molars of placentalia to a "tritubercular," and their inferior molars to a "tubercular sectorial" type, both of which he found to be of overwhelming preponderance in the Puerco beds, the oldest known deposits of tertiary mammalia.

I have elsewhere [1] raised objections to the inferences drawn from the Puerco fauna, and now one of the most strenuous defenders of trituberculy has, with his own hands, undermined the stronghold of the theory, by denying the Puerco fauna the claim to be in ancestral relation with later faunas, for he considers this old fauna to be merely "an independent radiation of placentals, like the Australian radiation of marsupials." [2]

Owing especially to the perseverance of Prof. Marsh, cretaceous mammalia were discovered in due time. The principal characters of their molars can be grasped at once by a single glance at the two beautiful and highly instructive plates published by Prof. Osborn, in December last. [3]

Whoever examines with an unbiassed mind the molars figured in the latter plate, must receive the impression that the term "trituberculate" applied to them can stand only upon the *lucus a non lucendo* principle. Speaking for myself, I cannot consider to be tritubercular, molars which consist of from five to ten tubercles; therefore the teeth represented on Pl. viii. in my opinion are polybunous (multitubercular), as well as those of Pl. vii., though in a different manner. Prof. Osborn informs us that the former "include a variety of forms *just emerging from the primitive tritubercular stage*" (the italics are mine), "lending overwhelming proof, if any more were needed, of the unity of origin of the molar types of the higher mammalia, from a tritubercular stem instead of from a multitubercular, as Forsyth Major has suggested." [4] I suppose that by "primitive tritubercular molar" we are intended to understand a molar which is in fact tritubercular *sensu strenuo*, namely, composed of no more and no less than three cusps arranged in a triangle; but I fail to discover in the pages which follow the above quotation, the proofs for the various assertions it contains.

In order to explain why for such complicated molars as those on the precited Pl. viii, the designation *tritubercular* is maintained, it must be recorded that this name is said to be meant to imply that the two outer cusps (paracone, metacone) and the single inner one (protocone) in upper molars, as well as the three anterior cusps (two inner and one outer) in lower molars, generally the best developed of all the cusps, are to be considered as typical, primitive; whilst the remainder, namely, the intermediate and all the others of superior molars supposed to play a subordinate part, as well as those composing the heel of inferior molars, are considered to be later additions to the crown.

It has not, however, been shown, and I deny, that the predominant cusps have always been such, and that the intermediate ones, as well as the inferior heel (talonid), are of later origin than the former, and have always been in a subordinate position with regard to them. Without searching farther than what is to be seen on Pl. viii., I state that the figures F are not in favour of the assumption that two of the supposed primitive cusps, the paracone and metacone, are always the best developed; externally to them, we have here two superadded cusps, the "parastyle" and "metastyle," [5] which are in a much better state of development than the reduced two "primitive" cusps. The latter, as the other figures of the plate suggest, may only gradually have acquired their predominance by supplanting the "styles," which in other patterns have become more or less obsolete. On the whole, the superior molars of these "tritubercular" cretaceous mammalia can best be compared with those of *Didelphyidæ*, as was done by Marsh, or to speak more guardedly, rather with the *Polyprotodontia* in general, the principal differences between the two consisting in the fact that the cretaceous forms are more complicated.

From the seemingly subordinate condition of the "heel" of lower molars, as compared with their anterior portion, it does not follow that the former is of later origin; the difference between the two in vertical extension obviously depends on one or more of the cusps of the so-called trigonid having secondarily become more elongated, for brachydonty and not hypsodonty is the original condition. If the heel were a later addition to the

1 *P.Z.S.* 1893, p. 198-199.
2 H. F. Osborn, "The Rise of the Mammalia in North America," pp. 30-31. (Boston, 1893.)
3 H. F. Osborn, "Fossil Mammals of the Upper Cretaceous Beds." (*Bull. Am. Mus. Nat. Hist.* v. 1893, pp. 311-330, pl. vii.-viii.)
4 *l.c.* p. 320.
5 Of their homologues, by the way, may be found traces in the molars of many existing mammals; see *e.g.* *H. Winge*, Om Pattedyrenes Tandskifte, 1882, Table III.

crown, we ought to find it in a more or less incipient stage in such remote forms as the cretaceous mammals, whereas the very reverse is the case, as admitted by Osborn himself;[1] in them the heel is mostly better developed than in such of later forms, marsupial or placental, which morphologically most closely approach them.

So that, in conclusion, the superior as well as the inferior molars, far from "just emerging from the primitive tritubercular stage," are more remote from it, both morphologically and chronologically speaking, than the tertiary and living forms.

According to the tritubercular theory, the so-called quadritubercular superior molars (composed of four principal cusps), were derived from the tritubercular pattern by the addition of a postero-internal cusp (hypocone). In order to test the value of this hypothesis, let us see what relation the cusps of the superior bear to those of the inferior molars. In a "quadritubercular" mammal, *e.g. Erinaceus*, the antero-internal cusp (protocone) of a superior molar works as a pestle in its mortar, below which is the posterior valley, formed chiefly by the talonid, whilst the hypocone functions in a similar manner in the hinder molar's anterior valley, formed by the trigonid. According to the theory, the superior "talon" (hypocone) and the inferior "talonid," are later additions to the crown; from this it would follow that the phylogenetically older of the two superior pestles, the protocone, was preformed before its mortar, and *vice versâ*, the posterior of the two mortars was in existence long before its pestle, the hypocone; so that the second pestle and the second mortar would make their appearance only in a distant future or never appear at all, the function of *their* respective mortar and pestle thus remaining for ages sinecures. The following reasoning, which appears to me more logical, may, however, be not unworthy of consideration. Starting from the assumption that the more complicated pattern, in our special case, the "quadritubercular" molar, is primitive as compared to the tritubercular, we had originally, viz. in the ancestral form of tritubercular molar, two superior pestles working in the two inferior mortars, as in the case of the recent *Erinaceus*. According to this view, the tritubercular type is derived from the quadritubercular, by the gradual suppression of the posterior pestle (hypocone), *pari passu* with the reduction or suppression of its mortar, the anterior valley, formed by the trigonid.

The impropriety of the term *tritubercular*, as applied to many patterns which in reality are multitubercular, is apt to create not a little confusion. Partially to this circumstance I ascribe some obviously contradictory statements to be met with in Mr. Goodrich's recent letter in this journal: *On the tritubercular theory*,[2] as well as in a previous paper by the same author,[3] to which he refers us for further information as to his views on the primitive mammalian molar.

On looking at the conclusions contained in the appendix ("On the primitive mammalian molar") to Mr. Goodrich's valuable paper on the mammalia from the Stonesfield slate, I felt gratified to find that he considers it extremely probable that the molars "of the ancestors of both Monotremes and Ditremes were of an indefinite multituberculate pattern," because I had for years advocated the view that the mammalian molar is derived from a polybunous form, a view in favour of which I have reopened the discussion on a recent occasion.[4] So, I naively believed at first that it was for this reason my paper was recorded in Mr. Goodrich's List of References. My gratification was, however, considerably abated on finding that I am merely alluded to in a footnote, where I am stated to have expressed views which are the very reverse of those which every attentive reader will find in my paper to which he refers.

In his letter on the tritubercular theory, Mr. Goodrich states:—"There is much evidence for the view that the upper molars of the pro-mammalian ancestors were of the tritubercular, and the lower molars of the tubercular-sectorial types; in fact, I think, we cannot do better than accept Prof. Cope's generalisation, if not as a definitely established theory, at all events as an excellent working hypothesis . . . that the superior molars of both ungulate and unguiculate mammalia have been derived from a tritubercular type; and that the inferior true molars of both have been derived from a tubercular-sectorial type."

1 H. F. Osborn, "Fossil Mammals of the Upper Cretaceous Beds." (*Bull. Am. Mus. Nat. Hist.* v. 1893, p. 322.)

2 Nature, May 3, 1894, pp. 6-7.

3 "On the Fossil Mammalia from the Stonesfield Slate" (*Quart. Journ. Micr. Science*, vol. xxxv. 1894, pp. 425-29).

4 *P. Z. S.*, 1893, pp. 196-214.

I would put the following questions:—(1) How does this last statement agree with the one above quoted from Mr. Goodrich's former paper, referring to "the ancestors of both Monotremes and Ditremes?" For these alone can be alluded to by the term "Pro-mammalia." (2) How does the acceptance of Cope's "generalisation," quoted by Mr. Goodrich, and which is the very quintessence of the tritubercular theory, agree with his criticism of this same theory in the beginning of his paper, where he exclaims, "Never before have its weaknesses been so obvious, its errors so plain"?

I leave Prof. Cope to reply to Mr. Goodrich's implication, that he extends the tritubercular and tubercular-sectorial types to the molars of the "Pro-mammalian ancestor."

C. I. Forsyth Major.

Natural History Museum,
S.W., May 10.

The Determination of Latitude and Longitude by Photography.

Latitude and longitude may be determined on shore with considerable accuracy by means of an ordinary photographic camera; and this method will, I think, prove useful for several reasons. The observation part of the business, which consists in taking the photographs, is separated from the measuring and calculating part, and may be performed by different persons at different times and places. For taking the photographs no scientific apparatus is wanted besides the camera and a watch, the latter to measure intervals of not more than a few hours with an accuracy of a second or so. Anyone may easily be instructed to take the photographs, as no mathematics and very little astronomical knowledge are wanted, only the measuring of the plates and the calculation requiring some scientific training.

I will first describe the determination of latitude. The general plan is well known to astronomers; it is here only adapted to the use of an ordinary camera.

If the lens is directed to the zenith, and the stars are allowed to draw their trails over the plate, it will evidently be possible to determine the latitude from the plate, provided the point of the plate is known which corresponds to the zenith. Now this point may be found in the following manner:—Let the camera float and be turned while floating. It will turn exactly round a vertical axis. The zenith will then be the only point of the sky whose corresponding point on the plate will remain unaltered. The way I arranged the experiment was this:—I placed the camera in a rectangular tin box, lens upwards, fixing it firmly by wedges. The box was ballasted so as not to be capsized when floating. Photographic plates will do as ballast, but it is better to take a plate of lead, which brings the centre of gravity lower down, and thereby increases the stability. I then filled a second rectangular box, somewhat larger than the first, with so much water, that when the first box floated in it, the rims of both boxes were in the same plane. Two opposite points on the rim of the inner box were fastened to the rim of the outer one, each with two strings, forming an obtuse angle. This prevented the inner box from turning during an exposure. The strings need not be tight, as the forces they have to resist are small.

Having placed the whole apparatus on a firm table in the garden, I removed the cap from the lens. As the trails of brighter stars may generally be measured more accurately than those of faint ones, I exposed long enough for a star of the third magnitude to pass sufficiently near the zenith to appear on the plate. After replacing the cap, I turned the whole apparatus carefully through an angle of 180°. For this purpose I had pressed a row of flat nails into the board along one edge of the outer box, and having turned it, I let the same edge of the box touch the row of nails from the other side. Before again removing the cap, I waited about three minutes to allow the oscillations of the water and the inner box to subside. The second exposure I made long enough for the image of a star of about the third magnitude to be thrown on the plate during the star's culmination near the trail of the star of the first exposure. In order to see that it is possible to determine the latitude from this plate, imagine first the trails of the two stars to touch. That would be a proof that they had passed the meridian on different sides, but at the same distance from the zenith. The mean of their declinations, taken from the almanacks, would therefore be equal to the distance of the zenith from the equator that is equal to the geographical latitude. If, on the other hand, the trails of the two stars do not touch, their shortest distance may be measured. Now the distance of the trails of any other two stars, which appear during the same exposure, will, when their declinations are taken from the almanacks, enable us to calculate what angle approximately corresponds to a certain length, the approximation being close for small lengths. Thus we are enabled to calculate what the declination of the second star would have been, if its trail had touched the trail of the first star, and thus the latitude may be found.

Generally there will be the trails of several stars in both exposures available, so that one plate will allow of several determinations, and thereby of an elimination of errors. The results of seven plates, taken on different nights in my garden in Hannover, Germany, will give an idea of the accuracy.

52° 22'·50
52° 22'·56
52° 22'·47
52° 22'·78
52° 22'·90
52° 22'·93
52° 22'·90

Mean: 52° 22'·72 (mean error of a single plate = 0'·2).

According to the *Preussische Landesaufnahme* the latitude should be—

52° 22'·84

The same plate may also serve to determine the deviation of a watch from local mean time, if the time of the watch is noted each time the cap is withdrawn and replaced. Imagine, first, that a star was photographed whose declination coincided with the geographical latitude, and imagine that the box could be turned infinitely quickly without any oscillations being started. If we then found that the two trails of the star corresponding to the two exposures touched each other at one end, the end corresponding to the moment the box was turned, we might conclude that the star at this moment was in the zenith. For there alone the image of the star would remain unaffected by the turning of the plate. Now, we can calculate from the almanack the local mean time of the moment when this particular star culminates, and this would give us the deviation of our watch from local mean time. Imagine now the box had not been turned at the moment the star culminated, but, say, ten minutes later. Then the two trails would not have one end in common. The ends corresponding to the moment when the box was turned, would be on opposite sides of the zenith at the same distance from it. Now we should be able by the length of the trails to determine what interval of time corresponds to a given length, and so the plate would show us that the culmination of the star took place ten minutes before the box was turned. If the box is not turned very quickly, the interval after replacing and before removing the cap must be taken into account. But it is evident that we can calculate where the ends of the trails would have been if the box had been turned infinitely quickly. If there is no star that passes exactly through the zenith, we must take one that passes near the zenith. This will also do. By the ends of the trails we find which point of the plate corresponds to the zenith, and at the same time we can, by the trails and their ends, find out the line representing the meridian. This gives us the necessary data for finding the deviation of our watch from local mean time. For a star near to the zenith a small error in the direction of the meridian will make very little difference. I have spoken of the ends of the trails as a means of determining local mean time only for the sake of simplicity. It is far preferable to proceed differently, and to interrupt the first and the second exposure a number of times, thus causing as many interruptions of each trail. Five seconds or less will do very well for the length of an interruption. These interruptions are preferable to the ends, because they are symmetrical, and their middle can with more accuracy be brought under the cross-hairs of a micrometer. My lens having a focus of about 24 cm. made one minute about equal to 0·6 mm. on the trails of stars that culminate near the zenith. With a micrometer it is not difficult to measure exact within 0·01 mm. which is equivalent to one second of time.

If by the help of a chronometer Greenwich mean time were known at the place where the photograph was taken, the longitude would thus also be determined. But a chronometer can be dispensed with if another photograph is taken of the moon and the stars. For this purpose the camera is taken out of its box, directed to the moon, and fixed as firmly as possible. A number of instantaneous photographs of the lunar disc are then taken, all on the same plate, at intervals of not less than two minutes, to prevent the images from overlapping. The camera must be touched as little and as gently as possible, so that it may remain in the same position. After a number of exposures, say six or eight, the camera is shut until the moon has quite gone out of the field. The cap is then again removed, and the stars draw their trails over the plate, interrupted here and there, the lens being now and then covered for five seconds. If the local mean time of the instantaneous exposures of the lunar disc and of all the interruptions is known, the Greenwich mean time may be found from the plate. One may apply three different methods. Either one can determine the right ascension of the moon or the declination, or one can measure lunar distances. I have tried all three, and prefer the second, provided the moon is not near the maximum or minimum of her declination. For the slower rate of change of declination is made up by the greater accuracy with which it can be measured, on account of the trails being lines of constant declination. Each image of the lunar disc allows a separate determination, so that the final value is the mean of a number of determinations. (For the details of measuring, see my article in the *Zeitschrift für Vermessungswesen*, August 1893.)

The results of one plate for the difference of Greenwich mean time and local mean time were by the three methods—

39·1 minutes
39·1 ,,
38·6 ,,

Mean 38·93 ,,

while the true value is 38·943. This very close coincidence must be considered accidental. But I think one can well rely on the determination from one plate not differing more than 0·2 minute from the real value. When exposing for a longer time, the dew will sometimes condense on the lens, and render it opaque. To prevent this, I place a screen before the lens with a hole in it a little larger than the lens. The screen keeps the lens from cooling below the temperature of the surrounding air, and thus removes the cause for the condensation of dew. When determining the latitude the screen was arranged as a lid of the outer box, and served at the same time to protect the camera from gusts of wind.

C. RUNGE.
Technische Hochschule, Hannover.

Sodium and Uranium Peroxides, &c.

IN your notes of May 17 you give an account of work done by Prof. Poleck on the action of sodium dioxide on the salts of various metals, from the *Berichte* of May 8.

Some of this work has been already recorded by other observers who used either sodium dioxide or hydrogen dioxide in alkaline solutions.

In the *Journal* of the Chemical Society, 1877, pp. 1-24, and pp. 125-143, I gave papers on the reactions of hydrogen dioxide, and described its action on uranium salts both in acid and in alkaline solutions. I do not wish, however, to say anything on a mere question of priority, but simply to point out inaccuracies in the formulæ given in NATURE from the *Berichte*.

Prof. Poleck gives for sodium peruranate the formula $Na_4U_2O_8 . 8H_2O$. This either involves the use of the old atomic weight of uranium, half of that now adopted, or it means that his salt is exactly like that prepared by me in every respect, excepting that it contains twice the proportion of uranium. Assuming the atomic weight at approximately 240, the correct formula of sodium peruranate is $Na_4UO_8 . 8H_2O$ (*Journal* of the Chemical Society, 1877, p. 139).

I also showed that hydrated sodium dioxide is readily obtained on adding alcohol to mixed sodium hydrate and hydrogen dioxide solutions (p. 125), so that the materials used by Prof. Poleck and myself are practically the same.

The uranium compounds are interesting as examples of a special highly oxidised type (see Mendeléeff's "Principles of Chemistry," vol. ii. p. 244), also as throwing light on the nature of certain analogous but unstable bodies, such as perchromic acid. (*Journal* of the Chemical Society, 1877, pp. 7-8). This was further confirmed by Dr. C. Häussermann last year, who has isolated a definite crystallised sodium perchromate, as described in the *Journal für Praktische Chemie*, quoted in NATURE in the notes given July 27, 1893, p. 300. THOMAS FAIRLEY.

Cataloguing Scientific Papers.

THE recent circular issued by the Royal Society anent the indexing of scientific literature affords me a pretext for suggesting in your columns a reform which I have long thought to be urgently required. It is that henceforward all scientific publications should be issued in only one volume per annum—in parts, if necessary, but consecutively paged and with only one index—and that this volume should be primarily referred to by the year of its publication, *not* by its number since the first issue of the publication. Two advantages would accrue from this system. In the first place, the date of all quoted work would be fixed; in the second place, the finding of the abstracts of papers published elsewhere, printed in the journals of scientific societies, would be rendered more easy. A little reflection will show that these benefits are not trivial. For example, suppose an author refers to a paper by Smith published in NATURE, vol. xi. I have not (may I be pardoned for saying so!) the slightest idea when NATURE was first issued, nor do I remember whether one or two volumes of this periodical appear per annum. I am therefore totally in the dark as to whether Smith's work is one year old or twenty years old, and consequently I am ignorant whether he is likely to have used the most modern appliances in his research, and whether he is likely to have been contradicted by subsequent observers. Again, I am referred by an author to a paper by Schmidt, in the *Berichte* of the German Chemical Society, vol. xx. Not possessing this journal, I hope to be able to find an abstract of the paper in question in the *Journal* of the Chemical Society, to which I subscribe; but as I have no notion in what year vol. xx. of this *Berichte* was published, I have to search through numerous indexes in order to find the abstract. A search for previously published work is already sufficiently difficult to cause many to shrink from the task; ten years hence it may be expected to be the most laborious and thankless work which the investigator has to perform. A. G. BLOXAM.

May 19.

Clavatella Prolifera.

THIS hydrozoan may be added to the list of the Jersey marine fauna. It occurs in rock pools on the higher littoral between the Point des Pas and Gorey, and probably at other places round the coast. I often found three or four colonies in one small pool; but the number of polypites in a colony was very small—generally two or three, rarely four, and only in one case five. The stolon runs along in the chinks of the Melobesia that grows over so many of the pools, hence it is not an easy matter to obtain specimens there. The walking-buds, however, were fairly plentiful.

May I ask if any correspondent of NATURE has ever seen the walking-bud of *Eleutheria*, in which both extremities of the bifurcated arms are said to consist of a ball of thread-cells?

May 22. HENRY SCHERREN.

THE DESTRUCTIVE EFFECTS OF SMALL PROJECTILES.[1]

THE effects of small projectiles when driven at high velocity through the tissues of the brain have always excited the deepest interest, for very obvious reasons.

This interest must always be two-sided, namely: (1) Physical; (2) Pathological; and it is upon these two points of view that I propose to speak to you this evening.

Conceive a cylindrical bullet with a conical head flying through the air some ten or fifteen times faster than an express train.

We have now to study what it is doing in its aerial flight, and what will happen when that terminates by the projectile striking both hard and soft substances.

This embodies matter for the purely physical side of the work.

[1] A lecture delivered at the Royal Institution on April 6, by Prof. Victor Horsley, F.R.S.

But imagine, further, that the hard and soft substances just mentioned are the skull and brain respectively, what will happen then?

This is the pathological part of the question, and it is one of the greatest moment; for whereas it is true that a few persons do survive being shot in the head, the large majority die; and it is my object to show you how a combination of physical and pathological experiments has revealed the reason why the majority do die, and revealed it, fortunately, so distinctly as to suggest means for warding off the fatal result.

(1) *Physical Considerations.*—First take the case of a bullet flying through the atmosphere. Here in this extremely beautiful photograph, kindly lent me by Prof. Boys, you observe that the bullet drives before it a wave of compressed air. Now this compressed air-wave is what is popularly called the wind of the shot, and to it used to be ascribed by military surgeons a certain proportion of deaths. The origin of this theory is difficult to discover, as the only case I am aware of in which the *post mortem* examination did not reveal hæmorrhage, fracture, &c. indicating that the shot had actually struck the body (though without injuring the highly elastic skin) is the instance given by the great Russian military surgeon Pirogoff, in his interesting surgical experiences of the Crimean war. Even this instance finds *à priori* a more reasonable explanation in syncope, and we shall see directly that the wind of the shot not only cannot, under any circumstances, kill a man, but also that its energy is far too slight for it to have any destructive effect whatever. It is rather curious to find that but few attempts have been made directly to estimate the wind of the shot, and those by Pelikan and others are only for large shot and by too coarse methods to be applicable in the case of a bullet, as the following experiment shows.

An extremely light vane of paper carrying a delicate mirror is suspended to a cocoon fibre, and carefully protected from currents of air in the room. A very gentle puff causes the vane to fly out most vigorously, yet we shall find that the ·380 bullet moving a thousand feet a second may pass within eight inches of it without causing the least deviation of a ray of light reflected from the mirror. It is only when the bullet passes within an inch or two of the edge of the vane that there is some slight rotation. The ·303 magazine service rifle, with a velocity of twice that of the larger bullet, produces little more than the same result. It is therefore obvious in this case that the far higher velocity is more than compensated for by the lesser sectional area of the projectile displacing the air. Although there was no proof of much displacement of the air, it was pretty generally held that when the bullet entered any substance the compressed air driven before it exercised an explosive effect. This opinion was more particularly supported by the Belgian physicist Melsens, who actually described it by the term "projectile air." The matter was taken up from the point of view of pure physics, and Magnus demonstrated that if a body like a bullet entered water, *e.g.* in falling the funnel which the displaced water makes in the axis of the body as soon as that is fully immersed, entangles air, and that it is this air which is carried by the body into the fluid, rather than that any air is forced in in front of the bullet. In answer to Magnus, Laroque invented the following ingenious experiment. He allowed a long body, incapable of wholly sinking, to drop into the water, and then found that there was air driven in in front of it; while, by the nature of the experiment, he had, of course, excluded the possibility of any air following the base of the projectile. I have repeated all these experiments (employing in Laroque's a slender rod of wood) and found that while his contention that air is driven in front of the bullet is completely substantiated, yet Magnus' observation is so far correct that air is also driven in after it, the fact being that the two conditions are not opposed but simultaneous. Magnus' view was further supported by the adverse criticism of the theory of projectile air of the celebrated French artillerist Morin, which criticism amounted to this, that when a projectile was directed against a *solid* body it must necessarily follow that so elastic a substance as air should be completely reflected from the surface. I should like to draw your attention to this word *solid*, because I believe that in that we find the key to the difficulty, and the apparent paradoxes presented to us are to be explained by the fact that the results are wholly dependent upon the simple question of the relative viscosities of the substances entered. To solve this, I employed the same falling bodies, and examined their entanglement of air in water and glycerine respectively, and found that whereas in the case of water, Laroque's non-floating rod drove air in front of it as well as probably at the side, yet when the same rod was caused to fall into glycerine of high concentration there was no air in front, but air-bubbles could be seen clinging to the sides of the rod. Further, in glycerine the entanglement of air in the funnel formed by the base of the bullet, as described by Magnus, was very striking. It appeared to me that whatever air was driven in front of it was wholly reflected by the sufficiently viscous fluid, and hence it must be, *à fortiori*, still more completely reflected from the surfaces of hard and soft solids like the skull and brain respectively.

To sum up, the so-called projectile air can have no real bursting effect, since, as I have demonstrated, in the first place it exerts very feeble pressure, as tested on a delicate vane, and in the second place it is certainly easily reflected from surfaces of but moderate density.

The Influence of Rotation produced by Rifling.—It is commonly thought that the spin of the bullet communicated to it by the rifling of the barrel, and which is very great, causes a considerable amount of the disturbance created in the interior of moist substances, which is usually spoken of as the bursting or explosive effect. Kocher thought that this would not be appreciable, and that the rotatory movement would only cause the displaced particles to take a course tangential to the surface of the bullet rather than perpendicular. Although the smooth surface of the bullet of course adds force to the idea that its rotation is not very effective, it is obviously a matter of both interest and importance that the matter should be more closely studied. Colonel Henrad made plaster casts of the tracks of shots, and obtained distinct spiral markings indicative of the rotation in question. Acting on this suggestion, it was easy to institute a series of experiments of the following kind. Pure modelling clay of firm consistence (for the influence of the water present *vide infra*) was rendered homogeneous by kneading, shaped into square blocks of varying length, and supported in a hard flat surface or in a box, the ends being open. The cavity made by the bullet in entering and traversing the mass was then filled with liquid plaster-of-paris, and a cast obtained. Examples of such casts are before you, and they completely display the rotation in question.

The first point which has to be borne in mind is the relation of the rotation to the projection or forward movement of the bullet. In passing through a body of little resistance like the air, it is clear that for every given unit of distance travelled, the displacement evoked by the rotation must be something very small, because although the bullet turns one and a half times in traversing the barrel, that is nearly a yard in length consequently, so far as the rotation is concerned, that for a unit, say one inch, of the flight of the bullet would be extremely small, namely about one-twentieth of the circumference of the bullet, which, roughly speaking, would be (for the ·380 bullet) about one-twentieth of an inch, the insignificance of which is obvious. The matter, however, assumes a somewhat different aspect when a bullet is engaged in a solid substance through which it is forcing its way with rapidly diminishing velocity. In such a case, where the projection journey of the projectile is quickly coming to an end, it becomes of special importance to see what is becoming of the factor of rotation. The plaster casts obtained in the manner indicated show clearly enough the interesting fact that the rotation persists to the end, when the bullet has simply taken its course through the atmosphere, and then entered the soft clay. Further, the casts also show what is a necessary deduction from our earlier considerations on this matter, namely, that as the rotation is preserved till the end of the trajectory, the twist is proportionately more pronounced as the forward movement is lost.

It is for our present purpose important to see whether the rotation is well marked when the projectile is completely deformed. To examine this point a new series of experiments were undertaken, in which the bullet was first caused to penetrate a flat bone before entering the clay. It is very clear that the rotation is still present. In discussing this question I have left unnoticed the fact that owing to the resistance of a body like clay, the cohesiveness of which of necessity varies slightly from point to point, there will be a great tendency for the bullet to change its direction, more especially as the base is heavier than the apex, and to this change of direction must be attributed in part the change of surface simulating the rotation effects due to the rifling. The two conditions, however, can be distinguished readily on careful examination.

So far as destructive effects in the brain are concerned, it is therefore clear that relatively little is to be ascribed to rotation.

Projection Destructive Effects.—The destruction by the bullet moving forward through a solid body is the most important matter for us to consider. There are two sets of factors determining the degree of destruction in any given substance.

(1) Factors due to the bullet.

(2) Factors due to the *physical constitution* of the solid.

(1) Factors due to the bullet. So far as the projectile is concerned, the chief considerations are (*a*) its momentum; (*b*) its sectional area; (*c*) its becoming heated.

(*a*) *Momentum.*—Although it will of course be generally understood that the greater the velocity the greater the damage for the same weight of shot, still, in connection with the small-bore service rifles of the present day, some seem to think that the small bullet, by virtue of its travelling at a great pace, would pierce the tissues without causing much general damage. The fallacy involved in this belief we shall see directly; but a single glance at the casts arranged in order of the velocities of the bullets, shows immediately the unreality of the notion. In every case the particles of the substance are hurried forward (particularly evident in the casts before mentioned) in front of the bullet, and thus by increasing the size of the moving mass such particles practically constitute a larger projectile. Much destruction is due to this, as Delorme has more particularly demonstrated in the well-known case of firing a bullet into a book, wherein one may see the laceration of the pages successively increased, although the momentum of the bullet is steadily diminishing and in proportion to the increasing laceration, so discs of increasing diameter are found in the cavity, having been cut from the preceding pages. The hurrying forward of the particles is very beautifully shown by Prof. Boys in his photographs of the débris of glass plates after a bullet has passed through them. In one case a large fragment of glass is shown to be moving parallel to the bullet, *i.e.* with the same velocity. This question of accessory damage is of much importance to the pathological problem how much damage is effected in the brain. I have found discs of bone forced through the brain, such discs (as will appear directly) being larger than the projectile itself. Small fragments are also hurried forward with the same velocity as the bullet, as these casts show, the plaster method thus confirming Prof. Boys' photographic record.

(*b*) *Sectional Area.*—From what has just been said, it is plain that the crushing effect of the bullet will be greatly increased if its diameter is enlarged; and it is understood that this was the reason why the Duke of Wellington opposed the introduction of the smaller bore weapon for the old musket called "Brown Bess." But few words, therefore, are requisite in dealing with this point. I wish, however, to draw attention to an extremely common result of the employment of leaden bullets, and a result which is wholly dependent on the principle just enunciated. In a photograph of the penetration of an iron plate by the magazine rifle bullet, it will be noticed that the diameter of the holes is almost twice that of the bullet as it leaves the muzzle of the rifle. When the bullet is picked up, however, after it has passed through the plate, the reason of this seeming absurdity is at once recognised, for the bullet is compressed into a hard mass of lead and nickel by its first impact on the front of the plate, of the size of the hole shown. It is important, therefore, for the military surgeon to consider what proportion of the damage is due to deformation of the projectile on its striking the body, but the sectional area demands very little attention when compared to the velocity as a source of destruction.

(*c*) *Heating.*—The notion that a bullet produced some of its destructive effects in consequence of its being raised in temperature, as a natural result of some of its momentum being converted into heat, has always been before scientists ever since the invention of fire-arms, and endless have been the suggestions put forward to support this idea. I am not going to waste your time on the matter because, in spite of the plausible papers of Hagenbach and Socin, there are certain facts plain and simple enough which, to my mind, completely dispose of the notion put forward by those authors, namely that the bullet undergoing deformation on striking a hard substance like bone becomes heated so intensely that it partly fuses. The simplest observation of all is that, I think, made by von Beck, and which I have often confirmed, namely that a bullet, though completely deformed by impact, may enclose a hair or piece of wood without these being in the least degree altered by heat; while as for its being heated in the barrel, &c., that cannot amount to 40 C., for Messner has shown that a bullet traversing dirty clothing carries with it living microbes, and deposits them in the object it strikes, still in a living state, so that they grow therein if the soil is a suitable one; and these observations have been fully confirmed by Delorme and Laveran. It is to be hoped that we have heard the last of this unquestionably exaggerated idea of the heating of a bullet.

(2) Factors due to the physical constitution of the solid.

We now enter upon the discussion of the most interesting of all the physical considerations determining the well-known bursting effect which a bullet produces on certain substances, *e.g.* clay, brain, &c., while simply perforating others, *e.g.* wood, iron, &c. The reason why a bullet behaves apparently quite differently when it is forcing its way through solids of different kinds, has been, as a matter of fact, answered ever since 1848, when Huguier made some remarkable, but little known, researches of the effects of bullets on soft tissues, after he had observed the results of the wounds inflicted in the fighting in Paris in 1848. It will be remembered that in that struggle, as in others, the appearance of bursting within the tissues was very noteworthy, and gave rise to the notion of explosive bullets having been employed by the combatants contrary to the received opinions of international comity. The whole question is a perfectly simple matter, and resolves itself merely into the proposition that destructive effects vary in direct proportion to the cohesiveness, *i.e.* the fluidity of the particles composing the body. Ever since the observations of Tresca, Roberts-Austen, and others, we have been made familiar with the phenomenon of the flow of metals when these are subjected to powerful pressure, and the mode of the displacement of the particles has always been compared to the displacement observed in viscous fluids. The extreme case in which fluidity is least present is that of the substances which we term brittle. In these, while much pulverisation occurs, the displacement of particles laterally is very slightly marked. Contrast the penetration of an example of this class, namely a flat, thin bone, with the effect produced on a more or less plastic solid like brain, and a striking difference presents itself, for whereas the bone is simply penetrated in the long axis of the bullet, the brain is thrown aside in every direction. Huguier made observations on certain dead organs, *e.g.* lung, liver, &c., and suggested that the reason why there was so much lateral disturbance was that the tissues contained water in large quantity, and that the energy of the moving projectile being imparted to the particles of water, caused the dispersion of these in a hydrodynamic fashion. Kocher, in 1874 to 1876, was the first who thoroughly dealt with this question in the manner shadowed forth by Huguier, and he proved, in a series of interesting experiments, which Dr. Kramer and myself have fully confirmed, that the effect is really a hydrodynamic one. One of the simplest of his observations you see before you, and is made as follows:—Two tin canisters are taken of precisely the same size and strength, and are filled with equal quantities of lint; but in the one case the lint is dry, in the other saturated with water. When a bullet of moderate velocity is fired through these canisters, it simply perforates the dry one, but causes the wet one to burst explosively. It is, however, not a simple question in dealing with these artificial schemata merely to provide a porous substance the cavities of which are filled with water, for I have found that if the intervening septa are strong, as, for instance, in the case of sponge, that the bursting effect is not so great. In fact, the water must be thoroughly incorporated with the substance, or, to speak more correctly, the substance must be more perfectly fluid. This can be easily demonstrated by taking dough containing different percentages of water, and since dough is a substance in which the incorporation of the water is very complete, it affords a particularly good example to employ. By firing bullets of precisely the same velocity through these samples, you see that the destruction is effected strictly proportionally to the fluidity of each specimen. This is the reason why it is really of no absolute value to make experiments on dead tissues, for the brain in a state of *rigor mortis* is practically a solid, since both its living protoplasm and blood in the blood-vessels has coagulated, whereas in the living condition the first is semi-fluid, and the second quite fluid. It was to investigate this point, as well as the previous questions, that I have paid more especial attention to the proportionate relation existing between the velocity and the explosive effect. The results are very obvious in the casts before you. This work has been immensely facilitated by the kindness of Sir Andrew Noble, who caused to be constructed at my request a modification of a 22-calibre rifle, whereby I can fire a 40-grain bullet with any velocity I wish from a few hundred feet per second to over 3500 feet per second.

The casts show that the effect in the clay is proportional to (1) the velocity of the bullet, (2) the wetness of the clay.

The method of proof is so convincing I need not detain you further in this discussion.

Since the question is, we now see, all-important, it becomes a matter of no small moment to study the effect exerted by bullets entering fluid (for example, water). In the first place, as may be seen by these experiments, the effect of the perforation of a skull, filled with water, by a bullet, as was first done by Kocher, is to cause the burst-of the sutures. I would draw your attention to the fact that the separation of the bones is most marked on the side of the entry of the bullet. It was the observation of this latter point which led me to think that it might be possible to automatically record the disturbance of the fluid, and this was effected in the following way.

A long trough having been prepared, with one end closed with rubber one-eighth of an inch thick, and a tall, white, flat surface lowered vertically into the trough, the latter is filled with a solution of methylene blue. A small bullet of low velocity (600 feet per sec.) is fired in the long axis of the trough, 1 cm. below the surface of the water. As a result, a wave is thrown up against the white screen, which is consequently marked with a blue splash, the same describing a curve, indicating, firstly, that the disturbance is greatest where the velocity and resistance, increased by compression, are both at their highest, *i.e.* soon after the bullet enters the fluid; and, secondly, that the displacement diminishes gradually as the momentum lessens.

Complete confirmation of the parallelism between soft solids and fluids in their behaviour to the rapidly-moving bullet is seen in comparing the cast of the track made by a bullet moving through clay, with the curves obtained by the water record.

In both, the maximal displacement occurs shortly after the bullet has entered the substance, and in both the diminution of disturbance is much more gradual than its development, and is evidently proportional in the main to the loss of momentum. A final proof is afforded by suspending columns of methylene blue in clear water, or salt solution, and then firing through the whole. With the ·380 bullet and three grains of smokeless powder the last column in the 4-foot trough was not disturbed.

This doubtless is a result which would be generally foreseen, but it was worth while to test it experimentally, and it certainly very strikingly demonstrates how localised the bursting disturbance is, which completely explains the limitation of the explosive effect on the skull on the side of entry. Sundry interesting subordinate points arose in the course of these experiments, and have served to afford the necessary control of the method, *e.g.* the peculiar splash of the bullet striking the rubber end of the trough alone, *i.e.* not penetrating; and, again, the tracing made by a bullet which, being fired a little too superficially, records the elevation of successive waves as it ricochets along the surface; and, finally, the record of a bullet deflected by the resistance of the water (as well as by want of horizontality), showing a long, oblique splash where it has carried up the fluid into the air.

From all these experiments on the pure physics of this subject we are justified in believing that when a bullet is fired against the head (whether that of a man or any other warm-blooded animal), so as to penetrate the cerebral hemispheres in a transverse direction, the following series of phenomena occurs. The impact of the bullet on the bone causes depression of that bone over an area larger than the diameter of the uninjured bullet, this causing a slight rise of tension in the skull, since that cavity is completely filled with fluid, *e.g.* the cerebro-spinal fluid and blood in the blood-vessels, together with the living brain, which, as has already been stated, is a semi-viscous substance. In the next instant the bullet enters the cavity, and the slight rise of tension is instantly converted by the universal displacement (explosive effect) of the contents, into a very severe rise of pressure, most marked on the side of entry. The lines of force which this pressure takes is shown in this diagram, and it will be obvious to you that these forces will on meeting the rigid skull tend, as I have already shown, to burst it, and if they fail in that, then they will certainly be reflected on to the brain, a matter, as we shall presently see, of special pathological significance. As you see from the diagram, the brain substance must be driven against the internal surface of the globular cranium. This driving of the brain against the hard bone is exemplified in every post-mortem examination. A good instance is seen in the accompanying specimen, in which, although the bullet traversed the extreme tips of the frontal lobe and the olfactory bulbs, numerous bruises are seen on the hinder portions, where they have been crushed against the bone. Similarly evidences of the direct transmission of the pressures are to be found at the base of the brain in the longitudinal fissure, &c., wherever, in short, the brain can be pressed against an unyielding substance. The final proof of the correctness of this interpretation is to be referred to directly, in which the vault of the cranium is removed before the shot, so that the energy of the pressure is expended in ejecting portions of the brain into the air, and not so much on the basal regions, as just described. So, too, the energy of the bullet is communicated in the same way to the fluid in the ventricular cavities (Duret's "choc cephalo-rachidien"), which tunnel the brain down to the medulla oblongata. The medulla oblongata is thus subjected to pressure from two sources: (1) the hydrodynamic displacement of the brain *en masse*; (2) the direct crushing effect due to the movement of the cerebro-spinal fluid in the ventricles.

We are now brought to the aim and object of these preliminary considerations, namely, the reason why these disturbances within the skull cause death, and how the fatal issue is produced; in short, we must pass from the questions of pure physics to the more complex problems of pathology.

(2) *Pathological Considerations.*—The experiments, the results of which I now wish to lay before you, constitute a long series which was carried out last year by Dr. Kramer and myself. We arranged the experiments as follows: A dog was placed under ether, and one femoral artery connected with a mercurial manometer to give record of the heart beats and pressure of the blood in the trunk arteries of the circulatory system. Another similar manometer was connected with the peripheral end of an artery so as to record the changes of pressure in the small capillary vessels, changes which I may remark incidentally are usually due to those disturbances in the central nervous system which we call vaso-motor. Thirdly, the movements of respiration are traced on the recording surface by means of rubber tambours known as Bert's and Marey's, respectively. If the pressure within the skull was also to be recorded, then a steel tube was fixed into a trephine opening filled with the salt solution, and connected by a rubber air-tube also with a Marey's tambour. Occasionally we put on the same paper a record of the contraction of the rectus femoris muscle, this latter being directly connected with a Fick's spring myograph. At the bottom of the tracing is given, firstly, the record of the movements of an electro-magnet signal (Smith's) interrupted by a metronome beating seconds. The last line traced is that from a Smith's signal in the circuit of a single cell, and one of the wires from which is made of very slender brass, and fixed across the muzzle of the pistol or rifle, so that when the shot leaves the muzzle it cuts it and breaks the contact (Woolwich method).

When a bullet of low velocity (600 f.p.s.) strikes the skull in a glancing fashion, there is only a trifling disturbance of respiration, but when the bullet enters the cranial cavity and sets up the powerful hydrodynamic pressure before referred to, a very severe effect is produced, namely, complete arrest of the respiration and a slight fall of the central blood pressure, this causing a similar feeble fall in the peripheral blood pressure. A little later (5-10 secs.) than the arrest of respiration a remarkable rise in the blood pressure occurs, this rise continuing until the normal tension is exceeded. These observations prove beyond doubt that the first cause of death is not what it is usually supposed to be, and as taught in the text-books, namely arrest of the heart and syncope, since, as you see, the heart goes on beating although the respiration has completely stopped. Furthermore, if we quickly perform artificial respiration we obtain recovery from the otherwise fatal arrest.

This suggests very strongly that the police and persons who are trained in giving the first aid to the wounded should be taught that with a gunshot wound of the cerebral hemispheres, the proper thing to do is to employ artificial respiration rather than the giving of stimulants, &c. But, as you may well expect, the matter does not stop here, nor is it so very simple, because we find that there are certain conditions under which the secondary rise of blood pressure does not occur.

It is now quite evident that the fatal phenomena of the gunshot wound of the cerebral hemisphere is in the first instance cessation of the breathing, and I have now to indicate in detail how this is produced by the hydrodynamic disturbance evoked within the skull cavity by the energy of the bullet. It is perhaps necessary to first remind you that the upper part of the spinal cord or medulla oblongata contains the chief centre for the movements of respiration. I would also draw your attention to the fact that therein is also the centre of origin of the vagus nerve, which nerve has the power of slowing the heart. Thus there are two important centres in the medulla which are liable to be affected by changes of tension around them induced, as above stated, when the bullet traverses the cerebral hemispheres in a transverse direction. It may be that the centres are principally affected by the mechanical pressure of the explosive effect, but this latter of necessity produces a certain amount of anæmia of the nerve centres; some of the effect may also be produced by that condition too. Supposing that the artificial respiration has been properly carried out, and the respiratory centre is revived into activity, there is yet another condition to be overcome, without which the animal or person dies, and for a long recognised reason, namely, that the bullet having in its passage cut through various blood-vessels, blood is poured out within the skull, and consequently raises very severely the intra-cranial tension. This constitutes, as a matter of fact, a second cause of death, for under these circumstances the accumulated blood causes such severe compression, that it not only again paralyses the respiratory centre but also irritates the vagus centre, causing a marked slowing of the heart. The proof of the truth of this statement is given at once the moment we cut the vagi nerves, for if these are divided the heart immediately resumes its former rhythm. The next curves are to exhibit the increase in the intra-cranial tension, which occurs the moment the bullet enters the skull. The line drawn by the Marey's tambour shows a violent increase of pressure at the moment of shot (first or explosive effect) and a certain recoil therefrom, this recoil being directly changed for a steady increase in tension brought about by the secondary cause of death, namely, the hæmorrhage, of which I have already spoken. To treat such hæmorrhage only ordinary surgical measures are requisite, but these will be impossible if the activity of the respiratory centre has not previously been restored in the manner already indicated.

To sum up, the basis of scientific discussion of the nature and causation of the phenomena evoked by bullet wounds of the cerebral hemispheres must rest on two principal factors—the velocity of the projectile and the development of hydrodynamic movement in the wet living tissues.

I am glad to have had the opportunity of laying before you the facts on a subject which combines the pleasure of pure physical research with the interest inseparable from the resolution of pathological problems.

GEORGE JOHN ROMANES.

ANOTHER of our not too numerous band of English biological investigators has been taken from us in the prime of life. The list is a heart-rending one, and its full share of sadness surrounds the fate of this last dear friend and companion. Garrod, Frank Balfour, Moseley, Herbert Carpenter, Milnes Marshall—all were younger at death than Romanes, and he only reached the age of forty-six just three days before he died. For some two years his friends have watched with anguish the progress of the disease—a condition of the arteries resulting in apoplexy—which has now ended his pain. Marvellous was the activity of mind and the eagerness with which he pursued his favourite discussions even to the day of his death. Nothing, perhaps, more touching was ever witnessed by those who knew and loved his kindly earnest nature than the calm conviction with which he realised that the hand of Death was laid on him, the pathetic smile with which he would say, as he puffed his cigarette, "Of course my life is only hanging by a thread, and I shall never be able to finish the experiments which would, I think, convince you."

George John Romanes was the son of the Rev. Prof. Romanes, and was born in Kingston, Canada, on May 20, 1848. He studied at Caius College, Cambridge, took honours in the Natural Sciences Tripos (1870), and was Burney Prize essayist in 1873. Having private means, he determined to devote himself to the study of psychology, which he proceeded to attack from two sides —that of physiology, and that of the doctrine of evolution. He further equipped himself for his task by mastering the teachings of modern writers on "philosophy." To contribute to a knowledge of the evolution of Mind was the ultimate aim of his numerous researches and discussions. He was fortunate as a young man in forming an intimate friendship with Mr. Darwin; and it was his ambition not merely to carry the application of Mr. Darwin's methods and principles into the great field of mental evolution, but also to strengthen and, where possible, supplement the Darwinian theory itself. Mr. Darwin assisted Romanes in this enterprise by leaving to him unpublished work of his own on "instinct" and similar subjects.

Romanes first became known to the larger public as a gifted and capable exponent of scientific doctrine by the lecture on "Animal Intelligence" which he gave in Dublin during the meeting of the British Association in that city in 1878. He was subsequently appointed Fullerian Professor in the Royal Institution, and gave numerous lectures both there and at the London Institution. He contributed a series of papers describing his researches on the nervous system of the Medusæ to the *Philosophical Transactions*, and was elected a Fellow of the Royal Society fifteen years ago. His literary activity was very great, and resulted in the publication of several large and well-known books, as well as in numerous essays and short articles of a controversial character published in the reviews and in this journal. His chief books are "Animal Intelligence," "Mental Evolution in Animals," "Mental Evolution in Man," "Jelly-fish, Star-fish, and Sea-urchins," "Darwin and after Darwin," and "An Examination of Weismannism." He had a keen love of public discussion and a native skill in dialectic, which may sometimes have led him to seek too eagerly an argumentative triumph. But his writings bear evidence of the most extensive knowledge and of a conscientious examination of all sources of information, combined with independence of judgment and much subtlety of analysis. The high estimation in which his work is held may be judged of from the fact that all his books have been translated into French and German, and that the book on which he was engaged when the first symptoms of his fatal illness appeared—namely, that entitled "Darwin and after Darwin"—was published simultaneously in the United States and in this country under special conditions highly satisfactory to him.

Four years ago, in order to enjoy greater quietude and the facilities of the newly erected physiological laboratory of the University, Romanes removed from London and took up his residence with his wife and family in a fine old house in Oxford, facing the cathedral house of Christchurch. Here he has left his name and memory not only to be cherished by the numberless friends who mourn his early death, but to be carried forward to all future generations of Oxford scholars by the lectureship founded by him three years ago. Gladstone, Huxley, and Weismann have been the first three "Romanes lecturers" nominated successively by the founder. Hereafter it will be the duty of the University to elect annually a lecturer worthy to follow them.

Whilst it would be premature to claim for Romanes the merit of a great discoverer or originator in psychology or in the philosophy of evolution, it is nevertheless true that by his keen criticism, careful mastery of details, and great literary fertility, he has exercised a most important influence—stimulating the thought and research of others by his example and enthusiasm, and by those contests in the arena of the "reviews" with Wallace, Spencer, and Weismann, which have made his name so widely known.

It is not generally known, though a fact, that Romanes produced, in addition to his numerous scientific writings, a considerable volume of verse, which was printed for private distribution, as well as occasional poems. These poems deal with philosophic and emotional subjects, and are often of great beauty. It should be mentioned (although it is not possible here to record every fact of importance in his life) that Romanes was for some years honorary secretary of the Linnean Society of London, and a member of the Council of University College, London; he was Rede lecturer in the University of Cambridge, an honorary LL.D. of the University of Aberdeen, twice Croonian lecturer of the Royal Society of London, and Rosebery lecturer in the University of Edinburgh, when the courses delivered by him formed the substance of his book, "Darwin and after Darwin."

One word before this too hasty notice is concluded as to his personality. His unaffected good-nature, and almost boyish simplicity and gaiety of character, endeared him to every man and woman with whom he came into contact. He has left behind him numberless friends, not one enemy.

E. RAY LANKESTER.

NOTES.

THE fourth volume of that very useful work of reference, the "Minerva Jahrbuch," which goes to press in July next, is to contain an engraved portrait of Lord Kelvin. If the portrait is as good as that of L. Pasteur, which adorned the third volume, it will be well worth having.

WE regret to note the death of Dr. B. H. Hodgson, at the advanced age of ninety-five. He was elected into the Royal Society in 1877.

DR. S. J. HICKSON, Fellow of Downing College, Cambridge, has been appointed Professor of Zoology in the Owens College, Manchester.

COLONEL LAUSSEDAT has been elected an "Académicien libre" of the Paris Academy of Sciences, in succession to the late General Favé.

THE Société des Arts de Genève have opened a subscription list for the purpose of raising a fund to erect a bronze bust of the late M. Colladon somewhere in Geneva.

THE gold medal of the Linnean Society has this year been awarded to Prof. Haeckel, of Jena, for his important contributions to zoological science.

THE new buildings of St. Thomas's Hospital Medical School will be opened on Saturday, June 9, at 4 p.m., by the President, H.R.H. the Duke of Connaught.

A GENERAL meeting of the Federated Institution of Mining Engineers will be held in the rooms of the Institution of Civil Engineers on Thursday and Friday, June 7 and 8. Arrangements have been made for a visit to Messrs. Siemens Brothers and Co.'s works at Woolwich on Saturday, June 9.

AN international photographic exhibition will be held in Arnhem, Holland, from July 14 to 29. The exhibits will be divided into six classes, one of which will include scientific photographs. Mr. G. S. de Veer is the Secretary of the Exhibition Committee; his address is Velperwege 94, Arnhem, Holland.

THE annual meeting of the Photographic Convention of the United Kingdom will be held in Dublin in July. The President for the year will be Sir Howard Grubb, and the committee of reception includes, among others, the Earl of Rosse, Viscount Powerscourt, the Lord Mayor, and the Astronomer Royal of Ireland. The proceedings will open on Monday, July 9, with a reception and conversazione in the Museum of Science and Art.

IN these columns on March 8 and May 10, we noted the gigantic landslip that had occurred in the Gurhwal district in India, and blocked up the valley of the Bihri Ganga river. The disaster that was expected to result from this has happened. A Reuter's telegram reports that the dam has burst, and the immense volume of water that had been kept back has flooded the district, sweeping away villages, and causing the loss of about two hundred lives.

LAST year was a critical one in the history of the Zoological Society of Philadelphia. We learn from the twenty-second annual report that an effort was made early in the summer to raise a fund by private subscription for the purpose of meeting a large financial deficit. This, however, met with little success, and all hopes of saving the Garden of the Society had been given up, when the Commissioners, who hold the ground upon which the Garden is situated, asked from the City Councils a sum of 10,000 dollars for purposes of maintenance, in addition to the 5000 dollars which had for several years been granted. This sum was promptly voted, the Zoological Society placing in the hands of the Board of Education fifty thousand tickets for free admission of pupils of the public schools to the Garden. This liberal and broad-minded action has prevented the closing of the Garden and the dispersal of the collection.

IN the House of Commons, on Thursday last, Mr. Strachey asked the President of the Board of Agriculture whether it was proposed to repeat the experiment of transmitting the weather forecasts to telegraph offices in rural districts, for exhibition during the time of harvest; and, if so, what were the arrangements to be made for the purpose. In reply, Mr. Gardner said it was proposed to repeat the experiment of last year, and that the counties of Cambridge, Somerset, Carnarvon, the East Riding of Yorkshire, Haddington, and Ayr had been selected for the purpose. The forecasts will be despatched to rural telegraph offices at such periods as will suit the agricultural conditions of hay and corn harvest in the respective counties, and Mr. Gardner hoped that those interested in the matter would supply information as to the results of the experiment, so that it could be determined whether the system was of sufficient utility to justify its continuance and extension. The forecasts are, of course, prepared at the Meteorological Office, which has for many years issued hay harvest forecasts to a limited number of stations, and has had them properly checked by the recipients. The results of these forecasts are regularly published in the Reports of the Meteorological Council, and they show that the percentage of success has been remarkably good in nearly all the districts.

THE weather over these islands has continued very unseasonable during most of the past week; the maximum shade temperature readings have been as low as 55° in many parts, and below 50° at some of the northern stations, while on Tuesday morning, the 29th inst., the minimum shade temperature fell below freezing point in the Midland counties. On the 26th a deep depression was situated over Germany, and caused very stormy weather over the south of England; in London the wind blew from the north-north-west with great force during Saturday night, the pressure amounting to 11½ lbs. on the square foot at Greenwich. The fall of rain which accompanied this disturbance was very great. On the Kentish coast it amounted to over 2½ inches, and more than 3 inches fell at the Helder. Slight thunderstorms occurred in the Midland counties and southern parts of England in the early part of this week.

THE influence of ancient village communities on the map of England is made the subject of an interesting paper by Mr. H. T. Crofton in the last number of the *Journal* of the Manchester Geographical Society. Mr. Crofton reproduces a portion of the six-inch ordnance survey map with the parishes coloured, and thus brings out the curiously complicated manner in which the boundaries are drawn, and the frequency with which portions of one parish are scattered in isolated patches through the neighbouring parishes. In order to explain these curious forms he points out that the ancient village communities of the primitive Celtic people, with their complicated adjustment of arable and pasture land, were not wiped out by the Roman conquerors, but gradually assimilated to the new distribution of property. Thus, acquiring a recognised character, the lands of separate tribes or families retained their ancient names and groupings, and to the present day the parishes of Manchester and its neighbourhood bear witness in their irregular boundaries to the primitive customs of the pre-Roman inhabitants of the land. The question of county and parish boundaries is one so full of interest for the student of primitive populations, that he must be grateful to the proverbial conservativeness of parochial authorities; still, intending students in this interesting field would do well to set to their task speedily before the changing of the old order destroys landmarks which can never be restored.

THE report of the Hydrographer to the Admiralty, published a few days ago, describes the work performed under the direction of the Lords Commissioners of the Admiralty during last year, in the examination and charting of seas and coasts in various parts of the globe. The necessity for accurate surveys on a large scale is strikingly illustrated by the number of rocks and dangers to navigation annually discovered, this number being steadily on the increase, no less than 201, which it has been deemed necessary to notify by notices to mariners, having been reported during the year 1893. Of these, 26 rocks were reported by H.M. surveying vessels; 35 by others of H.M. ships; 22 by various British and foreign vessels; 13 were discovered by vessels striking on them; and 105 were reported by colonial and foreign Governments. Ten vessels were employed in the surveys during the year covered by the report—four on home and six on foreign stations. The English stations were Plymouth Sound, the south coast, east coast, west coast, and the east coast of Ireland. On the west coast of Newfoundland the portion surveyed comprises from Cape St. George to a point 16 miles eastward of Cape Anguille, nearly 100 miles of coastline. An area of about 500 square miles was closely sounded. Of this locality there is at present no chart in which the navigator can place any confidence, and the new work will be especially useful. As might have been expected, a certain number of uncharted dangers were discovered, and no fewer than nine rocks with a less depth of water than five fathoms over them were found round the shores of the bay. A plan of Isthmus Bay, on a scale of 6 inches to the mile, was also completed. Dr. Bassett-Smith accompanied H.M.S. *Egeria*, and during the sounding of the Macclesfield coral bank in the China Sea was enabled to obtain a very valuable collection of corals from the deeper slopes of the bank, special attention being paid to the zone lying between the depths of 30 to 40 fathoms, from which he was able to prepare a highly interesting report on his investigations. The collections have been sent to the British Museum. The Solomon Islands, Queensland, Tasmania and the New Hebrides, and the Mediterranean were also the centres of marine surveys during 1893. The marine survey of India was carried out under the direction of officers of the *Investigator*.

AN ethnographic expedition to the islands of Inishbofin and Inishshark, County Galway, was made by Dr. C. R. Browne in the autumn of last year, and the results of his observations, communicated to the Royal Irish Academy in November, have now been published. A similar expedition was made to the Aran Islands in 1892, and both were undertaken in connection with the Dublin Anthropometric Committee. These local investigations in selected parts of Ireland are as important as the results are interesting. The people visited, on the whole, much resemble the inhabitants on the opposite coast of Connemara, and their appearance testifies to a mixed origin. The average height is 5 ft. 6⅓ in., which falls short of the Irish mean stature as found by Gould, and the Anthropometric Committee of the British Association, by about two inches. Sight and hearing are very acute, and Dr. Browne says that the distance at which the islanders can make out a sail or a bird on the wing is amazing. The proportional measurements of the face and upper limb with reference to the stature differ in some respects, not only from those of the Aran islanders, but also from the accepted canons, and form the proportions obtained by Quetelet, Gould, and others, in their investigations on several European peoples. Though a large proportion of the marriages are consanguineous unions, the uniformity of strain does not appear to have produced any effect except a great similarity of appearance; no cases of malformation or congenital diseases are ascribed to it. Marriages are arranged by the parents from considerations of suitability of families, not, as in many other places, by money bargains. If the bridegroom be the eldest son, who usually inherits the parent's house, &c., the bride goes to live with his family. Sometimes, on the occasion of a wedding, "strawboys" go round with long straw masks on, and if they do not get either money or liquor will threaten to break the windows and furniture of the house. Many other customs are described by Dr. Browne, and his notes on the legendary lore of the islands will be read with interest. The Dublin Anthropological Laboratory is to be commended for extending its work by these local investigations.

THE description of the external anatomy of the brain of a Chinaman, contributed to the current number (part lxv.) of *Brain*, by Mr. C. H. Bond, is noteworthy, for only seven Chinese brains had previously been reported upon. Several decided differences from what is looked upon as the normal are pointed out as existing in the Chinese brains. First of these stands out a greater prominence given to furrows running transversely as compared to those in the antero-posterior direction. As to convolutional complexity, the Chinese brains were up to the normal standard, and in the frontal lobes rather beyond the average. The weight of the brain studied by Mr. Bond was 1182 grammes, that is, 176 grammes less than the weight of an average male adult brain. The proportion of the cerebral hemispheres to the cerebellum was as 5 is to 1. In the case of the average man the proportion is $8\frac{1}{2}$ to 1, and for the chimpanzee it is $5\frac{3}{4}$ to 1. It is pointed out that if the brain investigated was at all typical of the race to which it belonged, then the small size and weight of the cerebrum as compared to the cerebellum is a point worthy of special emphasis. The number which includes Mr. Bond's description also contains the presidential address to the Neurological Society, delivered by Dr. D. Ferrier, F.R.S., last January, his subject being "Recent Work on the Cerebellum and its Relations."

THE current number of the *Journal de Physique* contains a discussion of the metals suitable for the manufacture of standards of length, from the pen of M. C. E. Guillaume. Those of iridio-platinum, originally proposed by M. H. Sainte-Claire Deville, have fulfilled all expectations as regards durability, but the price of the metals brings the cost of a metre rule up to about £400. The conditions to be fulfilled are a comparatively low price, hardness and good polish, constancy of length at a certain temperature, power of resisting moisture and ordinary laboratory chemicals, and, for large rules, a high modulus of elasticity. The condition of constancy excludes all alloys containing zinc. The metals studied by M. Guillaume were nickel, white bronze, aluminium bronze, and phosphor bronze. Ferro-nickel, although much less oxidisable than steel, and harder and twice as rigid as bronze, could not be used owing to its feeble resistance to the action of water. Bars of the above four metals were submitted to repeated heating in steam and cooling. A comparison with standard No. 17 of the Conservatoire gave a shortening of $0\cdot3\,\mu$ (thousandths of a mm.) in the case of nickel, the amounts for the bronzes being 2, 5, and $-0\cdot3\,\mu$ respectively. The nickel was lengthened to the same amount by magnetisation. Phosphor and aluminium bronze were blackened by the steam, and are therefore not suitable. White bronze (consisting of 35 parts nickel to 65 parts copper) was found suitable for engraving a scale on, though it might be attacked by traces of sulphur or chlorine. Contact with mercury only leads to amalgamation after several hours, thus showing a great superiority to silver. Nickel is, on the whole, the most suitable metal. But it is difficult to obtain bars of the commercial metal free from numerous small punctures. Until this difficulty is surmounted, an alloy of equal parts of nickel and copper may render good service at moderate cost.

"THE DANGERS OF MILK" is the title of a useful little article in the April number of *Modern Medicine and Bacteriological Review*. Whilst the boiling or Pasteurisation of milk is advocated, it is pointed out that too much reliance must not be placed on this treatment as regards the entire removal of germs enabling the milk to be kept for any considerable time before use. Spores of bacilli may still be present, which, after some hours, may develop to such an extent that the bacilli may become so numerous as to render it acid and unfit for consumption. It is suggested that people entrusted with the feeding of infants on cow's milk should be supplied with litmus paper, by which the acidity of the milk should be tested before use. An interesting account will also be found in this number of a paper by Dr. Ledoux-Lebard, on the action of light on the diphtheria bacillus. Amongst the conclusions arrived at by the author, we read that whilst the direct rays of the sun arrest the development of these germs, and sterilise the culture medium in a few days, diffused light has no bactericidal action on diphtheria bacilli in *neutralised bouillon*, but has a markedly deleterious action on them when immersed in *distilled water*. Hitherto it has been found that micro-organisms are less sensitive to light in water than in culture media, but possibly Dr. Lebard's results may be explained by the fact that he used *distilled* water, which is well known to act prejudicially in itself on many bacteria.

ON the occasion of the celebration, last May, of the 150th anniversary of the foundation of the American Philosophical Society, Mr. S. H. Scudder presented a paper entitled "Tertiary Tipulidæ, with special reference to those of Florissant, Colorado." This important memoir has now been issued separately, and it will direct attention to the remarkably well preserved and numerous remains of insects, found at Florissant, in a lake deposit supposed to be of Oligocene age. Several hundred specimens of the family of "Crane-flies" or "Daddy Long-legs" have been collected there, and the nine finely drawn plates which accompany the paper completely represent many species. It is remarked that previous illustrations of fossil Tipulidæ rarely represent more than the wings, so that, merely as illustrations of fossil remains, Mr. Scudder's plates far surpass all that have gone before. The new forms described in the memoir number twenty-nine species of ten genera of Limnobinæ, and twenty-two species of five genera of Tipulidæ. No such extensive addition to tertiary Tipulidæ has been made since Loew first indicated the riches of the amber fauna of Europe. A careful study of the remains leads the author to several conclusions, some of which can be expressed as follows:—(1) The general facies of the Tipulid fauna of the western territory is American, and agrees best with the fauna of about the same latitude in America. (2) All the species are extinct, and though the Gosinte Lake and the ancient lacustrine basin of Florissant were but little removed from each other, and the deposits of both are presumably of Oligocene age, not a single instance is known of the occurrence of the same species in the two basins. (3) No species are identical with any of the few European tertiary Tipulidæ. (4) Of the fifteen genera described, eight are not yet recognised among the living, these genera including about one-third of the species. (5) With one exception all the existing genera which are represented in the American tertiaries are genera common to the north temperate zone of Europe and America, and are generally confined to these regions.

THE second part of "The Natural History of Plants," from the German of Prof. Kerner, by Dr. F. W. Oliver, has just been published by Messrs. Blackie and Son.

THE report of the Trustees of the South African Museum for the year 1893 has been distributed. The accessions to the collection during the year included 367 new species, of which two were mammals, eight reptiles, three fishes, six molluscs, and 348 insects.

THE paper on "The Genesis of the Chalk," read by Dr. W. F. Hume before the Geologists' Association in January last, appears in the May number of the Association's *Proceedings*, together with the presidential address on "Geology in the Field and in the Study," delivered by Mr. H. B. Woodward.

THE late Prof. Milnes Marshall's little book on "The Frog," known to be a most concise introduction to anatomy, histology, and embryology, has reached a fifth edition. A note by Dr. Hurst informs us that the preparation of this edition for the printer was Prof. Marshall's last professional act, and was completed only a week before his death.

THE Marlborough College Natural History Society, founded just thirty years ago, has issued its report for 1893. The report chronicles the work of the sections of astronomy, botany, entomology, geology, microscopy, zoology, and meteorology during the year. It also includes an anthropometrical report containing the statistics of weights and measurements of members of the school. This is a feature that other societies in our schools and colleges would do well to take up, for the anthropological information thus collected is very useful.

IT is well known that many amateur photographers send their negatives to professionals to be printed. The Indian amateur, however, has usually to make his own prints, as there are few professional photographers in the far East who undertake the work. To make up for this dearth of available assistance, the *Journal of the Photographic Society of India* reports that the society of which it is the official organ have established a printing department for its members. Though such a departure might be adversely criticised in the case of a British society, it may be pardonable in India.

VOLUMES viii. and ix. of the *Annalen der k. k. Universitäts-Sternwarte in Wien*, edited by Prof. E. Weiss, have recently been issued. The former volume contains the results of meridian observations made at Vienna Observatory during 1886 and 1887, of comet observations made between 1890 and 1892, and of observations for positions of planets, comets, and comparison stars. In vol. ix. are given the zone observations made by Dr. Palisa during 1884 in connection with the Vienna star catalogue. This volume also includes the results of observations of planets during 1890, and meteorological observations made in 1887 and 1888.

MESSRS. J. AND A. CHURCHILL have published a new edition of "Materia Medica, Pharmacology, and Therapeutics," by Dr. C. D. F. Phillips. The work originally appeared in 1882, but was out of print for some years. Dr. Phillips has made numerous emendations and additions in order to bring his book in touch with the present state of knowledge of the physiological and therapeutical actions of remedies. More than usual space has also been devoted to pharmacy. The present volume deals with the actions of inorganic substances, and a new edition of its companion volume on the vegetable, animal, and organic compounds will be published to supplement it.

THE tidal streams round the Isle of Wight can be found at any hour on any day by means of an arrangement devised by Mr. F. Howard Collins, and published by Mr. J. D. Potter. A plan of the island, with arrows showing the directions of tidal currents, is drawn in each of twelve sections of a cardboard circle pivoted at the centre. This circle is capable of being moved round inside another, upon which the hours from one to twelve are marked. When the inner circle has been set to the time on the outer one at which high water occurs at Portsmouth, the directions of the arrows opposite any hour on the latter show the direction of the tide at that hour. Yachtsmen in the Solent and round the Isle of Wight should find the chart useful.

IN the June number of *Natural Science* Dr. A. R. Wallace compares the Palæarctic and Nearctic regions, as regards the families and genera of their mammalia and birds. It has been suggested by several zoologists that these two regions should be united so as to form one new region—the Holarctic—co-extensive with the extra-tropical northern hemisphere. Dr. Wallace finds, however, that the two regions, instead of being so much alike that they should be united to form a single region, are really exceptionally distinct, and that their union would not be an improvement upon Dr. Sclater's system of zoological regions. The journal also contains articles on the distinguishing of sex in ammonites, by Messrs. S. S. Buckman and F. A. Bather; problems in experimental psychology, by Prof. E. B. Titchener; the mode of formation of ground ice, by Mr. R. D. Oldham; the significance of the bird's foot, by Mr. F. Finn; and cell-division, by Mr. M. D. Hill.

THE new series of *Science Gossip* is really an improvement upon the old one. Each month pages are specially devoted to astronomy, notes and queries, science abroad, zoology, geology, botany, and transactions of scientific societies. The articles in the June number include one by Mr. A. T. Tait, on the beautiful dendritic crystals sometimes found on the pages of books. The author remarks that he has never seen a specimen of these arborescent crystals in a book older than 1835 or younger than 1882, and that rather more than twenty years are usually required for their fullest development. He has examined a large number of volumes of foreign origin, but has never discovered any of the crystals upon their pages. The crystals are supposed to owe their formation to chemical action set up by the accidental deposition of minute fragments of copper upon the surfaces of paper during the processes of manufacture or printing, so it is suggested that differences between British methods of paper-making and printing, and those in vogue in America and on the continent, may account for the absence of the crystals.

IN a communication to the Société Chimique, M. Girard explains the interesting fact that when wood charcoal is heated with sulphuric acid, for the purpose of preparing sulphur dioxide, colourless crystals are frequently observed to form. M. Terreil has previously pointed out the occurrence, but without offering any evidence as to its nature. M. Girard now finds that if excess of carbon is used, and the operation is continued until the complete cessation of the evolution of gas, so large a sublimate of the crystals is obtained as to cover the sides and neck of the flask, and to almost obstruct the delivery tube. In order to purify the substance it is only necessary to dissolve it in water, boil until sulphur dioxide is expelled, precipitate any sulphuric acid by the necessary quantity of barium chloride, evaporate to dryness, and recrystallise from alcohol. The well-formed colourless crystals obtained are found to consist of pyromellitic acid, $C_6H_2(COOH)_4$, one of the isomeric tetrabasic acids of the benzene series, and the acid whose anhydride is produced when mellitic acid is heated. Mellitic acid is a substance well known from the fact of its occurrence in combination with alumina in honey-stone. The crystals of pyromellitic acid obtained in the interesting manner above indicated are soluble without decomposition both in boiling sulphuric and boiling nitric acids. Their aqueous solution reacts like an ordinary dilute acid, decomposing carbonates with effervescence. The crystals themselves are efflorescent in the air, and upon heating they volatilise with production of a sublimate of long needles, melting about 280°, and which prove to be pyromellitic anhydride. M. Girard further shows that when sulphuric acid reacts upon wood charcoal which has previously been well calcined at a white heat, or upon coke, no production of pyromellitic acid is observed. On the other hand, substances richer in hydrogen and oxygen than wood charcoal, such as the denser varieties of cellulose, yield it in relatively large quantities. It appears, therefore, to be produced by the action of sulphuric acid upon that portion of the wood charcoal which is least carbonised and retains a larger proportion of hydrogen and oxygen. Now it is well known that pyromellitic acid may be obtained by the action of sulphuric acid upon mellitic acid. M. Verneuil has recently shown, while these experiments of M. Girard were in progress, that when sulphuric acid acts upon wood charcoal a certain amount of mellitic acid is produced. It is therefore practically certain that by the action of sulphuric acid upon wood charcoal, in addition to the production of the gaseous dioxides of sulphur and carbon, mellitic acid is produced which in turn is converted by a further quantity of sulphuric acid into pyromellitic acid, and the latter is deposited in crystals in the cooler portion of the flask in which the reaction occurs.

THE additions to the Zoological Society's Gardens during the past week include two Brown Capuchins (*Cebus fatuellus*, ♂ ♂) from Guiana, presented respectively by Mr. Charles Gordon Frazer and Miss Florence Marryat; two Four-horned Antelopes (*Tetraceros quadricornis*, ♂ ♂), from India, presented by Mr. W. F. Sinclair; four common Swans (*Cygnus olor*), British, presented by Lord Braybrooke; two Jameson's Gulls (*Larus novæ-hollandiæ*), from Australia, presented by Sir Ferdinand von Mueller, K.C.M.G.; two Hoary Snakes (*Coronella cana*), a Crossed Snake (*Psammophis crucifer*), an Infernal Snake (*Boodon infernalis*), from South Africa, presented by Mr. J. E. Matcham; two Natterjack Toads (*Bufo calamita*), British, presented by Miss Peckham; three Stock Doves (*Columba œnas*), British, presented by Mr. Lionel A. Williams; a yellow-cheeked Amazon (*Chrysotis autumnalis*), from Honduras, two Alligator Terrapins (*Chelydra serpentina*), from North America, deposited; a White-bellied Sea Eagle (*Haliætus leucogaster*), two Wonga-Wonga Pigeons (*Leucosarcia picata*), from Australia, purchased; a Reindeer (*Rangifer tarandus*, ♀), a Japanese Deer (*Cevous sika*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

SUN-SPOTS AND WEATHER.—The first part of vol. vi. of "Indian Meteorological Memoirs" (Calcutta, 1894) contains a paper by Mr. W. L. Dallas, Assistant Meteorological Reporter to the Government of India, on the relation between sun-spots and weather, as shown by meteorological observations made on board ships in the Bay of Bengal during the years 1856 to 1879. The region selected offered peculiar advantages for such inquiry. The annual periodic changes in it are small, and the aperiodic changes are very slight. There is also comparatively little horizontal air motion, and, being a sea surface, the area is not liable to the sudden changes which affect a land observatory, and result from irregularities in the elevation of the land surrounding an observatory. The discussion of the pressure observations shows that there are certain points of similarity between barometer readings and the number of spots on the sun. The number of years during which the number of sunspots exceeded the normal average coincides with the number of years during which the pressure was below the average, and *vice versâ*, while the maximum pressure differences, whether above or below the average, occur one year after the maximum sun-spot variations in both directions. The same general agreement is disclosed by the discussion of temperature observations, but here again there is the same want of exact relation. In the case of pressure the curves show that a defect of pressure prevailed during the years in which the relative number of spots was excessive; and an excess of pressure during the time they were at or about their minimum. So in temperature, it appears from Mr. Dallas' investigation, that there exists a general defect when the number of spots is low, and a general excess when the number of spots is high. The indications are, therefore, that years of maxima and minima in a solar cycle are also years of maximum and minimum solar radiation.

Another paper on sun-spots and weather has also recently been received (*Bulletin de la Société les Amis des Sciences et Arts de Rochechouart*, 1894), the author being Prof. J. P. O'Reilly. By extracts from the annals of Ireland (*Annala Proghacta Eireann*) and those of Ulster (*Annala Uladh*), it is shown that remarkable years of dryness and of cold in Ireland and in Europe are connected with the cycle of solar activity.

EPHEMERIS FOR TEMPEL'S COMET.—The following positions are extracted from the search ephemeris for Tempel's comet, given by M. Schulhof in *Astr. Nach.* No. 3219:—

Ephemeris for Paris Midnight.

1894.		R.A.		Decl.
		° ′ ″		° ′
June 2	...	1 0 16	...	S. 0 22·8
4	...	5 58	...	S. 0 3·9
6	...	11 37	...	N. 0 14·5
8	...	17 11	...	0 32·3
10	...	22 41	...	0 49·6
12	...	28 8	...	1 6·3
14	...	33 31	...	1 22·4
16	...	38 49	...	1 37·9

The comet is not in a good position for observation, but it may possibly be picked up in the east shortly before sunrise.

JUPITER'S SATELLITES IN 1664.—Under this head we reprinted, on February 1, a letter from the New York *Nation* upon a supposed observation of five satellites of Jupiter, made by John Winthrop in 1664. The note led Mr. Frank H. Clutz to determine whether there was any "fixt starre with which Jupiter might at that tyme be in neare conjunction" (*Johns Hopkins University Circular*, May). He finds that the date of observation in our present reckoning was August 16, 1664, and on that date the star B.A.C. 6448 (R.A. 18h. 46m. 55·6s. Decl. – 23° 21′ 33″·04) was at a distance from Jupiter of about 10′·5, which is approximately the distance that the outer satellite may reach. In brightness the star is about the same as the three smaller satellites—between the sixth and seventh magnitudes. Mr. Clutz thinks, therefore, that this star was the object which Winthrop took for a fifth satellite.

ANNIVERSARY MEETING OF THE ROYAL GEOGRAPHICAL SOCIETY.

THE report of the Council of the Royal Geographical Society was presented at the annual meeting on May 28. The total number of Fellows at May 1 was 3775, a net increase of 29 during the year.

The President and Council for the ensuing year were ballotted for and elected. The principal changes are the retirement of the honorary secretary, Mr. D. W. Freshfield, and the retirement from the Council by rotation of Mr. Francis Galton, Generals Sir W. D. Jervois, J. T. Walker, and Sir Charles Wilson, and Mr. Delmar Morgan. Mr. Clements R. Markham was re-elected as President, the Hon. G. N. Curzon was added to the list of Vice-Presidents, Sir John Kirk was elected Foreign Secretary, and Major Leonard Darwin to co-operate with Mr. H. Seebohm as Secretary. The following new Councillors were elected:—Dr. Robert Brown, Right Hon. Hugh Childers, General Goodenough, Lord Lamington, Admiral A. H. Markham, Admiral E. H. Seymour, and Colonel J. K. Trotter.

The Society's medals were presented in the absence of their recipients, Captain Bower and M. Reclus; the minor awards, already announced in NATURE, were also given, and a series of educational prizes to students from the training colleges.

The President then delivered his annual address, reverting from the recent custom of dealing with the progress of geography during the year to the earlier practice of devoting special attention to some prominent features of exploration.

The greater part of the address was devoted to the polar expeditions of the present year, the facts regarding which have already appeared in NATURE. Mr. Markham is a high authority on Arctic travel, and his views will carry much weight. He professes a strong preference for large expeditions organised by government, and commanded by naval officers, believing that men combining high scientific attainments, great experience of ice-navigation, and the rare qualities of a leader of men, all of which are necessary for a great polar explorer, are seldom to be found except in the service of a government with a wide range of selection. Still he would encourage all enterprise and every carefully planned expedition, on however small a scale. Without expressing any confidence in the correctness of Nansen's theories, he felt no doubt as to the great scientific results which must accompany his journey. With regard to Mr. Jackson's projected exploration in Franz-Josef Land, Mr. Markham did not favour Austria Sound as the best approach to Petermann Land, and he pointed out the drawback of the winter quarters of the expedition being so far south as Eira Harbour, between which and the point where really new ground can be broken, there intervenes a space of nearly 200 miles to be traversed each season; but with wise management and favourable conditions of ice and weather, a good measure of success appeared quite possible. In his scheme for retracing Parry's footsteps north of Spitzbergen, Mr. Wellman transgresses the best established canon of Arctic travel, which is never to enter the drifting pack away from land; but as he has started early, Mr. Wellman may possibly enough beat the record of the farthest north, a motive which was deprecated by the Austrian explorer, Weyprecht, as the bane of good Arctic work. Little service to geography is to be looked for from this expedition, unless there are islands north of Spitzbergen which may be explored. In speaking of Mr. Peary's journeys in the north of Greenland, Mr. Markham said: "For my own part, I look upon Peary as an ideal explorer. He chose one of the greatest and oldest of the geographical problems that remain to be solved, and he set to work as if he really intended to find the solution. Every detail of equipment was thoughtfully considered, gear was tried and tested before being used, a brilliant preliminary journey over the inland ice was made. All was done in the workmanlike style of a true discoverer. I therefore believe that Peary will succeed. I am sure that he deserves success." There is, in Mr. Markham's opinion, ground to hope that Björling and Kalstenius may be still alive; "the two Swedish lads are the stuff of which heroes are made, and every civilised people must be interested in their rescue." Want of funds has prevented a search expedition from being sent out, and the two Swedes who have left for Ellesmereland trust to be landed there by the good offices of whalers. No efforts on the part of the Council were spared to inaugurate a great Antarctic expedition, the promotion of which is now under consideration by the Royal Society.

In the evening the anniversary dinner of the Royal Geographical Society was held in the Whitehall rooms of the Hôtel Métropole.

THE MAGNETIC DEFLECTION OF CATHODE RAYS.

THE current number of the *Electrician* contains a translation of a very interesting paper by Herr P. Lenard, on the deflection of the cathode rays by a magnet. It is well known that when the cathode rays traverse a magnetic field they are deflected from their otherwise rectilineal path, and in the form of tube ordinarily employed this deflection increases with an increase in the pressure of the residual gas in the tube. In this particular the cathode rays behave just like a current of negatively charged particles projected from the cathode. The paths of such particles would be curved in a magnetic field, and the curvature would increase with a decrease in the speed with which the particles travel, *i.e.* they would be more curved in a denser and more resisting medium. The above explanation is not in accord with the results of the experiments the author has made, and which have led him to consider the cathode rays as phenomena in the ether. In fact, the author finds that when the observation tube and the tube in which the rays are generated, are separated by a gas-proof aluminium partition, so that the gaseous pressure can be varied in the two tubes independently, that the above explanation entirely fails, and that everything confirms his previous view that these rays are phenomena in the ether, and not electrically charged particles. For instance, if the pressure of the gas in the discharge-tube be kept constant, while that in the observing tube be lowered from 33 m.m. to 0·021 m.m. it is found that the deflection produced remains constant. Higher pressures than 33 m.m. could not be employed, as under these circumstances the medium became so turbid to these rays as to entirely destroy all definition in the phosphorescent spot. If, however, the pressure of the gas in the observing tube be kept constant, while that in the discharge tube is varied, a marked influence on the position of the deflected spot is at once observable. Thus, if the pressure is altered so that the sparking distance in the discharge tube changes from 2 cm. to 4 cm. there is an alteration in the deflection of from 12·2 m.m. to 8·5 m.m. Thus it would appear that the difference in the deflection observed with varying gas pressures in the ordinary form of tube is not caused by difference of the medium in which the deflection is observed, but in the difference of the rays themselves, which are produced with varying pressures of gas. A curious deformation in the shape of the deflected phosphorescent spot was observed, for while the undeflected spot was always circular in form, the distribution of light being dependent on the turbidity (*i.e.* density) of the gas in the tube, in very turbid gases the edge of the spot is undefined. If the gas becomes rarer there appears in the centre of the spot a more or less sharply defined kernel, surrounded by a less bright penumbra. After deflection the spots become elliptical in shape, which may be due to the fact that the rays no longer met the screen at right angles, but when the gas was so rarefied that there was a central bright spot and a penumbra, the appearance of the spot was subject to sudden changes. While the position and shape of the central spot remained constant, the penumbra changed both in shape and position, sometimes even being quite separate from the bright spot. The penumbra was in every case more deflected than the bright spot, thus showing that the penumbra contains rays of greater deflectibility than the core, but never of less. This is borne out by previous experiments, which had shown that it is the rays that are most easily diffused that are most deflected.

SOME LONDON POLYTECHNIC INSTITUTES.[1]

II.

ON account of a mistaken idea as to the true end of education, the object of technical instruction is often defeated. Many young operatives take up courses of study in order that they may become clerks in manufactories where technical knowledge is desirable. This notion causes the ranks of the mechanic class to lose many of their brightest men, while the supply of clerks increases. What has to be impressed upon the minds of students in trade classes is that the object of the instruction is to enable them to perform their duties in a more efficient manner, not to remove them from one sphere of life to another. This point was very well expressed by Sir Benjamin Baker at the beginning of this year, in presenting the prizes and certificates to students at the People's Palace. "It is necessary," he said, "for teachers and students alike to remember that a certain amount of scientific or theoretical knowledge in the future, still more than in the present, must be considered as an indispensable element of success in the great battle of life, but not as a thing having necessarily any more market value in itself than a knowledge of reading and writing, nor must the facilities in acquiring knowledge now enjoyed by students be carried to such an extent as to incapacitate them from acting in an emergency promptly and reliantly without help from books or professors, or the benefits of scientific and technical education would be too dearly bought, and the self-education system of our predecessors would turn out the better men."

The People's Palace owes its existence almost entirely to the Drapers' Company. In the year 1890 this company took the entire management of the educational work, which was carried on under the supervision of Mr. William Phillips Sawyer, the clerk to the Company. Two years later, on the Drapers' Company having offered an annual contribution of £7000 to the Palace, a new scheme was drawn up by the Charity Commissioners, which provided for an annual grant of £3500 from the City and Parochial Charities' Funds, in addition to the Drapers' Company's contribution, and a new body of Governors was formed, of which the Master of the Drapers' Company acts as chairman. This body, besides representatives of the Drapers' Company, consists of members appointed by the London University, the London County Council, the London School Board, the Trustees of the City and Parochial Charities' Funds, and the Lord President of the Council.

The educational work consists of (1) the day technical

[1] Continued from p. 90.

school, under the management of Mr. D. A. Low, head master, which is largely recruited from the public elementary schools, and to which the Drapers' Company have contributed yearly £1000 to be expended in scholarships. (2) The evening classes, under the management of Mr. J. L. S. Hatton, Director of Evening Classes.

The evening classes are conducted with a view to giving students a practical and theoretical knowledge of the arts and sciences, and to prepare them for the examinations of the Department of Science and Art, the City and Guilds of London Institute, and of the Society of Arts. It will be concluded, therefore, that instruction is given in a large number of subjects; in fact, the time-table includes more than fifty classes in pure and applied sciences, and further, the Governors offer to consider the formation of classes in any similar subjects provided a sufficient number of students offer themselves for admission. Thus the subjects taught at the institution are those for which there is a demand. It would hardly be expected that purely scientific subjects would be in favour in the East End of London. The object of the majority of the students in such a district must be a desire to command better wages as workmen rather than the simple pursuit of knowledge. Some, however, are actuated by a higher spirit. Among the classes conducted by Mr. Hatton is one on the differential and integral calculus, another on analytical conic sections, and a third on the theory of determinants. And many, if not most, of the students of these subjects are not pupil teachers merely aiming at the obtaining of a certificate and nothing more, but young men who after passing their days in grimy workshops find recreation in mathematical exercises of no mean order. It is such ardent spirits as these that bring credit upon the institutions assisting in their development, not the mercenary "pot-hunter."

Strange as it may appear, there are numbers of young men in London who are unable to pay the small entrance fees to classes at these institutes. While at the People's Palace a short time ago, the writer had pointed out to him a young mechanic who, though he had been a student, found himself in circumstances so low that he could not pay the entrance fees for the classes in which he desired to continue his studies. He pleaded with the Director of studies for free admission, and, it need hardly be said, his request was granted. That young man is now in his seventh heaven of delight, for he attends classes six nights a week, and revels in the privilege that has been extended to him. To all who are desirous of democratising knowledge, this case —and it is not an isolated one—must appeal very strongly. The man who wishes to work but finds his labour unwanted is an object of everyone's sympathy. But his claims for assistance are no stronger than those of the man who craves for knowledge and has not the means of attaining his desire. The London Polytechnics are doing an excellent work by reducing the tolls that for many years barred the ways of wisdom. But though the fees to classes represent only a small part of the income of these institutions, it is doubtful whether any very great educational advantages would accrue from their abolition. "That which is easily gained is lightly prized," is an old saying and a true one, and if all students were admitted free to Polytechnic classes, they would possibly not appreciate the instruction so highly as they do at present. Perhaps the best way to meet the case of poor students would be for private benefactors to bestow a small sum upon Polytechnics for the purpose of paying their fees. It is not suggested that these free studentships should be competed for, but that they should be obtainable by any who desired to join classes, and were prevented by the inability to pay the fees; provided only that the Director of studies satisfied himself as to the poor circumstances of the applicant.

The engineering department at the People's Palace is under the control of Mr. Robert Holt. Students are permitted to enter any of the classes in engineering subjects, but are always strongly advised to take up theoretical courses at the same time. For the first year the subjects thus recommended are mathematics, geometry, and machine construction; for the second year, more advanced mathematics, geometry, and machine construction, with theoretical and applied mechanics and steam; while third-year students take still higher developments of mathematics, machine construction, steam, and applied mechanics, and also mechanical engineering. It will be seen, therefore, that by following this line of study a theoretical training is obtained which must be of the greatest advantage in the engineering workshop. Only when a knowledge of theoretical principles is regarded as an essential qualification for entrance into the workshop, can the teaching be sound, and when this is more generally recognised among engineering students we may expect to see some results of technical education.

For some time Prof. Holt had in his mind a scheme for the erection of a machine shop, a pattern-making shop, a smithy, and an experimental workshop, but the necessary funds were not available. It has just been announced, however, that the Drapers' Company, supplementing their former benefactions, have voted the sum of £4000 for the erection of a new engineering laboratory with workshops.

The creation and extension of workshops such as exist at the People's Palace for various trades will do much to bring the workmen to a higher degree of efficiency. But in order to discover if the teaching is suitable for the students, and whether they make satisfactory progress, it is necessary from time to time to hold examinations which completely cover the work done. At present, however, there is only one general examination in technical subjects, namely, that of the City and Guilds of London Institute, which covers only a small range of the subjects usually taught, classes of such importance as those in practical engineering and practical carpentry finding no place in this examination. To remedy this defect, the educational committee of the People's Palace have taken steps to form a joint examination board of the London Technical Institutes. It is proposed that the examination consist of three parts :—(1) An inspection of practical work certified to be the unaided work of

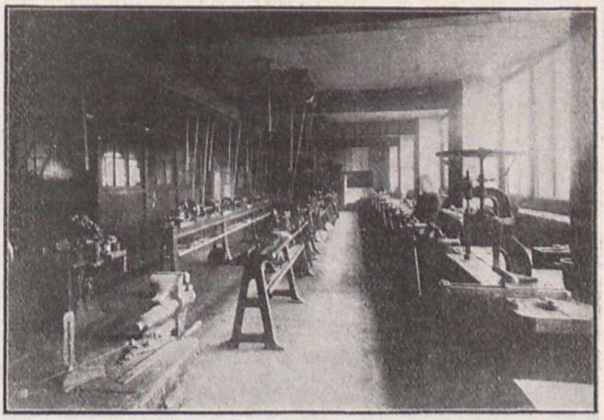


FIG. 3.—Engineering Workshop of the People's Palace.

the student; (2) a *viva voce* examination; (3) a written examination. The intention of the committee is to make the examination more a mechanical qualifying one than one of general technical theoretical character, as will be gathered from the subjoined extract :—

"It is proposed to lay more stress on the *viva voce* part of the examination than is usually done, for the following reasons. It has been found that one of the great difficulties in conducting an examination on the above basis is to place the workman—unaccustomed to express himself in writing—on an equality with the clerk, who has not the same practical knowledge and experience. On paper, the workman frequently finds himself defeated by the clerk, and consequently looks with suspicion on such examinations as the City and Guilds, the results of which he, with justice, considers to be no just criterion of the merits of the candidates. In our Universities, in olden days, *viva voce* and written examinations were held concurrently, so as to afford those who had no facility for expressing themselves in writing an opportunity of showing the extent of their knowledge. With the advance of learning and the ever-increasing opportunity for expressing oneself in writing, the need of the *viva voce* examination at the University has died away, and it is at present little more than a useless formality. In the case of the workman, however, who has the greatest difficulty in expressing himself on paper, it is eminently desirable to revive the old system."

Examinations conducted in this manner have already been carried out at the People's Palace with some success, and it certainly seems desirable to extend them. After all, the majority of the students in Polytechnics desire certificates which guarantee that the holder, when applying for work, is a thoroughly competent workman. By enlisting employers of labour, and representatives of various trades, as examiners, the work done is truly tested from a practical point of view, and the certificates awarded by them is of use in obtaining employment. In all probability there will be a difficulty in arranging a joint examination board on the lines suggested by the People's Palace committee, but however this may be, it seems desirable that some provision should be made for determining the amount of directly useful knowledge obtained in the Polytechnic workshops.

Before passing to another Polytechnic, a few words must be said with regard to the extent of the work carried on at the People's Palace. The number of class tickets issued for the current session is 7408. Such subjects as light, sound, physiology, botany, and physiography attract comparatively few students, the reason evidently being that they do not directly bear upon industries. Though we cannot but regret this lack of interest in subjects most of which are necessary for a proper scientific education, it is not strange that in the East End, where the battle of life is so keen, people should only be interested in matters which they think may assist them to earn a living. Engineering subjects are greatly favoured, as many as 300 students attending the class in machine construction and drawing. The average attendance each evening at classes in all subjects is about nine hundred.

Dr. Macnair, who until recently was the head of the chemistry department, made that branch of science very popular among students, and Dr. Hewitt, who has succeeded him, will doubtless sustain the character of the work. The research laboratory, which it is proposed to arrange, will help to this end.

We come now to the Battersea Polytechnic Institute, formally opened last February. The Institute has been built and equipped at a cost of nearly £53,000, the greater part of which was raised by voluntary subscriptions. It is at present in possession of a fixed endowment of £1500 per year, but this will be raised to £2500 when the sum of £60,000 has been collected. As only £2200 is now wanted to complete this figure, the Institute will probably soon be in possession of the further endowment. The London County Council will also eventually contribute to the Institute an annual sum estimated to amount to about £1500. The Institute contains workshops for various trades, physical and chemical laboratories, and numerous rooms for classes and lectures. Instruction is provided in technological subjects, in general science; art, including wood-carving and metal chasing; music; and in commercial and general education. The principal is Mr. Sidney H. Wells, and Dr. W. E. Sumpner is the head of the electrical engineering department. Mr. S. H. Davies has charge of the chemistry department, and Mr. W. E. Walker carries on the engineering work in conjunction with Mr. Wells.

For the first time in the history of London Polytechnics, the Governors appointed a Principal, and by selecting for the post a man in whom theoretical and practical knowledge are happily combined, they did their best to secure a well-balanced scheme of instruction. Without expressing an opinion upon the advisability of putting each Polytechnic under the control of a Principal, we would point out that an educational head who teaches is bound to be prejudiced in the direction of his special branch of study to the detriment of other branches. By placing at the head of affairs a man who is not a specialist, and properly arranging each department of the educational work under a competent head, each branch is sure of its right share of attention. At the Goldsmiths' Institute there are ten departments, each under a head who, with Mr. Redmayne, arranges the details of work. The system has been proved to work well, and there is no friction between the departmental heads and the head of the Institute, owing doubtless to the fact that they feel that he is not unduly prejudiced in favour of any one department. The system of putting the whole Institute under a Principal is being tried at Battersea. Time will show whether this manner of control, or that adopted at New Cross, best furthers the interests of all branches of an Institute's work.

A few remarks with regard to the lines adopted at Battersea should be of interest. The Battersea Institute is open to persons

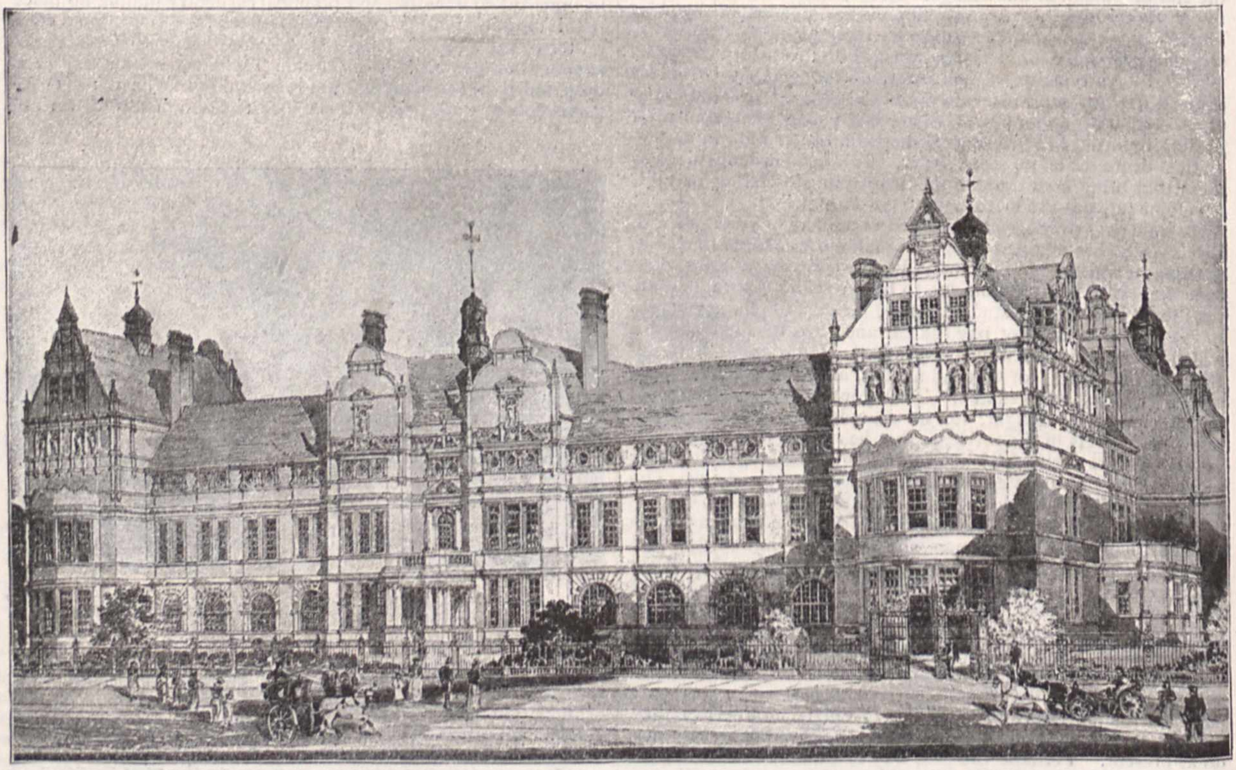
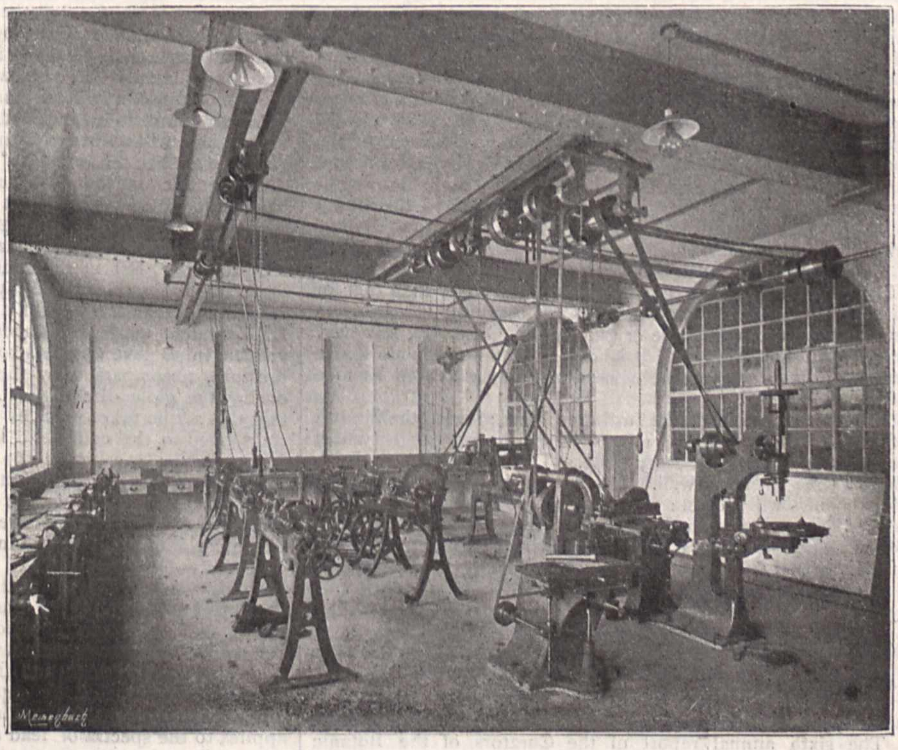


FIG. 4.—The Battersea Polytechnic Institute.

of either sex, without limit of age, who are students of any class in it. Persons who wish to join a trade class are required to satisfy certain conditions before permission is granted them. There is a reason for this stipulation. By attending a course in a trade subject, it is possible for men to become dexterous enough to do jobbing work without serving an apprenticeship in that trade. This is not only detrimental to the interests of the skilled workman, but it also encourages inefficient labour, for though the way to do a thing may be picked up in a workshop course, the way to do it well can only come by practice. In order to prevent this rapid manufacture of workmen, many Polytechnics in the provinces make each trade class a close preserve for the instruction of apprentices and workmen belonging to that trade. Thus, a carpenter would not be permitted to join a class in bookbinding. Something can be said both for and against this preservation. There is the possibility that the smattering of knowledge obtained in a Polytechnic workshop may be thought by some sufficient to qualify as a workman, but this is very doubtful. On the other hand, if a person wishes to learn it seems a pity to place any barrier in his way. Many young men are apprenticed to trades for which they have no taste whatever, and an institute which enables them to follow their inclination is doing a good work.

Membership of the Institute is open to any student between sixteen and twenty-five years of age, upon the payment of a nominal fee. Among the privileges to which members are entitled are: admission to ordinary evening classes, lectures, and entertainments at reduced fees, use of reading-room, and facilities for joining clubs and societies. This system of membership is calculated to develop an *esprit de corps* among the students, which will do much to make the Institute a success. Only by such means can a Polytechnic earn the title of a People's University. The establishment of these institutes has certainly put an end to many small science classes, and objections have been raised to this concentration of work. Teachers who for years have shown the "young idea" how to pass South Kensington examinations, have found their occupation gone when such an educational and social centre as now exists at Battersea has been started. But while everyone condoles with the teachers upon their misfortune, we must point out that the mode in which most sporadic classes under the Department of Science and Art are carried on is capable of improvement. Usually a teacher rushes to his class-room, gives an hour's instruction, and then leaves the students until the following week. A Polytechnic Institute, however, is looked upon by the students in it as their *alma mater*. The teachers are generally in the building ready and willing to help the inquiring mind, instead of being merely periodic visitors.

The classes at the Battersea Institute are chiefly intended for persons engaged in earning their own livelihood. Special courses at reduced fees are arranged applicable to various trades and industries, and students are strongly urged to take these courses in preference to single classes; indeed, everything is done to give the students a thorough and scientific education. In order to encourage students to take up mathematics, the fees in that subject are lower than for any other science or trade class. Some inducement of this kind is necessary, for very few workmen recognise that mathematics is a subject of immense importance, and forms the groundwork of all applied sciences. An excellent departure from stock subjects is the formation of a class in technical mensuration, in which the needs of students attending the trade classes are met, and engineers, builders, plumbers, bricklayers, masons, carpenters, joiners, and other operatives are taught the application of mensuration to the practical problems which occur in their work. Another class worthy of special mention is one in graphic statics, designed to teach the application of graphics to architectural, building, and engineering construction. A course of experimental work is carried on in a fine mechanical laboratory, only those who possess a knowledge of elementary mathematics, mechanics, and drawing being admitted to it. The electrical department, under Dr. Sumpner, is provided with a well-equipped laboratory, and the electric lighting plant of the Institute is available for experimental purposes. The chemical laboratory is also well-equipped and arranged. Altogether, we are of opinion that the Battersea Institute has started well. Its sphere of usefulness is limited for want of a larger endowment than it at present possesses, but doubtless further funds will be received when the important work it is doing for the quarter of a million inhabitants of south-west London is more widely known.



From a Photograph by Russell & Sons, 17, Baker Street, W.

FIG. 5.—Engineering Workshop of the Battersea Polytechnic Institute.

This survey would not be complete without a few words on the admirable day schools in connection with these institutes. Until recent years there were no facilites for the education of boys who had passed through public elementary schools, and desired further training in preparation for the workshop and manufactory. Continuation schools, such as those at Battersea Polytechnic, the People's Palace, and the Goldsmiths' Institute, supply the needful knowledge of science and technology, and, at the same time, carry on the subjects of general education. They represent a most important rung in the educational ladder, and every encouragement should be given to them.

At Battersea the same teachers conduct the day and the evening classes. The Institute thus possesses a permanent staff, all the members of which give the whole of their time to the work. There can be no doubt that this system of organisation is far preferable to that in which visiting masters are employed.

It may be well to briefly state the conclusions to be drawn from an examination of the work of London Polytechnics. In the first place, the funds at the disposal of the Institutes are usually not sufficient to permit the educational needs to be properly supplied. In order to supplement the sum arising from endowment, grant-earning classes have to be held, which means that subjects come to be considered for what they will bring to the Institute's exchequer rather than for what they are worth. The Technical Education Board of the London County Council have taken steps to remedy this evil by contributing maintenance grants, and capital grants for equipment, apparatus, &c., the former being allotted according to a scale calculated to promote educational efficiency, and regularity of attendance. The Department of Science and Art, and other Examining Bodies, should consider the advisability of treating Polytechnic Institutes in a similar manner, instead of regarding them as mere collections of classes. The less an institute of this kind depends upon payment by results, the more likely is it to develop in the proper direction.

Very little provision is made in the institutes for really advanced work or research, but this will probably come, for in London, technical education is only in its experimental stage. Many years of work will have to be done before any London institute will be able to find students for instruction of such an advanced character as that given in continental Polytechnics. Mr. Ll. Smith recommended, in his report to the London County Council, that a grant should be made "towards the maintenance of an advanced department of applied science, bearing on some local industry, under the control of a well-qualified instructor who gives all his time to the work of the institute." The Technical Education Board have promised a contribution for this purpose when a Polytechnic desiring it shall have drawn up a detailed scheme of work, and the Board is satisfied that the proposed class will be of value to the industries of the district.

As to the recreative side of the institutes, little need be said. The desire for physical exercise is so much stronger than that for mental development, that there is a possibility of recreation swamping education in one or two cases. Generally, however, the two sides are very well balanced, and admirably assist one another in the development of men of thought as well as men of muscle.

For the rest, Polytechnic Institutes have aroused the interest of the working class, and men now realise the necessity of a scientific grounding for every trade. To have done this in so short a time promises well. In a few years, perhaps, London Polytechnics will be able to compare favourably with those in other European capitals, and when that day arrives a generation of workmen will have sprung up which, for aptitude and efficiency, should be able to hold its own against the world.

R. A. GREGORY.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. V. H. Veley and Mr. G. C. Bourne have been appointed Examiners for the Burdett-Coutts Scholarship.

The sixth annual report of the Curators of the Botanic Garden shows a deficit of nearly £200 on the close of the financial year. This is due principally to the decrease of income derived from rents and profits of estates. The Curators report that the existing endowment is inadequate to maintain the Garden, and that it will be necessary to call on the University at no distant date, to consider whether a moderate annual subvention should not be made to place the Garden on a satisfactory basis. The deficit would have been greater but that the Professor of Botany has made, *proprio motu*, a contribution of £50 towards the funds of the Garden. The new range of glass-houses, including the palm house and the succulent house, has been completed and proves satisfactory.

Elections to Scholarships in Natural Science will be held at the following Colleges:—Balliol College, examination to begin on November 20, a scholarship in Natural Science worth £80 a year, on the foundation of Miss Hannah Brakenbury. Balliol, Christ Church and Trinity College. At Balliol two Scholarships of the value of £80 a year and one Exhibition of the value of £40 a year. Christ Church, one Scholarship of the value of £80 a year and one Exhibition of the value of £85 a year. Trinity College, one Scholarship of the value of £80 a year. The examinations for these Scholarships will begin on Tuesday, November 20.

CAMBRIDGE.—Dr. Bradbury, the Downing Professor of Medicine, has appointed as his assistant in Pharmacology Mr. C. R. Marshall, Research Fellow of Owens College, Manchester.

The Rede Lecture will be given in the Anatomy School by Mr. J. W. Clark, Registrary, on June 13 at noon. The subject is "Libraries during the Middle Ages and the Renaissance."

A considerable number of courses in scientific subjects, including Chemistry, Mineralogy, Geology, Anatomy, and Pathology are announced for the ensuing Long Vacation, which is more and more assuming the character of a regular term.

No less than twenty-three women are announced as having "deserved Mathematical Honours" in Part I. of the Mathematical Tripos.

By the election of Dr. Hickson to the Professorship of Zoology at Owens College, Manchester, a vacancy is created for a University Lecturer in Invertebrate Morphology.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 5.—On the measurement of surface tension of water and mercury in capillary tubes, by G. Quincke. In accurate measurements of the surface tension of water by elevation in capillary tubes the marginal angle must be taken into account. It is different from zero, and generally increases with the age of the tubes. For the same kind of glass the surface tension of water at 18° is generally found to increase with the diameter of the capillary tube. For wide tubes of normal Jena glass or English flint glass the surface tension at 18° was 7·846 and 7·776 mgr.—On the magnetic deflection of cathode rays, by Philipp Lenard. The magnetic deflection is not affected by the medium in which the rays are observed, but remains the same for a given species of cathode rays, whatever may be the gas, the intensity, and the pressure. But at different pressures within the generating apparatus different cathode rays are produced, showing varying amounts of deflection.—On a sodium-nitrogen compound, by L. Zehnder. Sodium mirrors deposited electrolytically in vacuum tubes gave rise to strong absorption and rapid fall of pressure, accompanied by the formation of a brown mirror during the glow discharge. A detailed investigation showed that this action takes place as soon as metallic sodium has been transferred to the cathode. The compound formed, probably NNa_3, is not deposited on the cathode, but on the glass walls near the anode.—On the elliptic polarisation of reflected light, by K. E. F. Schmidt. In the case of glasses of equal refractive indices and different dispersive powers the glass with the higher dispersion shows the wider range of angle at which ellipticity is observed.—On the spectra of tin, lead, arsenic, antimony and bismuth, by H. Kayser and C. Runge. The authors have continued their efforts to find uniformities in the structure of the metallic line spectra through the periodic series of the elements. The above metals were taken as convenient representatives of the fourth and fifth rows. The spectrum of tin may be reconstructed by superimposing three equal spectra differing by a constant oscillation frequency. The same law applies to the spectra of lead and arsenic. In the case of antimony, six such spectra are superposed, and in bismuth four.—Line spectra, by J. R. Rydberg. This is a comparison of the spectra of calcium and strontium.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 10.—"Preliminary Report on the Results obtained with the Prismatic Camera during the Total Eclipse of the Sun, April 16, 1893." By J. Norman Lockyer, C.B., F.R.S.

During the total eclipse of 1871 observations were made by Respighi and the author with a spectroscope deprived of its collimator, and a series of rings was seen corresponding to the different rays emitted by the corona and prominences. A similar instrument, arranged for photography, was employed during several succeeding eclipses, but the photographs were on so small a scale that none of the results came up to the expectations raised by the observations of 1871. As the Solar Physics Committee is now in possession of a prismatic camera of 6 inches aperture, the prism having a refracting angle of 45°, it was determined to employ it during the eclipse of 1893. The instrument was placed at the disposal of the Eclipse

Committee by the Solar Physics Committee, and was entrusted to Mr. Fowler, who took the photographs at the African station.

It also seemed desirable that a series of similar photographs should be taken at another point on the line of totality, even though an equally efficient instrument were not available. A spectroscope with two 3-inch prisms of 60°, used in conjunction with a siderostat, accordingly formed part of the equipment of the expedition to Brazil, and was placed in charge of Mr. Shackleton.

The present preliminary report is intended to indicate the kind of results obtained, and some of the photographs are reproduced for the information of those specially interested, as it will be some time before the complete reductions are ready for publication.

The most conspicuous lines, or rather portions of circles, seen in the photographs taken during totality, are the H and K lines of calcium, and in these rays the images of the various prominences are very clearly outlined.

The lines of hydrogen, extending far into the ultra violet, are also very prominent, and numerous other lines are seen in addition.

Isochromatic plates were used for some of the exposures, and on some of these the ring formed by the characteristic line of the coronal spectrum (1474 K) is clearly depicted, especially in the Brazilian photographs. A comparison with the photographic records of the corona shows that the prismatic camera has picked out the brightest parts of the corona in this way. All the photographs show a bright continuous spectrum from the inner corona.

"On the Leicester Earthquake of August 4, 1893." By C. Davison, M.A., King Edward's High School, Birmingham.

On August 4, 1893, at 6.41 P.M., an earthquake of intensity nearly equal to 6 (according to the Rossi-Forel scale) was felt over the whole of Leicestershire and Rutland and in parts of all the adjoining counties. The disturbed area was 58 miles long, 46 miles broad, and contained an area of about 2066 square miles. The direction of the longer axis (about W. 40° N. and E. 40° S.) and the relative position of the isoseismal lines show that the originating fault, if the earthquake were due to fault-slipping, must run in about the direction indicated, passing between Woodhouse Eaves and Markfield, and hading towards the north-east. The anticlinal fault of Charnwood Forest, so far as known, satisfies these conditions, and it is highly probable that the earthquake was caused by a slip of this fault; greatest in the neighbourhood of Woodhouse Eaves, and gradually diminishing in amount in either direction, rather rapidly towards the north-west and much more slowly towards the south-east. The total length of the fault-slip may have been as much as twelve miles or even more, and there can be little doubt that it was continued for some distance under the Triassic rocks on which Leicester is built.

Royal Society, May 10.—"The Stresses and Strains in Isotropic Elastic Solid Ellipsoids in Equilibrium under Bodily Forces derivable from a Potential of the Second Degree." By C. Chree, Superintendent of Kew Observatory.

The problem solved in the present memoir, viz. that of an isotropic elastic solid ellipsoid under the action of bodily forces derived from a potential

$$\tfrac{1}{2}(Px^2+Qy^2+Rz^2),$$

is the most general case of equilibrium under forces derived from a potential of the second degree. The above potential covers forces arising from mutual gravitation or from rotation about a principal axis in an ellipsoid of any shape.

The solution obtained satisfies without limitation or assumption of any kind all the elastic solid equations. It enables the variation in the effects of gravitation and rotation with the change of shape of the ellipsoid to be completely traced.

The results obtained for the very oblate and very oblong forms seem to show that in many cases of bodily forces the assumptions usually made in the treatment of thin plates and long rods would not be justified.

By comparison with the author's previous researches, a close similarity is shown to exist between the phenomena in rotating flat ellipsoids and thin elliptic discs on the one hand, and rotating elongated ellipsoids and long elliptic cylinders on the other.

Royal Society, May 24.—"On certain Functions connected with Tesseral Harmonics, with Applications." By A. H. Leahy, late Fellow of Pembroke College, Cambridge, Professor of Mathematics at Firth College, Sheffield.

Royal Society.—*Correction.*—In the abstract of the paper "On the Specific Heats of Gases" (Part III.), by J. Joly, F.R.S., read (in place of the formula given):—

$$Cv = a + 2b(100-t) + 3c(100-t)^2.$$

Royal Microscopical Society, May 16.—Mr. A. D. Michael, President, in the chair.—Mr. C. Lees Curties exhibited and described a microscope which had been specially made for photographic purposes. The leading feature of the instrument is that the nose-piece is removable, so that an ordinary photographic lens can be substituted for the objective if required. He also exhibited a new form of apparatus for obtaining instantaneous photographs of objects under the microscope; as examples of what could be done with this apparatus, he showed photo-micrographs of blood-corpuscles taken with powers × 306 and 600 diameters, and also some low-power photos of living specimens of *Lophopus* with tentacles extended. Dr. W. H. Dallinger thought the photomicrographs were extremely good. He noted in the immediate vicinity of the *Lophopus*, there were some vorticellæ, and this suggested that it might be possible to take them in the act of closing, so as to get an idea how the movement was performed.—Mr. Shrubsole said he had brought to the meeting a few living specimens of *Gromia*, which were shown under the microscopes on the table. One peculiarity of these specimens was that instead of possessing but one aperture, there was a zone of small apertures round a central one. This he thought was a good reason why this object should be removed from the Monostomia. After describing a naked rhizopod closely allied to *Lieberkuhnia*, and an organism resembling *Shepheardella*, Mr. Shrubsole said he had on the previous day obtained from the water off Sheerness some masses of a dirty-looking substance containing all sorts of forms of gelatinous objects, in which were imbedded a number of granules; they were the cause of what the fishermen called "foul water," or "May water." They were only seen for certain seasons and for a short time, and it would be an interesting inquiry to find out what became of them.—Prof. Jeffrey Bell said that he had just been present at the annual inspection of the Marine Biological Laboratory at Plymouth, and he found that one of the greatest troubles there had been the condition of the water. Only two fish had died during the last twelve months, but the Director was desirous of obtaining information as to the diatomaceous and desmidaceous condition of the water in the tanks. Inquiries naturally suggesting themselves would be what the organisms really were which caused this "foul water"; was the "foul water" due to their presence, and were they a great number of larva undergoing transformation?—Prof. Bell called attention to the three frames of photo-micrographs which formed the Society's exhibit at the Chicago Exhibition, and which had just been returned. The Fellows would have now the opportunity of seeing them and determining whether they were worthy of the medal which they were told had been awarded the Society.

Quekett Microscopical Club, May 18.—Mr. A. D. Michael, Vice-President, in the chair.—Mr. C. L. Curties exhibited a new instantaneous photo-micrographic apparatus, and explained the method of using it. Some excellent pictures of pond-life, and fresh human blood corpuscles, &c., taken by this apparatus, were handed round for inspection, and one group of *Lophopus*, fully extended, surrounded by vorticellæ, was particularly admirable and life-like. The Chairman thought this apparatus would be especially valuable for obtaining representations of quickly-moving organisms, which were almost impossible to draw in a natural way because of their rapid volutions, and they might get composite pictures which would throw some light on this difficult subject of locomotion in minute animals, such as had been done by Muybridge and others with the horse, for instance.—Mr. G. Western read some interesting notes of foreign rotifers which had since been found in Britain, amongst them being *Notholca heptodon*, *Bipalpus vesiculosus*, *Chromogaster testudo*, *Æcistes mucicola*, and *Æ. Socialis*, *Brachionus dorcas*, and others, which were accompanied by beautifully executed drawings by Mr. Dixon-Nuttall. Mr. Western pointed out the uncertainty and variability of many of the characters relied upon for specific, and in some cases for generic, value, such as the presence or absence of setæ, antennal appendages, or even of the eyes. Mr. Michael said with regard to the eye he had frequently found the same peculiarity among the Hydrachnea or water-mites; in the same gathering would perhaps be met with specimens otherwise identical, some with and some without eyes, or the eye present on one side only. The pigment greatly varied in amount, or was entirely wanting, but without sections it was difficult to say whether that was the case with the true nervous part of the visual organ, which, from its transparency, was easily overlooked in merely surface views.

PARIS.

Academy of Sciences, May 21.—M. Lœwy in the chair.—Researches on trimethylene and propylene, and on a new class of hydrocarbons; dynamical isomerism, by M. Berthelot. Trimethylene and propylene have, respectively, − 17·1 Cal. and − 9·4 Cal. for heats of formation from their elements. The corresponding dibromides, sulphates, and alcohols have nearly the same heats of formation; just as trimethylene and propylene differ by − 7·7 Cal. in heat of formation, so the formation of bromides, sulphates, and alcohols from these substances liberates more heat in the case of trimethylene, the excess being +9·4, + 8·8, and +10·2 Cal. in the respective cases. The dibromides liberate heat on the further addition of bromine as follows:—

	$+Br$.	$+Br_2$.	$+2Br_2$.	$+3Br_2$.
Propylene dibromide	+0·522,	+0·872,	+1·397,	+1·661 cal.
Trimethylene dibromide	+0·592,	+1·010,	+1·567,	+2·052 ,,

The heat of formation of terebenthene is +4·2 Cal., of citrene is + 21·7 cal., and of liquid camphene is about 24 Cal. The corresponding hydrochlorides have nearly the same heats of formation. From these data it is argued that trimethylene and terebenthene belong to a new class of hydrocarbons, and are dynamical isomerides of propylene and camphene respectively.—A note by M. Lœwy accompanying the presentation of a volume of the "Annales de l'Observatoire de Bordeaux."—On the formation of urea in the liver after death, by M. Charles Richet. The formation of urea is analogous to the production of sugar. Urea continues to be formed in the liver after removal from the body and cleansing from blood, &c., by washing, probably by hydrolysis due to the action of a soluble diastase.—The insects of the carboniferous period, by M. Charles Brongniart.—On the superficial tension of saline solutions, by M. H. Sentis. If F be the superficial tension of the saline solution, f that of water at the same temperature, u the volume of 100 molecules of water, and v that of a mixture of n molecules of the salt with 100 − n molecules of water, we have

$$\Phi = F - \frac{100 - n}{100} \cdot \frac{f}{\sqrt[3]{\frac{v}{u}}},$$

where Φ is the action per unit of length between the molecules of the salt and the molecules of water. With regard to Φ—(1) This action is independent of the temperature between 0° and 25°; (2) it is proportional to n up to the most concentrated solutions; (3) it is independent of the nature of the salt and approximately equal to 0·78 dyne per centimetre for each radical equivalent (*e.g.* $\frac{\Phi}{n}$ for NaBr, KCy, $MgSO_4$, $CaCl_2$, and K_2CrO_4 is respectively 1·6; 1·5; 1·6; 2·3; and 2·4).—Properties of magnetic substances at various temperatures, by M. P. Curie. Oxygen, manganese chloride, ferrous sulphate, and palladium follow the law expressed by $k = \frac{A}{T}$ where k is the specific coefficient of magnetisation, A is a constant, and T is the absolute temperature. The temperature of magnetic transformation of nickel is near 340°. Its coefficient k between 373° and 806° is independent of the intensity of the field, and decreases regularly and very rapidly as the temperature rises. The temperature of magnetic transformation of magnetite is about 535°. From 550° to 850° it behaves like nickel, from 850° to 1370° it obeys the same law as oxygen. Iron exhibits very complex phenomena. Between 860° and 1280° there appears to be another modification of iron formed; before 860° and beyond 1280°, iron behaves like nickel.—On a system of new scales, by M. Alexandre de Bertha.—Apparent death produced by alternating currents. Restoration to life by means of artificial respiration, by M. A. d'Arsonval. In the cases where death has apparently been caused by direct action of the current on the nerve centres, without lesion or destruction of the tissues, it is found possible to revive the patient by the treatment adopted with apparently drowned persons.—On a method permitting the measurement of the mental intensity of vision and the longitudinal aberration of the eye, by M. Charles Henry.—Absorption spectra of hydrobromic solutions of cupric bromide, by M. Paul Sabatier. The absorption between $\lambda = 660\,\mu\mu$ and $\lambda = 440\,\mu\mu$ is far more intense than in the cases of the alcoholic solution of the anhydrous salt or the aqueous solutions of the green and blue hydrates.—On the molecular transformations of some chromic compounds, by M. A. Recoura.—On some combinations of ammonia with various silver salts, by MM. Joannis and Croizier. The compounds $AgBr.3NH_3$, $AgBr.1\frac{1}{2}NH_3$, $AgBr.NH_3$, $AgI.NH_3$, $AgI.\frac{1}{2}NH_3$, $AgCy.NH_3$, $AgNO_3.3NH_3$, $AgNO_3.2NH_3$, $AgNO_3.NH_3$ have been studied, and their temperatures of dissociation, as also their characteristic formulæ for the pressures of dissociation at any temperature, are given.—On the detection of hydrochloric acid, by MM. A. Villiers and M. Fayolle.—On geraniol from the essence of *Andropogon Schœnanthus*.—Does digestion of proteid matters without digestive ferments exist? by M. A. Béchamp.—Essay on a theory of the temporal (bone), by M. S. Jourdain.—On the increase of temperature of earth-layers with the depth in the low Algerian Sahara, by M. Georges Rolland. In many parts of the low Algerian Sahara, between 30° and 35° Lat., the temperature increases with the depth at least 1° for 20 metres, and often much more rapidly.—Agronomic map of the canton of Ferté-sous-Jouarre, by M. Gatellier.

BOOKS and PAMPHLETS RECEIVED.

BOOKS.—Studies in Forestry: Dr. J. Nisbet (Oxford, Clarendon Press).—Systematic Survey of the Organic Colouring Matters: Drs. G. Schultz and P. Julius, translated and edited by A. G. Green (Macmillan).—Discourses, Biological and Geological: T. H. Huxley (Macmillan). Geology: C. Bird (Longmans).—Primitive Civilizations, 2 Vols.: E. J. Simcox (Sonnenschein).—Lehrbuch der Zoologie: Dr J. E. V. Boas (Jena, Fischer).—Blackie's Chemistry Demonstration Sheets; eight Sheets (Blackie).—Micro-Organisms in Water: Prof. P. Frankland and Mrs. P. Frankland (Longmans).—Climbing and Exploration in the Karakoram Himalayas: W. M Conway (Unwin).—Étude Industrielle des Gites Métallifères: G. Moureau (Paris, Baudry).

PAMPHLETS.—The Marine Biological Laboratory 6th Annual Report, 1893 (Boston).—A Description of Two Large Spinel Rubies: Dr. V. Ball (Dublin).

CONTENTS.