THURSDAY, DECEMBER 16, 1886

THE PALISSY OF CALICO-PRINTING

The Life and Labours of John Mercer, F.R.S. By Edward A. Parnell. (London: Longmans and Co., 1886.)

THE subject of this memoir was one of the most remarkable men of his time. A son of the soil, and almost wholly self-taught, he effected what was practically a revolution in one of our staple industries by his discoveries in technical chemistry and by his application of chemical principles to the dyer's art. With no laboratory training other than that which he gave himself, he by his skill and sagacity as an experimentalist added enormously to the resources of a great industry: owing nothing to academies, and uninfluenced by schools of learning, he made himself master of the chemical philosophy of his time, and by the acuteness and originality of his speculations he has permanently influenced the development of theoretical chemistry. In Lancashire, the scene of his work, the name of John Mercer is held in hardly less esteem than that of John Dalton; and probably to many people in Cottonopolis the director of the Oakenshaw Print-Works was a far more important personage than the old Quaker in George Street, who gave lessons in the *New System of Chemical Philosophy* at the rate of half-a-crown an hour. The Atomic Theory has doubtless contributed much to the intellectual greatness of Manchester, and Manchester men are not ungrateful: they have named one of their streets after its illustrious author. Still calicoes and calico-printing are what they have to live by, and although they have not yet, so far as we know, named a street after John Mercer, they have shown, by the widespread adoption of his processes, a very practical appreciation of the value of his labours.

John Mercer is the Palissy of calico-printing. Not that there was anything in the least degree tragic in the life of the Lancashire dyer; his career was one of almost uninterrupted success, and his domestic peace was unclouded. But he had the great potter's indomitable will and fixity of purpose; his unwearied patience and unremitting industry. Both men had the same high ideal of their art and the same contempt for false work. Each began his life at the bottom rung of the social ladder, and each found his life's work in a direction other than that in which he set out. Both were men of strong religious feeling, and both left the faith of their forefathers in compliance with the dictates of principle, but with this difference, that whilst the Huguenot artist found the Bastille and death, John Mercer could build his Sunday-schools in peace and quietness, and find contentment in a standard of doctrine which Mr. Matthew Arnold has characterised as the product of a mind of the third order.

John Mercer was born on February 21, 1791, at Dean, near Blackburn. His father was originally a hand-loom weaver, but the development of the factory system had led him to take to agriculture. He died when the son was barely nine years old, and John was set to work as a "bobbin-winder." A pattern-designer belonging to the Oakenshaw Print-Works, in which Mercer was destined to play so considerable a part, gave him his first lessons in reading and writing; and the Excise-surveyor at the same works (it was in the days when each square yard of printed calico paid an Excise duty of threepence) taught him the elements of arithmetic. He soon became noted for his aptitude at figures, and later on for his skill in music; and for a time he found a congenial exercise for his artistic faculty in the band of a militia corps. Music remained a passion with him throughout his life, and although, we are told, a man of great self-possession, he was sometimes entirely overcome by it. Mercer was sixteen years of age, and had settled down apparently to the work of a hand-loom weaver, when a very slight incident—as slight as that which made Palissy a potter—gave an entirely new direction to his thoughts. His mother, it appears, had married again. Visiting her one day, John was so much struck with the orange colour of the dress of his little step-brother on her knee, that, to use his own words, he "was all on fire to learn dyeing." He had no means of obtaining instruction: he had no book on the subject, nor could he procure any receipts. He found, however, that the dyers of Blackburn, some five miles distant, obtained their materials from a certain druggist in that town. Mercer repaired to him, and requested to be supplied with materials for dyeing. "What do you want?" inquired the shopman. "I can't tell you," replied John; "will you tell me the names of all the different materials you sell the dyers here?" "Oh, I sell them peach-wood, Brazil-wood, logwood, quercitron, alum, copperas, and others," mentioning their names. Mercer reckoned his money, and found he could afford threepence for each dye-stuff. Armed with these articles he returned home, "full," as he says, "of dyeing and dyeing materials." He seems to have been fortunate in obtaining the use of a convenient place for his experiments, where he had all the necessary apparatus for small trials. Here he commenced entirely by "rule-of-thumb"; but by industry and close observation he acquired considerable knowledge of the properties of dye-stuffs, and ascertained the methods of dyeing in most of the colours then in vogue.

To become a dyer was now the dominant idea of Mercer's life. Everything comes to him who waits, and fortunately for Mercer, as it seemed at the time, he had not to wait long. The Messrs. Fort, the proprietors of the Oakenshaw Print-Works, heard of the success of his dyeing experiments, and offered him an apprenticeship in the colour-shop of their factory. It was one thing to get inside a colour-shop and quite another to get any information there. No workmen are more jealous of their *arcana* than the foremen of colour-shops: their knowledge even to-day is almost entirely empirical, and their secrets are invested with a degree of mystery which is frequently ludicrously disproportionate to their value. After ten months' irksome labour Mercer's indentures were cancelled. The Continental disturbances of 1810 reacted disastrously upon all industries connected with the cotton manufacture, and the "Berlin decree," which led to the destruction of all printed calicoes and other goods of English manufacture then in bond in certain European States, was severely felt by the Lancashire printing establishments. Mercer was forced for a time to abandon the calling of a colour-mixer, and to return to his work at the hand-loom. But his brains were still among his colour-pots. It was characteristic of the man, that, being in Blackburn to procure a marriage license, he should be led to a secondhand bookstall in the market-place to search for printed matter relating to his favourite art. At a time when Mary Wolstenholme might properly consider him as more anxious about the *res angusta domi*, he was engaged in negotiating the purchase of "The Chemical Pocket-Book; or, Memoranda Chemica, arranged in a Compendium of Chemistry, by James Parkinson, of Hoxton." This book, together with "The Tables of New Nomenclature, proposed by Messrs. De Morveau, Lavoisier, Berthollet, and De Fourcroy, in 1787," opened out a new world to him. He had, at the very outset of his trials, convinced himself that it was only by a thorough knowledge of the properties of dyeing materials, and of their behaviour under varying conditions, that the operations of the dyer can be intelligently carried on: he now saw that all this knowledge must primarily depend upon chemical science, and that it was on chemistry that the extension of his art must ultimately rest. This view of the relations of science to practice strengthened with Mercer's experience. Years afterwards, when he had attained to fame, he was called upon to express his opinion concerning the necessity of technical education in this country. "I entirely concur with you," he wrote to a friend, "that for the preservation and benefit of the British arts and manufactures, the masters, managers, and skilled artisans ought to be better instructed in the *rationale* and scientific principles involved in their operations. Chaptal remarked that 'practice is better than science' (*i.e.* abstract principles), 'but when it is necessary to solve a problem, to explain some phenomenon, or to discover some error in the complicated details of an operation, the mere artisan is at the end of his knowledge, he is totally at a loss, and would derive the greatest assistance from men of science.' Probably no person would, from his own experience, confirm the above remark, as regards the art of calico-printing, more heartily than myself." He observed that, "as regards good practical men, no district could excel Lancashire; but in all the processes, from the grey piece to the finished print, embracing thirty to forty operations, both the science and practical experience of the cleverest are requisite to keep all things straight and to detect the cause of, and rectify, mishaps. . . . An amusing volume might be written about ludicrous mistakes, and equally ridiculous attempts to rectify them."

Mercer's first important invention in calico-printing was made in 1817, and curiously enough it was in the application of a colour akin to that which had fired his ambition to become a dyer. He found in the alkaline sulphantimoniates an excellent medium for procuring a bright orange colour on cotton fabrics. Heretofore no good orange suitable for the use of the calico-printer was known. The best orange was made from a mixture of quercitron yellow and madder red, but it was difficult to adapt it to other colours in the styles then in demand. Mercer's antimony orange supplied the want: it was not only a fine colour in itself, but was capable of being combined and interspersed in a great variety of styles. This discovery led to his re-engagement at the Oakenshaw Works: after a seven-years' service he was admitted as a partner, having as a co-partner, for a while, Richard Cobden; and he remained connected with the firm until its dissolution in 1848, when he retired from business with a moderate fortune.

It would be difficult in the space at our disposal to do full justice to the many discoveries and improvements which Mercer introduced into the art of dyeing and printing. His skill and energy led not only to the invention of new styles and new colours, but to the development even of new branches of chemical industry. His application, for example, of chromium compounds practically created the manufacture of bichrome: when Mercer first began experimenting with this substance its cost was half-a-guinea an ounce; it is now produced by the hundreds of tons, and may be bought retail at less than sixpence per pound. Some of his processes are, of course, obsolete, but many are still in use: the "manganese bronze," for example, which he introduced in 1823, seems to re-appear about every ten years, and was in large demand some three or four years since. Mercer was an indefatigable experimenter: nothing is more extraordinary than his skill and inventiveness in the application of his new colours to the creation of fresh styles or novel combinations; his genius in this respect was almost kaleidoscopic.

One of the greatest improvements made by Mercer in the operations of the dyer was his introduction of the alkaline arseniates in what is called the "dunging" operation, the object of which is to remove that portion of the mordant which has not become insoluble and firmly attached to the fabric by the process of "ageing." The loosely-attached mordant, unless previously removed, would dissolve in the dye-bath, to the injury of the whites and the deterioration of the dyeing liquor. Of scarcely less importance was his method of preparing mixed cotton and woollen fabrics so as to enable the mixed fibres to acquire colouring-matters with equal readiness. His observation of the extraordinary facility with which certain "lakes," or compounds of alumina with organic colouring-matters, are dissolved by oxalate of ammonia led to the introduction of a method of using aluminous colour-precipitates in steam colour-work, which was extensively employed in the East Lancashire print-works. And lastly, his method of preparing stannate of soda was not only of service to the calico printer by greatly cheapening an indispensable agent, but was of considerable pecuniary benefit to himself.

Mercer's skill and knowledge were ungrudgingly given to the fellow-workers in his art, and he was constantly appealed to by the calico-printers and chemical manufacturers of Lancashire for assistance and advice. His acquaintance with the literature of the abstract chemistry of his time was very remarkable. He had indeed all the essential qualities and instincts of the scientific mind: there was a certain comprehensiveness about the man, a certain vigorous grasp of general principles, and a largeness of view which made his influence felt at once among men of science. There is no question that had Mercer devoted himself to pure science he would have attained hardly less distinction than he has secured as a technologist. His method of work was essentially scientific. Thus no sooner did he become acquainted with the doctrine of chemical equivalents than he had the strengths of his chemicals and reagents adjusted to a simple relation of their equivalents. Mercer indeed was one of the earliest workers in volumetric analysis; in 1827 he devised a method of valuing bleaching-powder and bichrome by means of standard solutions. His speculations on the nature of white indigo, on the constitution of bleaching-powder, and on the ferrocyanides and nitro-prussides were much in advance of his day. His theory of catalysis, which he illustrated by many striking and original examples, was extended by Playfair, and has been subsequently worked out by Kekulé as the only satisfactory explanation yet given of a very remarkable and interesting group of phenomena. Graham's early experiments on the heat of chemical combination and the nature of solution induced Mercer to test the practicability of effecting the partial separation of different hydrates by some process of fractional filtration. These experiments, made from a pûrely scientific stand-point, resulted in the discovery of the mode of action of the caustic alkalies on cellulose, and led to the process which has come to be known as "mercerising," in which cotton fabrics are "fulled" by their contraction on treatment with caustic soda. Mercer appears to have been the first to notice the remarkable solvent action of an ammoniacal copper solution on cotton, which could be re-precipitated as almost pure cellulose by the addition of an acid. His habit of searching for first principles led him, as far back as 1854, to speculate on the relations among the atomic weights of the chemical elements, and the constitution of chemical compounds: he brought his views before the Leeds meeting of the British Association in 1858. He was an early worker on photography, and devised several modifications of the cyanotype process adapted to printing on cambric and similar fabrics.

Mercer was one of the original Fellows of the Chemical Society, and he was a juror of the Exhibitions of 1851 and 1862. In 1852 he was elected into the Royal Society. He died, ripe in years and rich in the contentment afforded by the retrospect of a well-spent life, on November 30, 1866. T. E. THORPE

THE BRITISH INTERNATIONAL POLAR EXPEDITION

Observations of the International Polar Expeditions, 1882–83: *Fort Rae.* 326 pp. 4to, and 29 plates. (London: Trübner and Co., 1886.)

AT the Polar Conference of Vienna in April 1884 it was declared to be very desirable that the results from all the circumpolar stations should be published by Christmas 1885. This time was not kept strictly by any of the parties. The first Report completed was that of Lieut. P. H. Ray, of the U.S. Army, for Point Barrow, which appeared early in 1886, and this has now been followed by the present volume, which came out in August last.

The other Expeditions, however, have not been idle, for several have issued portions of their Reports: *e.g.* the French for Cape Horn; the Russians for Sagastyr at the mouth of the Lena; and the Austrians for Jan Mayen; while quite recently the Germans have announced the publication of the results for their two stations—Cumberland Sound and South Georgia.

The British Expedition was from the outset at a serious disadvantage. It was not until April 2, 1882, that the definite sanction of the Government was obtained, and the party were obliged to sail from Liverpool on May 11 in order to catch the Hudson Bay Company's convoy from Winnipeg. Accordingly the time available for preparations and training was extremely short, and no special instruments could be made.

The party consisted of Captain (now Major) H. P. Dawson, R.A., with two sergeants and a gunner of the same service. The journey was prolonged and fatiguing, lasting three months and a half, and the Expedition only reached its destination at 10 p.m. on August 30. Only one day was thus available for unpacking, &c., before the regular hourly observations commenced.

The start for the return journey was made within three hours of the time of the final observation, and even then it was only owing to a fortunate shift of wind on Lake Athabasca, which opened the ice and allowed the boats to get through, that the party was able to reach Manitoba, with its baggage, in October. Otherwise the instruments must have been left behind for some months, as the Expedition must have completed its journey by sledge.

The observations have been discussed in strict accordance with the International scheme, the units employed being metric and centigrade. The magnetic discussions were carried out by Major Dawson in conjunction with Mr. Whipple. The meteorological work was intrusted to Mr. R. Strachan and Mr. John A. Curtis, of the Meteorological Office.

The magnetic observations are specially interesting, from the proximity of the station to the magnetic pole The disturbances were therefore of great frequency and violence, as will be seen from the plates to the volume. The auroral journal also affords a copious store of information on that subject.

The following few results, which we extract from the observations made by the Expedition, will be of interest to our readers:—

The barometer at Fort Rae varied between 771 mm. (30·35 inches) and 721 mm. (28·39 inches), with a maximum daily range of 24 mm. (0·94 inch), and the least of 0·7 mm. (0·03 inch).

The highest thermometer-reading recorded by the Expedition was 25°·6 C. (78°·1 F.), whilst the lowest was − 44°·6 C. (− 48°·3 F.) in the air, the terrestrial radiation instrument registering − 46°·7 C. (− 52°·1 F.).

On the coldest day experienced (January 3) the mean temperature of the twenty-four hours was − 41°·9 C. (− 43°·4 F.), whilst that determined for the hottest day (August 13) was 19°·9 C. (67°·8 F.), giving an extreme range of average daily temperature of 61°·8 C. (111°·2 F.).

The highest mean velocity of the wind recorded any day was 8·5 metres per second (19 miles per hour) from the north north-west.

The average magnetic declination at Fort Rae was 40° 20′ E., the extreme change observed in the diurnal range being 11° 25′. On the most quiescent day the angular motion of the needle was 0° 17′, both values largely exceeding movements observed in these latitudes.

The dip or inclination of the needle was 82° 55′, whilst the measured values of the total and horizontal magnetic forces were 0·62 and 0·08 electrical units respectively.

OUR BOOK SHELF

Natural History, its Rise and Progress in Britain, as developed by the Life and Labours of Leading Naturalists. By Alleyne Nicholson, M.D., D.Sc., Regius Professor of Natural History in the University of Aberdeen. British Science-Biographies. (London and Edinburgh: W. and R. Chambers, 1886.)

THIS little octavo volume of about 300 pages is a readable book, and accurate in its information as far as it goes. But, besides being sketchy—which is no doubt a fault incidental to the form of the series—it is strangely ill-balanced. In the first place, the author has travelled beyond the limits of his title by giving biographical sketches of Aristotle, Linnæus, Lamarck, and Cuvier—together constituting more than a third of the whole number of "British Science-Biographies" with which they are intermingled. In the next place, as regards the "British Science-Biographies" which are given, there is no proportion observable between the relative magnitudes of these British biologists and the amount of notice which is respectively bestowed. Running the eye over the table of contents, we find that separate chapters are devoted to eleven "leading naturalists" of this country. These, of course, must be understood by his general readers, for whom the book is designed, as representing what, in the author's opinion, are the eleven greatest names in the records of British biology. Yet six of these names are Sir Hans Sloane, Gilbert White, Alexander Wilson, William Swainson, Edward Forbes, and Robert Chambers! To take only the first and last of these names, surely when a whole chapter, with a portrait, is devoted to Sir Hans Sloane, it is remarkable that no mention at all should be made of Sir Joseph Banks; or that, when another whole chapter is assigned to Robert Chambers, we should nowhere encounter the name of Robert Brown. It appears to us that when a Professor of Natural History undertakes to popularise his science, his aim should be to place before what this writer calls "unprofessional readers" a true conception of the merit that attaches to solid work in science, as distinguished from the celebrity that belongs to a graceful writer or to an interesting personal character. He should endeavour to raise the popular mind to a just appreciation of *naturalists*: he should not pander to the already accomplished popularity of *authors*. Now, if this has been the aim of Prof. Nicholson—and in his preface he says as much—in our opinion he has shot wide of his mark. But, as before observed, if his object has been to produce a readable assemblage of short biographies, calculated to suit the popular taste, we should say he has every reason to be satisfied with the result.

The Journal of the Royal Agricultural Society of England. Part II., 1886. (John Murray, Albemarle Street.)

THE current number of this *Journal* furnishes an excellent illustration of the wide limits of agricultural science, and the varied knowledge required of its professors. There is perhaps no art or occupation which so directly requires elucidation from so many sciences; hence the varied nature of the bill of fare provided by the *Journal* Committee of the Royal Agricultural Society. In proof of this assertion we may take the contents of the entire volume for 1886, the second part of which lies before us. Pathology is treated of in papers upon foot-and-mouth disease; Pasteur and his work; lung parasites, by the late T. Spencer Cobbold, M.D.; and abortion in cows. Anatomy and physiology are the topics in Prof. Brown's paper upon organs of the animal body, their forms and uses. Chemistry and botany are amply represented in reports by Mr. Carruthers and Dr. J. Augustus Voelcker. Entomology in the form of papers on the recent appearance of the Hessian fly is the theme of Miss E. A. Ormerod. Social science is illustrated by Mr. H. M. Jenkins's report upon farming and agricultural training in reformatory and industrial schools, and engineering in the report of the Judges on the Exhibition of Implements at Norwich.

The more immediately agricultural information is embodied in many interesting papers, among which may be mentioned continued reports upon field and feeding experiments at Woburn; experiments on ensilage conducted at Crawley Mill Farm, Woburn; report on the prize-farm competitions in Norfolk and Suffolk, 1886; the report on the Exhibition of Live-Stock at Norwich; and lessons from the winter of 1885-86.

The number issued during the past month also contains the examination papers on agricultural education set during the present year, and much statistical information useful to agriculturists. With such a large mass of material at hand, it is by no means easy to compress remarks into the limits of a short notice. The names of the authors of the various contributions is a guarantee of their value, and any person who desires to keep pace with scientific agriculture, whether actually engaged in agricultural pursuits or not, will do well to peruse these pages. The most interesting papers, and those containing the newest information on subjects of vital interest to us, are as follows:—(1) An inquiry into several outbreaks of abortion in cows, by C. J. B. Johnson, L.R.C.P., who traces most of the cases to the presence of ergot (*Claviceps purpurea*) in grass and hay. (2) Report on ensilage experiments, in which the results are less favourable to this innovation upon old-fashioned practice than some of the apostles of the movement could wish. Silage is found inferior to homely, honest hay and roots. It is true that silage made from green oats showed a distinct superiority, but the question still remains open whether these promising young oats, sacrificed while in the green stage, might not have developed into still greater value had they been allowed to bloom and fructify and bear their thirty, sixty, or perchance a hundred-fold. Promoters of ensilage have little to congratulate themselves on in this result of strict inquiry and accurate tests brought to bear upon their hobby. No doubt they will be equal to the occasion. The prize-farm competition is, as usual, interesting, but it is a matter of regret that, in such a noted county as Norfolk for farming, the best-known agriculturists, whose farming has been the admiration of their countrymen for generations, should apparently have held aloof from the competition. The first prize was awarded to a suburban farm close to Norwich, and but little can be learnt from management carried on under quite exceptional circumstances. It is also a pity that the able officials of the Royal Agricultural Society do not insist upon a greater uniformity in the reports of their judges in the matter of statistics. For purposes of comparison it would be well if some tabular statement could be made out, as for example as to the amount paid in rent, in labour, feeding-stuffs, and trade expenses; also as to the gross and net produce per acre in each case; the yield of corn in bushels, and of roots in tons; the uses made of straw; the amount of work expected per day from horses and men; the hours of labour; the rate of payment for day and for task work, &c. The reader looks in vain for any such comparisons. Statements regarding them he finds in respect of this or that farm, but any plan by which he may compare or note extremes and means he looks for in vain. Considering the many years in which prizes for the best-managed farms have been given, it is a matter for wonder that it is simply impossible to construct any comparative statement as to points of management in the numerous farms inspected and reported upon. Lastly, we must notice Mr. H. M. Jenkins's report on the cultivation of tobacco in the north-west of Europe, a fairly hopeful paper as to the introduction of this cultivation into England. It would ill become the able secretary of our greatest Society to throw cold water on any suggestion made for the good of agriculture, especially in these sad times; but alas for the frosts of June, July, August, and September, which most of our years carry in their bosoms! Gardeners and farmers know them and dread them. Our summers are not to be relied upon, or we should grow tobacco—ay, and grapes!

JOHN WRIGHTSON

Madagascar: an Historical and Descriptive Account of the Island and its Former Dependencies. Compiled by Samuel Pasfield Oliver, late Captain R.A. Two vols. (London: Macmillan and Co., 1886.)

CAPT. OLIVER has made a useful compilation of information on Madagascar in all its aspects. The compilation consists largely of extracts from previous writers. Capt. Oliver himself visited Madagascar a good many years ago, and has naturally taken much interest in the island and its people ever since. It is evident these two volumes must have cost him much labour, which will no doubt be appreciated by those in search of information on Madagascar in a handy form. After an historical sketch, the first volume is devoted to geography, topography, climatology, geology, and natural history. These, in the second volume, are followed by chapters on natural and agricultural products, ethnology, manufactures, administration, trade and finance, bibliography and cartography, and a very long chapter, with appendixes, on the Franco-Malagasy war. The work, we should say, is exceedingly well supplied with maps and plans, of which there are nineteen altogether.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

An Ice Period in the Altai Mountains

M. B. VON COTTA, who once visited the Altai Mountains, is decidedly of opinion that there are no traces of the Ice period on this range. But at the southern part of the Altai, where there are some large glaciers and many ridges covered with eternal snows, there are undoubted traces of a mighty spreading of ancient glaciers. At least this is the conviction I brought back in 1870 from a rapid examination of nearly the same localities as those which have been recently visited by Mr. Bialoveski.

The deposits of ancient glaciers may be observed, far more to the south, on the ranges of Tarbagatay and Saoor, the southern limits of the basin of the Irtysh. There are not now any glaciers on Tarbagatay, but some sporadic snow-spots. As to the range of Saoor, it attains to the height of 12,500 feet above the level of the sea, and snow always lies there in large masses. But there are no glaciers, properly so called.

Along the northern declivities of these mountains there are at many places large deposits of boulder- or cobble-stones, in great part composed of granite, which forms the crest of both ridges. The boulders are of various rocks and of different sizes, from an inch to some feet in diameter; and they are mingled together in complete confusion, the small boulders being generally well rounded, the large ones more angular, and the intervals being crammed with clay and sand without any traces of layer or assortment. The relation of these deposits to the neighbouring defiles is in most cases incomprehensible. Only at the sources of the River Kenderlik the boulders lie as if the ice which had carried them down had but lately melted. Here, instead of the sections of defiles in the form of the letter V, we find, beginning from the elevation of nearly 3000 feet above the level of the sea, a broad defile with transverse section in the form of the letter U. The walls (or cheeks, as the Russians call them) of this defile are composed of inclined layers of sandstone and limestone (probably Tertiary deposits), replaced, nearer to the crests, at first by diorite and subsequently by granite. The bottom of the defile is filled up with a close layer of boulder-stones, many of which reach some 10 feet in diameter, the greater number being of gray granite with dark ellipsoidal inclusions. Just the same granite forms the crests of Saoor. To the height of 8500 feet the defile rises steeply enough; but after this limit the inclination becomes more faint. Higher up, the defile grows broader, and at the height of 10,000 feet it is stopped up by two deep valleys crammed with close snow, and surrounded by steep snowy peaks. The full length of the layer of boulders reaches some ten English miles, with a direction from south to north.

The Saoor chain is a post-Tertiary elevation, but the Altai range certainly arose at a most remote time. It must have formed dry land since the Cretaceous formation at least. Here might be found the solution of the question whether there was on the earth an ice period more ancient than that of which we have evidence in the ice-deposits of Europe and North America. Some facts observed by myself seem to me to show that the question must be answered in the affirmative.

E. MICHAELIS

Oostkamenogorsk, November 3

How to make Colourless Specimens of Plants to be preserved in Alcohol

MANY plants assume a brown colour when placed in alcohol for preservation. The colouring-matter is partly soluble in the alcohol, partly not, and is the product of the oxidation of colourless substances of the cell-sap. This unpleasant change may be prevented in a very easy manner by using acid alcohol. To 100 parts of common strong alcohol add 2 parts of the ordinary concentrated solution of hydrochloric acid of the shops. Parts of plants brought into this liquid while yet living will become absolutely colourless, or nearly so, after the alcohol has been sufficiently often renewed. Such parts as already had a brown colour before, being brought into the mixture, usually retain this character.

By this method colourless specimens may be made of such plants as *Orobanche* and *Monotropa*, which, when treated in the ordinary manner, always become of a dark-brown tint. There are only some species with coriaceous leaves that cannot be treated with success with the acid alcohol; colourless specimens of these must be made by plunging them into boiling alcohol.

The acidity of the mixture here recommended is nearly 0·2 Aeq. A greater quantity of acid is neither noxious, nor does it improve the effect. A lesser quantity was in many cases found not to be sufficiently efficacious. The specimens may remain for months, perhaps for ever, in the acid alcohol without any injury.

If the alcohol, after having been used, is to be decolourised by distillation, the acid should be neutralised by a previously-determined quantity of ammonia or carbonate of soda.

Old specimens, which have become brown in consequence of being treated in the ordinary manner, cannot, as a rule, be decolourised by using the acid alcohol. This, however, may often be done by adding to the alcohol some chlorate of potassa and some sulphuric acid.

HUGO DE VRIES

University of Amsterdam, December 1

Virtual Velocities

DE MORGAN in his "Differential and Integral Calculus," p. 501, says:—

"The principle of virtual velocities, like all other fundamental theorems, has had no proof given of it in the admission of which all writers agree. From its universality and simplicity it may be supposed to be rather the expression of some axiomatic truth than the proper consequence of first principles by means of a long course of regular deduction."

Would you kindly allow me to submit to your readers the following attempt to base the principle of virtual velocities and D'Alembert's principle on easily admitted axioms?

(1) The *power* of a force imparted to any molecule is (or is measured by) the product of the force itself, and the effective component in the line of the force, of the velocity of the molecule to which the force is imparted, and is positive or negative accordingly as the force and the effective component of the velocity are in the same or opposite directions.

(2) The power of a system of forces, whether imparted to the

same or different molecules, is the algebraical sum of the powers of the individual forces.

From the parallelogram of motions it follows that—

Prop. I. The power of the resultant of a system of forces imparted to a single molecule is equal to the power of the forces. Whence—

Cor. 1. If the forces imparted to a molecule are in equilibrium, their power for any actual or hypothetical motion of the molecule is zero.

Cor. 2. If the forces imparted to a molecule are not in equilibrium, their power for any motion in the direction of the resultant is positive.

Definition.—A system of molecules is said to be passive for a given motion when for that motion the power of its internal forces is zero.

Prop. II. The power of the external forces of a system for actual or hypothetical motions for which the system is passive is equal to the power of the resultant motions of the several molecules of the system.

For (by Prop. I.) the power of the resultant forces for each (and therefore for all) of the molecules is equal to the power of the external together with that of the internal forces, but the latter, in the case of the entire system, is zero by hypothesis.

Cor. 1. If external forces be imparted to a passive system at rest in a given position such that for any hypothetical motion through that position the power of such forces is zero, the system will remain at rest.

For if motion ensued, the resultant and therefore (Prop. I.) the external forces would have positive power for such motion, which is contrary to hypothesis.

Cor. 2. If external forces be imparted to a passive system at rest, and be in equilibrium, the power of these forces for any hypothetical motion of the system through this position of rest is zero.

For as the whole system is at rest each molecule is at rest, and the resultant forces of the molecules are all of them zero, whence their power and therefore that of the external forces (Prop. I.) is zero.

It will be seen that Prop. II. is (or is equivalent to) *D'Alembert's Principle*, and its two corollaries constitute what is called the *Principle of Virtual Velocities*.

It may be urged that this merely relegates the difficulty to determining for what motions systems are passive. This really, however, presents no difficulty, for it is obvious that a system is passive generally when its internal forces neither tend to produce or destroy kinetic energy in the system; so that (1) rigid systems are passive for all motions consistent with their rigidity; (2) all systems are passive for rigid motion; (3) inelastic and theoretically perfect funicular systems are passive; and (4) inelastic and theoretically perfect fluid systems are passive, &c.

D'Alembert's principle and the principle of virtual velocities ought to form the basis of that part of kinetics which involves the idea of the transmission of force, whether the result is motion or equilibrium. D'Alembert's principle is the most general. The principle of virtual velocities is to it what Maclaurin's theorem is to Taylor's. The form in which it is given in Prop. II. above is more convenient for use than that in which it is generally stated, viz. that the resultant forces reversed balance the impressed forces.

Lagrange's proof of the principle of virtual velocities and its modifications are altogether too artificial and unsatisfactory.

Cape of Good Hope F. GUTHRIE

Recent Gales

THE gales of October 16 and December 8 varied considerably. In the former gale there were constant oscillations, from ·004 to ·010 of an inch, every 30 seconds between 1 a.m. and 2 a.m.; whilst in the December gale there were no oscillations, but a constant fall that was most rapid during squalls. The difference between the dry and wet bulb thermometers in the October gale was only a quarter of a degree, whilst in that of December it exceeded from $2\frac{1}{2}°$ to $3\frac{1}{2}°$ (or a difference of from thirteen to eighteen times as great). During the gale in October, 1·160 inches of rain fell, and in that of December 0·758 of an inch.

The lowest reading (corrected for temperature) of the barometer at 530 feet above the sea was on October 16, 28·019, and on December 8, 27·693 inches (this occurred at 8 p.m.).

The barometer reduced to sea-level was less than 28·5 inches from 11.30 a.m. of the 8th till 8.15 a.m. of the 9th (or nearly 21 hours). The October gale was W.S.W., and the December gale W.

		Hour	Barometer reduced to sea-level	Temp. °	Wet bulb °	Diff. °
Oct.	15,	4.15 p.m.	28·880	49·7	49·5	0·2
	16,	12.15 a.m.	28·811	47·8	47·6	0·2
		2.15 ,,	28·699			
		7.45 ,,	28·591	47·2	47·0	0·2
		8.30 ,,	28·668	47·7	47·5	0·2
		10.0 ,,	28·744	47·8	47·6	0·2
		2.45 p.m.	28·941	47·8	47·6	0·2
		5.0 ,,	29·042	47·8	46·8	1·0
Dec.	8,	2.20 a.m.	29·212			
		3.30 ,,	29·144			
		8.5 ,,	28·596			
		10.0 ,,	28·561	40·3	38·7	1·6
		2.0 p.m.	28·431	40·3	37·5	2·8
		3.30 ,,	28·378	37·3	34·7	2·6
		6.0 ,,	28·287			
		7.30 ,,	28·278			
		8.0 ,,	28·273	39·7	37·0	2·7
		9.0 ,,	28·286			
	9,	12.30 a.m.	28·327	37·0	33·4	3·6
		2.45 ,,	28·297			
		5.50 ,,	28·342			
		10.0 ,,	28·642	42·0	38·7	3·3
		7·0 p.m.	28·987			
	10,	10·0 a.m.	29·339	41·6	38·6	3·0

The last gale commenced at 1 a.m. on the 8th (with constant squalls of hail and rain), and was most violent from 4.45 p.m. till 8.30 p.m.

Thunder and lightning occurred from 11 a.m. till 11.30 a.m.; and from 4 p.m. till 4.40 p.m. on the 8th, and from 1.35 a.m. till 2.45 a.m. on the 9th.

Much damage was done to house-roofs. Very few trees were blown down here, for in this exposed situation trees are better prepared to resist gales. About 11 feet of the top of a large specimen of *Picea Webbiana* was destroyed. E. J. LOWE

Shirenewton Hall, Chepstow, December 11

Note on the Manipulation of Glass containing Lead

IN reading Mr. Shenstone's very useful little treatise on glass-blowing (reviewed in NATURE of the 9th inst., p. 123), I have failed to notice any mention of an expedient which I have found very useful for dealing with English flint-glass containing much lead silicate; although I greatly prefer for most purposes the readily fusible "soda-glass" used probably everywhere except in England.[1]

Of course, all ordinary flames, such as those of the Bunsen burner and the blow-pipe, consist, in part, of reducing gases which cause the separation of lead from glass introduced into them. This reduction can be prevented or remedied, as Mr. Shenstone says, by holding the glass a little in front of the visible flame; but there is in this region hardly enough heat to do all that is required in the manipulation of the glass.

If, however, oxygen instead of air is used in a Herapath blow-pipe, the resulting flame has so little reducing power, that lead-glass can be safely held well within it; and this is the flame that I always use in dealing with such glass.

It is true that oxygen is, at present, rather more expensive than air; but most, if not all, laboratories have a supply of the gas, either in a gas-holder or a bag, for the optical lantern and other purposes; and with it the manipulation of lead-glass becomes what shaving is, in certain advertisements, *said* to be—"a luxury." H. G. MADAN

Eton College

P.S.—The oxy-coal-gas blow-pipe is also extremely useful for difficultly-fusible "combustion-tubing." Bulbs of fair size can be blown, and side-junctions, &c., made in this glass, with almost the same facility as in ordinary "soda-glass."

[1] The *best* glass of this kind is that used by Geissler, Alvergniat, and others, for making their marvellous specimens of glass-work; but I doubt if glass of the same excellence, in regard to fusibility and freedom from any tendency to devitrify, is generally procurable.

Fireball of December 4, 1886

THE fireball seen at Stonyhurst College, near Blackburn, on December 4, 9h. 16m., and described in NATURE of December 9, p. 133, was observed here as follows:—

1886, December 4, 9h. 17m., meteor equal ♀. Path from 184° + 52° to 195° + 47°, rather swift. At the point 180° + 50½° it left a short brilliant streak of about ½°, which remained visible to the eye for 1½ minute. The meteor gave a distinct flash in the moonlight, and the streak was projected just where the maximum outburst took place.

I have made a preliminary comparison of the observations recorded at the two places, from which it appears that the fireball, when first seen at Bristol, was some 64 miles vertically over a point of the earth's surface near Farndale, in Yorkshire. Travelling to south west, it evolved an enduring light-streak when 49 miles high, near Thirsk, and disappeared near Otley, at an elevation of 28 miles.

These values are derived chiefly from the Bristol observation, but they are somewhat uncertain, because the meteor was at a great distance from that city, and appeared close upon the sensible horizon. According to the Stonyhurst path, the figures are less, the streak being computed at a height of 42 miles near Thirsk, and the end point of the meteor, near Otley, is indicated at only 19 miles above the earth. The observations are extremely discordant in altitude. The exact place of the streak is given by both observers, and if we adopt a mean height of 45 miles we cannot be far wrong.

The apparent radiant-point derived from the two paths is at 137° + 59°. Before seeing the Stonyhurst observation, I attributed the fireball to a shower near β Ursæ Majoris, at 162° + 58°, from which I saw many swift streak-leaving meteors at the end of November and beginning of December, both in 1885 and 1886. I have a strong suspicion the observed paths of the fireball are slightly in error, both as to direction and length, and that the radiant should be near β Ursæ. In this case the motion would have been from near Guisborough to Harewood at heights of about 68 and 27 miles, but this does not differ materially from the course previously assigned.

In presence of the doubts as to the fireball's exact path in the air, it is most desirable to hear of further observations, and re-investigate it. W. F. DENNING

Bristol, December 11

THE DISPERSION OF PLANTS BY BIRDS

THE part taken by birds in the dispersion of plants is one of great interest in view of the difficulty of accounting for the appearance of certain species in remote islands, no less than in localities nearer to each other, or divided by such barriers as mountain-ranges or deep seas. This subject has, more or less, engaged the attention of botanical travellers from the time when Darwin published his classical "Journal of Researches," nearly fifty years ago, down to the publication of Mr. Hemsley's "Botany of the *Challenger* Expedition," Part I., which was issued as lately as last year. In the careful summary of plants probably distributed by birds, *loc. cit.* pp. 44-49, it is mentioned that seeds may be carried by birds in either of two ways. First, by seeds, especially those provided with barbs and hooks, attaching themselves to the feathers of birds, and, in the case of aquatic or burrowing birds, being embedded in mud and thus carried accidentally outside; or, secondly, by seeds swallowed by frugivorous birds being for a time lodged within, and dejected afterwards in such a state as to be capable of germination. My object now is not to treat generally of this subject, but to place on record two remarkable and striking instances where seeds carried and dispersed by birds have come immediately under my own observation. The examples which I shall here describe will, I believe, show clearly that birds are capable of acting as very effective agents in the dispersal of plants, and that the results are so apparent as to be placed beyond reasonable doubt.

In cases where seeds of a light character are provided with barbs or hooks, they are well adapted for attaching themselves to passing objects, and are most favourably placed for dispersal by means of birds. The particular plant with barbed seeds which I describe under this category has not, I believe, been mentioned before; but it is deserving of notice, as it fully meets all the requirements incidental to this form of dispersal, and, moreover, I have had, for some years, very favourable opportunities of observing its behaviour. This plant is *Uncinia jamaicensis*, Pers. (Cyperaceæ), which grows in damp places in the mountains of Jamaica, at elevations of 5000 to 6000 feet. It is generally found overhanging small pools of stagnant water or on banks of mountain rivulets. Its slender tapering spikes, when ripe, literally bristle with long exserted rachilla, each shaped something like a shepherd's crook (hamate), but with the hooked part so closely fitting and elastic, that, if drawn along the back of the hand, it would grasp and draw out the finest hairs. Now, such places as are affected by this Uncinia are also the frequent resort of numerous birds that come there to drink or bathe, or to seek coolness and shade. In the case of migratory birds, and especially those that cover long distances in their flight, the high lands are generally those first touched. This is doubtless owing to the elevation at which they fly to escape surface-currents or local objects. I have often noticed birds from the north (the United States) on their way south, and again birds from the south returning to the north in early spring, frequenting the high lands of Jamaica, and resting there for a time before continuing their journey. Some such birds have been easily caught by hand, so exhausted were they with their long flight. In two instances I have found small migratory birds so completely entangled in the hooks of the Uncinia (*Gardener's Chronicle*, 1881, p. 780) that they were unable to extricate themselves; and, unless set at liberty at the time, would probably have died in that situation. In these instances the hooks of the Uncinia overstepped their proper function; for, obviously, no benefit would arise to the plant from the death of the birds, but only in the removal of the seed to another place. Larger birds, of course, would not be caught; but on the other hand, if they came within reach of the Uncinia, they could hardly get away without detaching a large number of the fruits and transporting them wherever they went. In the case of the Uncinia, there is present nearly every condition necessary to secure a very complete dispersion of its fruits. The plant, in the first place, is possessed of light portable seeds easily carried about from one locality to another; in the second place, the seeds are provided with highly specialised hooks which effectually grasp anything that comes within their reach; and lastly, the plant affects just those places which are visited by birds, and seldom fails to secure a sure and trusty carrier. It follows, as a matter of course, that *Uncinia jamaicensis* is found plentifully distributed in the track of migratory birds, and is found in similar situations in the mountains on the mainland in Central America, Venezuela, Ecuador, &c.

So much for seeds with barbs and hooks. We now come to the second class of seeds, namely, those which are swallowed by frugivorous birds and dejected in a state suitable for germination. The most striking example I know of the dispersion of such seeds, and of the results which immediately follow, are shown in connection with the pimento industry of Jamaica, which, as shown below, depends entirely for its existence on the offices of frugivorous birds. The pimento of commerce is the dried fruit of the pimento allspice, or Jamaica pepper-tree (*Pimenta vulgaris*). No other country supplies this article (although the tree itself is widely distributed both in the West Indies and on the mainland), and the value of the exports of pimento from Jamaica have reached (in 1880) a total of 100,000*l.* This is probably the largest spice industry in the world, and, to repeat what is mentioned above, it is wholly dependent upon the action of frugivorous birds. In Lunan's "Hortus Jamaicensis," vol. ii. p. 67, published about the end of last century, it is stated that "the usual method in forming a new pimento plantation or 'pimento walk' is nothing more than to appropriate a piece of woodland in the neighbourhood of a plantation already existing; or, in a country where the scattered trees are found in a native state, the woods of which being fallen, the trees are suffered to remain on the ground till they become rotten and perish. In the course of twelve months after the first seasons (rains), abundance of young pimento plants will be found growing vigorously in all parts of the land, being without doubt produced from ripe berries scattered there by the birds, while the fallen trees, &c., afford them both shelter and shade." In a foot-note it is added that "birds eagerly devour the ripe seeds of the pimento, and, muting them, propagate these trees in all parts of the woods. It is thought that the seeds passing through them undergo some fermentation which fits them better for vegetation than those gathered immediately from the tree." The present plan for forming pimento plantations in Jamaica is exactly as described above. In fact, the planters firmly believe that no other plan is likely to produce good pimento walks, although it has been shown by experiments in the Botanical Gardens that by careful treatment plants of pimento can be raised in nurseries in large numbers, exactly as any other economic plants. It remains, however, that all the present pimento plantations in Jamaica have been formed by the action of frugivorous birds, and to this agency alone we are indebted for the commercial supply of a most valuable and wholesome spice.

Kew, December 3 D. MORRIS

SOUNDING A CRATER

THE following is a brief account of my third ascent of Asama Yama, an active volcano about 75 miles north-west from Tokio. My first ascent was made in the spring of 1877. The time we stayed on the summit, which is about 8800 feet above sea-level, was exceedingly short. The crater looked like a bottomless pit, with perpendicular sides. It was audibly roaring, and belching forth enormous volumes of sulphurous vapour, threatening suffocation to any living thing they might envelop. The drifting of these vapours across the snow, with which the upper part of the mountain was covered, had rendered it so bitter that we were unable to use it as a means of quenching our thirst. A quantity of this snow was carried to the bottom of the mountain in a handkerchief, where it was bottled, and carried to Tokio for chemical examination. The examination, however, only yielded *pure* water, from which it was concluded that the liquefaction of the snow had been accomplished by heating over a fire, and whatever it was that had given the snow its peculiarly bitter taste had been evaporated. My next visit to Asama was in the spring of 1886. One of the chief objects of this expedition was to satisfy a curiosity which had arisen with regard to the depth of the crater. Many visitors to the summit reported that at favourable moments, when the wind had blown the steam to one side, they had been able to see downwards to an enormous depth. One set of visitors, who had remarkable opportunities for making observations, were convinced that if the crater was not as deep as the mountain is high above the plain from which it rises (5800 feet), it must at least be from 1500 to 2000 feet in depth. Although I had provided myself with sufficient wire and rope to solve this problem, owing to the inclemency of the weather and the quantity of snow then lying on the mountain the expedition proved a failure. One of our number had to give up the attempt to reach the summit at about 6000 feet above sea-level, while I and my remaining companion only reached it with great difficulty. Our stay was very short. The wind, which was at times so strong that we were often compelled to lie down, rendered it impossible to approach the crater, and after a few minutes' rest we beat a retreat, worn out with fatigue, across the snow-fields, towards our starting-point.

Two months after this, a visitor who ascended the mountain by moonlight reported that the crater was only 200 feet in depth, and that at the bottom there was a glowing surface. A second visitor, Colonel H. S. Palmer, R.E., estimated the depth as being between 500 and 600 feet. This estimate was based on the convergence of the walls of the crater, which he saw to the depth of about 300 feet, and the diameter of the crater, which he estimated by walking round a semi-circumference as about 370 yards. Previous estimates of the diameter had been 200 yards, three-fourths of a mile, and 1000 metres. The Japanese say that the periphery is 3¾ miles. These last estimates, as pointed out by Colonel Palmer, are nearly in the ratio of 10, 81, 85, and 150!

These wildly discordant results as to the dimensions of Asama, and the increasing curiosity on this question, led me, in conjunction with Messrs. Dun, Glover, and Stevens, to face the fatigue of ascending Asama for the third time. We left our resting-place, Kutoukake, at the foot of the mountain, at 4.30 a.m. on the morning of October 2, and in company with five coolies we reached the summit at 11 a.m. After a short rest, we commenced our measuring operations, the general arrangements of which were entirely the suggestion of Mr. Dun. When these are explained, they are no more remarkable than the manner in which Columbus caused the egg to stand; but before Mr. Dun made his suggestion, the various schemes which were proposed would, to my mind, have been unpractical and unsatisfactory. One suggestion was to roll a cannon-ball, with a string attached, down the crater; another was to shoot an arrow carrying a string into the hole; a third suggestion was to fly a kite across the crater; &c., &c.

Mr. Dun's method, as carried out, was as follows:—First, a light rope some 500 yards in length was attached to a block of rock lying on a high portion of the rim of the crater. Next, this rope, which I shall call the cross-line, was carried round the edge of the crater for about 150 or 200 yards. Here a heavy brass ring was tied upon it, and through the ring was passed the end of a copper wire coiled on a large reel. This was the sounding-line. Close to the ring, a string, which I shall call the guy-rope, was made fast to the cross-line. This being completed, the cross-line was then carried on round the rim of the crater until it reached an eminence, as near as we could judge, opposite to the point where the other end of it was attached to the block of rock. After this, the same line was jerked clear of pinnacles and boulders lying round the edge of the crater. The cross-line now formed two sides of a triangle, stretching across the crater from where the ring and lowering apparatus were to two points diametrically opposite to each other. By letting out the guy-rope, the cross-rope could be stretched until it formed a diameter to the crater, with the ring in the middle. The getting of these ropes into position was a matter of no little difficulty. First was the fact that clouds of vapours not only prevented us from seeing from station to station, but also from seeing far out into the crater. Secondly, on account of the hissing and bubbling noises in the crater itself, we could only communicate with each other by sound for short distances. And, thirdly, there was the difficulty of clearing the cross-rope from the ragged edges of the crater, which involved considerable risks in climbing. All being ready, word was passed along to haul on the cross-rope; and, as it tightened, the guy-line was let out, together with the sounding-line, running parallel to it, but passing through the ring. Owing to the twisting of the cross-line by tension, and the consequent revolution of the ring, the wire was broken, and the first attempt at sounding failed. This difficulty was overcome by attaching the guy-rope to the ring itself. Very luckily, owing to the sounding-wire having been entangled in the cross-rope by the twisting before it broke, the apparatus it carried was recovered. This apparatus consisted of an iron wire, to which were attached a number of metals of low fusibility, like antimony, zinc, &c., together with pieces of wood, india-rubber, sealing-wax, &c. By the melting, burning, or fusing of some of these, it was hoped to obtain a rough idea of the temperature. Above these came a small net, containing what was christened the "automatic chemical laboratory." This consisted of pieces of blue and red litmus-paper, Brazil-wood paper, and lead paper. With the assistance of my colleague, Dr. E. Divers, I had planned a number of chemical tests; but from previous experience I had learnt the impossibility of carrying out anything but the simplest of experiments when working on the summit of a live volcano.

At the second sounding, at a distance of about 100 feet from the edge, bottom (side ?) was reached at 441 feet. The wire of metals, &c., came up without change, farther than the softening and bending of the sealing-wax. The automatic laboratory had a strong smell of the action of acid vapours. The blue litmus was turned red, and the lead paper was well darkened. Assuming the lead paper to have been blackened by sulphuretted hydrogen, then, as pointed out to me by Dr. Divers, the absence of this gas at the surface, and the presence of sulphurous acid, might be due to the decomposition of sulphuretted hydrogen by oxidation or by sulphurous acid in the presence of steam. The presence of sulphuretted hydrogen would indicate a relatively low temperature.

At the third sounding, the line, which was a copper wire, gave way at a depth of about 200 feet, carrying with it a mercurial weight thermometer and other apparatus which I had reserved for what I hoped to be the best sounding.

The fourth and last sounding was made, as measured on the guy-rope, at a distance of about 300 feet from the edge. In this case, the line, which was strong twine, after striking bottom when nearly 800 feet of it had run out suddenly became slack. On hauling up, 755 feet were recovered. The end of this line was thoroughly carbonised, and several feet were charred. Assuming that the guy-rope was paid out at an angle of 45°, we may conclude that the depth at this particular place was *at least* 700 feet. It is probable that the greatest depth is about 750 feet

A final experiment was to attach a stone to the end of the cross-rope, and then throw it into the crater, with the hope of hauling at least a portion of it up the almost perpendicular face on the other side. Unfortunately the line caught, and, in the endeavour to loosen it, it was broken.

Before we left the summit, we were very fortunate in obtaining views of one side of the bottom of the crater. This we did by cautiously crawling out upon an overhanging rock, and then, while lying on our stomachs, putting our heads over the edge. The perpendicular side opposite to us appeared to consist of thick horizontally-stratified bands of rock of a white colour. The bottom of the pit itself was white, and covered with boulders and debris. Small jets of steam were hissing from many places in the sides of the pit, while on our left, where we had been sounding, large volumes of choking vapours were surging up in angry clouds.

After this we descended the mountain, reaching our hotel at 8 p.m., after 15 hours' absence.

This concludes the narrative of a holiday excursion, partly undertaken with the object of making a few scientific observations. The results which were obtained are undoubtedly very few, while the labour which was expended and the risks which were incurred were very great. All that we did was to solve a problem chiefly of local interest, to learn a little about the nature of the gases which are given off by one of the most active volcanoes in this country, and to enjoy the spectacle of a phenomenon which it is the lot of very few to witness When a stranger gazes for the first time down upon the burnt and rugged sides of an apparently bottomless pit, which, while belching out enormous clouds of steam, roars and moans, he certainly receives an impression never to be forgotten.

The recorded eruptions of Asama took place in the years 687, 1124 or 1126, 1527, 1532, 1596, 1645, 1648, 1649, 1652, 1657, 1659, 1661, 1704, 1708, 1711, 1719, 1721, 1723, 1729, 1733, 1783, and 1869. This last eruption was feeble, but the eruption of 1783 was one of the most frightful on record. Rocks, from 40 to 80 feet in some of their dimensions, were hurtled through the air in all directions. Towns and villages were buried. One stone is said to have measured 264 by 120 feet. It fell in a river, and looked like an island. Records of this eruption are still to be seen, in the form of enormous blocks of stone scattered over the Oiwake plain, and in a lava-stream 63 kilometres in length. JOHN MILNE

Tokio, October 10

THE MATHEMATICAL TRIPOS[1]

II.

VERY important regulations came into effect in 1848. The examination, as thus constituted, underwent no further alteration till 1873, and the first three days remain practically unchanged at the present time. The duration of the examination was extended from six to eight days, the first three days being assigned to the elementary and the last five to the higher parts of mathematics. After the first three days there was an interval of eight days (soon afterwards increased to ten), and at the end of this interval the Moderators and Examiners issued a list of those who had so acquitted themselves as to deserve mathematical honours. Only those whose names were contained in this list were admitted to the five days, and after the conclusion of the examination the Moderators and Examiners, taking into account the whole eight days, brought out the list arranged in order of merit. No provision was made for any further examination corresponding to the examination of the Brackets, which, though forming part of the previous scheme, had been discontinued for some time. A very important part of the scheme was the limitation, by a schedule, of the subjects of examination in the first three days, and of the manner in which the questions were to be answered; the methods of analytical geometry and differential calculus being excluded. In all the subjects contained in this schedule, examples and questions arising directly out of the propositions were to be introduced into the papers, in addition to the propositions themselves. Taking the whole eight days, the examination lasted 44½ hours, 12 hours of which were devoted to problems.

In the same year as these regulations came into force, the Board of Mathematical Studies (consisting of the mathematical Professors and the Moderators and Examiners for the current and two preceding years) was constituted by the Senate. Although the new regulations had so strictly limited the subjects, and parts of the subjects, which could be set in the first three days, they had imposed no limitation whatever upon those which could be set in the last five days, the subjects of examination appearing in the schedule simply as pure mathematics and natural philosophy. Accordingly, the first matter to which the newly-constituted Board turned its attention was that of restricting the subjects on which questions should be set in the last five days of the examination.

It becomes necessary, therefore, at this point, to refer

[1] Address delivered before the London Mathematical Society by the President, Mr. J. W. L. Glaisher, M.A., F.R.S., on vacating the chair, November 11, 1886. Continued from p. 106.

briefly to the range of subjects which were included in the examination. Of the nature of the questions proposed prior to 1828, the first year in which all the papers were printed, very little can be known except what can be gathered from the problem papers and the specimens of the other papers that have been preserved;[1] but there can be no doubt that their character was determined by the ordinary Cambridge treatises then in use, which, it is well known, were far behind the corresponding treatises published on the Continent. Woodhouse's "Principles of Analytical Calculation" (1803), and "Plane and Spherical Trigonometry" (1809) are the earliest indications of the introduction of the analytical element into the mathematics of the University; a more decided impulse in this direction was given by the translation of Lacroix's "Differential and Integral Calculus" by Herschel, Peacock, and Babbage (1817), followed by Peacock's "Examples on the Differential and Integral Calculus," and Herschel's "Examples on the Calculus of Finite Differences" (1820).

The reform in the mathematical studies of the University which was effected by Herschel, Peacock, and Babbage, is well known. It is to them that we mainly owe the revival of mathematics in this country, and the restoration of intercourse with the rest of Europe after three-quarters of a century of isolation. Peacock was Moderator in 1817, and he ventured to introduce the symbol of differentiation into the examination, his colleague, however, retaining the old fluxional notation. The old system made its appearance once more in 1818, but in 1819 Peacock was Moderator again, with a colleague who shared his views, and the change was fully accomplished.

The introduction of the notation and language of the differential calculus into the Senate House examination forms an important landmark in the history of Cambridge mathematics. From that time onward the University began to make up slowly but surely the ground she had lost; step by step the analytical processes and methods superseded the older geometrical modes of treatment; and each year saw a substantial increase in the range of subjects included in the course of study.

Only second in importance to the revolution effected by the substitution of the differential for the fluxional calculus was the rise of analytical geometry in the first thirty years of the century; and, considering the amount of attention that this subject has received at Cambridge in the last fifty years, and the accessions that have been made in this country to the analytical theory of curves and surfaces, a peculiar interest attaches to the introduction into the University of the algebraic treatment of geometry and the early stages of its development. The first edition of Wood's "Algebra," which appeared in 1795, contained, as Part IV., a chapter of thirty pages "On the Application of Algebra to Geometry," in which are given the equations of the straight line, ellipse, cissoid, conchoid, and other curves, the construction of equations, &c. This chapter remained unchanged in the ninth edition (1830), and seems to have formed the only introduction to analytical geometry existing in the University until 1826, when Hamilton[2] published his "Principles of Analytical Geometry, designed for the use of Students in the University." This was not the first English treatise on analytical geometry, as Lardner's "Algebraic Geometry" was published, three years earlier, in 1823; but it was the first Cambridge book, and the first which included solid geometry. The problem papers from 1800 to 1820 show that at the beginning of the century analytical geometry was always represented to some extent, though scarcely as an independent subject, most of the questions relating to areas, loci, &c., in which but little more than the mode of representation by means of ordinates and abscissæ was involved. Hymers published his "Analytical Geometry of Three Dimensions" in 1830, and his "Conic Sections" in 1837. The latter at once superseded Hamilton's treatise, and remained the standard work on the subject for many years.

In applied mathematics the character of the questions proposed was largely influenced by the publication of Whewell's "Mechanics" (1819), Whewell's "Dynamics" (1823), Coddington's "Optics" (1823), Woodhouse's "Plane Astronomy" (1821-23), and Airy's "Tracts" (1826). A second edition of this last work, which appeared in 1831, contained a tract on the "Undulatory Theory of Light," a subject which was freely represented in the examination for many years. Not only were the questions modified, in character and range, by the publication of new mathematical treatises in the University, but they were also affected to a certain extent by some of the professorial lectures. At this time, too, the Smith's Prize examination exerted a beneficial effect upon the Senate House examination, certain classes of questions which were originally introduced into the former having shortly afterwards been admitted into the latter. Between 1830 and 1840, questions in definite integrals, Laplace's coefficients, electricity, magnetism, and heat were also introduced. There were no regulations of any kind, and the responsibility of introducing innovations and alterations rested solely with the Moderators and Examiners. The uncertainty as to the subjects that the examination would embrace, and the want of any due notice of any extension of them, were found to be serious inconveniences to the higher class of students, although, as has been already stated, the introduction of a new subject had been generally preceded by the publication of a work by a Cambridge mathematician, in which it was treated in a manner adapted to the examination.

The Board of Mathematical Studies was created by the Senate on October 31, 1848, and in May of the following year they issued a report to the Senate in which, after giving a short review of the past and existing state of mathematical studies in the University, they recommended that, considering the great number of subjects occupying the attention of the candidates and the doubt existing as to the range of subjects from which questions might be proposed, the mathematical theories of electricity, magnetism, and heat should not be admitted as subjects of examination. In the following year they issued a second report in which they recommended the omission of elliptic integrals, Laplace's coefficients, capillary attraction, the figure of the earth considered as heterogeneous, &c., besides certain limitations of the questions in lunar and planetary theory, &c. In making these recommendations the Board expressed their opinion that they were only giving definite form to what had become the practice in the examination, and were only putting before the candidates such results as they might themselves have deduced by the study of the Senate House papers of the last few years. The Board also recommended that the papers containing book-work and riders should be shortened.

From 1823 onwards, the examination was conducted in each year by four examiners—the two Moderators and the two Examiners, the Moderators of one year becoming as a matter of course the Examiners of the next. Thus of the four examiners in each year two had taken part in the examination of the previous year. The continuity of the examination was well kept up by this arrangement; but perhaps it had the effect of causing its traditions to be rather too punctiliously observed, the papers of each year being, as regards the subjects included, exact counterparts of the corresponding papers of the previous year. The resolutions of the Board in 1849-50 were not binding on the successive Moderators and Examiners up to 1872, but each year they seem to

[1] The problem papers were printed from 1779; but only those of the present century are accessible in the Cambridge University Calendars and other publications.

[2] Late Dean of Salisbury: born April 3, 1794; died February 7, 1880.

have felt themselves bound to follow the precedent of their predecessors, so that no new subjects were introduced. One would suppose from an examination of the papers set that those of the last five days must have been framed in accordance with a schedule as precise and detailed as that which governed the first three.

In 1865 the Board recommended that after 1866 Laplace's coefficients and the figure of the earth considered as heterogeneous should be included in the examination, but this appears to be the only extension of the range of subjects recommended by the Board during the time that the regulations of 1848 remained in force.

The period that followed the constitution of the Mathematical Board was one of activity in the whole University. The first examinations of the Moral Sciences Tripos and of the Natural Sciences Tripos were held in 1851. In 1850 a Royal Commission was issued to inquire into the University and Colleges, and in 1852 their Report was presented to Parliament. In consequence of this Report, a Bill was introduced into Parliament, which received the Royal assent in 1856; and, under its powers new statutes were framed, both for the University and the Colleges. Amid all these changes the Mathematical Board, though not very active, was not idle. The subjects which chiefly occupied its attention were the alteration of the date of the first three days from January to the previous June (as by recent changes the poll-men were examined in June, and so received their degrees seven months before the mathematical honour men), and the introduction of the *vivâ voce* element into the examination. Neither of these innovations, though frequently discussed and finally recommended by the Board, was received with much favour in the University. With regard to the latter, the opinion seems now to have become general that an admixture of the *vivâ voce* element, however valuable it may be in the lecture-room, is useless, or even worse, in testing the proficiency of candidates with the view to arranging them in strict order of merit. The change of time from January to June was at length effected, as will be seen, by the regulations which came into operation in 1882.

In 1866 the attention of the Board was directed to the exclusion of certain important branches of mathematics from the studies of the University, owing to the fact that they were not represented in the Tripos examination. The rewards attending a high place in the Tripos were so great that the reading of most of the best men was directed almost wholly to this end; it was therefore practically impossible to introduce new mathematical subjects into the University without assigning to them some place in the Tripos. Now, although the recommendations of 1849-50 had curtailed the range of subjects, the course had nevertheless extended itself in some directions—where the name of the subject permitted of such extension—and especially in analytical geometry and higher algebra. The fact of this extension taking place in certain subjects, while others were wholly omitted, alone sufficed to show the need of some revision of the limitations imposed upon the subjects that might be set. The Board, after careful consideration, came to the conclusion that the time had come when it was desirable to allow the candidates a certain option with respect to the higher branches of mathematics, and that this could be effected by increasing the number of subjects and arranging them in several divisions over which the marks were distributed in a known proportion. Each candidate would be at liberty to devote himself to such of the divisions as he thought most advantageous, there being nothing to prevent his taking up all the divisions, if it were possible for him to do so. In a Report dated May 8, 1867, the Board gave expression to these views, and recommended a scheme for the five days, according to which the subjects of examination were arranged in five divisions, with an approximately determinate number of marks assigned to each division. The subjects included in the five divisions were thirty-five in number, and included elliptic integrals, elastic solids, heat, electricity, and magnetism. On June 3, 1867, a syndicate was appointed by the Senate to consider the proposals of the Board; and the regulations recommended by this syndicate were approved by the Senate on June 2, 1868, and came into operation in January 1873.

In this new scheme of examination the three days were left unchanged, and the schedule of subjects for the five days, and their arrangement in divisions as proposed by the Board, were adopted with very slight modifications, the marks awarded to the five divisions being to those awarded to the three days in the proportion of 2, 1, 1, 1, $\frac{2}{3}$ to 1 respectively.[1]

The new regulations also made two other changes of importance: they added an extra day to the examination and increased the number of the examiners from four to five. The extra day was the day immediately following the three days, and it was devoted to easy questions upon the subjects in the five days' schedule. Although the papers set on this fourth day were put before all the candidates, they were taken into account along with the five-day papers, and not with the three-day papers; so that this day had no effect upon the alphabetical list of those who deserved mathematical honours; which, as before, was dependent upon the three days' marks only.

The Additional Examiner was appointed on the nomination of the Mathematical Board, and held office for one year only; and, to render his duties as little irksome as possible, he was not required to take part in the first three days—the most laborious part of the examination as far as the looking over the papers is concerned, on account of the quantity of work sent in. It was thought that in introducing the new subjects of electricity and magnetism into the examination, certain non-resident Cambridge mathematicians whose names were closely connected with great recent advances in these subjects might be willing to give the University the benefit of their assistance, and that the influence of eminent non-resident mathematicians upon the examination, and therefore also upon the course of studies in the University, would be of the greatest value. These hopes were abundantly justified.

The general working of the new system soon disclosed the fact that the desired effect of inducing the best candidates to make a selection from the higher subjects, and concentrate their reading, had not been attained. It was found that, unless the questions were made extremely difficult, more marks could be obtained by reading superficially all the subjects in the five divisions than by attaining real proficiency in a few of the higher ones; and the best men of the year were tempted, not to say compelled, to extend their reading as widely as possible over the book-work of the whole range of subjects. Thus, with respect to the main object which the framers of the scheme had in view, it was a complete failure.

Accordingly, on May 17, 1877, a syndicate was appointed by the Senate to consider the higher mathematical studies and examinations of the University. This syndicate consisted of eighteen members representing nearly all phases of mathematical research and study in Cambridge; they met every week during the whole academical year, and the thorough examination and discussion that the subject received, both on the syndicate and in the University at large, brought out in the strongest light how great were the intrinsic difficulties connected with the retention of the order of merit, and how wide was the diversity of opinion—so much so, that at one time it seemed almost hopeless to attempt to devise a scheme

[1] The regulation assigning the proportion of marks to be awarded to the different divisions was one which was found in practice very difficult to carry out, even approximately.

that should receive a fair amount of general support. Even when the subjects were restricted, as they had been in the twenty-five years from 1848–72, it was sufficiently difficult to include in one list all the various classes of candidates—those who may be described as professed mathematicians, who intended to devote themselves to mathematics after their degree as investigators or teachers; those who adopted mathematics as their subject of study on account of its unrivalled mental training, and subordinated their whole reading to the single object of obtaining the highest place their abilities would enable them to reach; and those who, without any hope of obtaining a good place in the list, desired, nevertheless, to graduate in the Tripos, on account of the high position held by mathematics among the branches of a liberal education. But, when the range of subjects was extended, there was the further dilemma: if there was to be a single order of merit, all the questions must be submitted to all the candidates; but, if a candidate was to be at liberty to attempt all the questions, it appeared that, under any scheme that could be devised, the best candidates would find it more to their advantage to read the elementary portions of all the higher subjects than the higher portions of a few. If the questions were to be alternative, how could the order of merit be retained? How was it possible to compare one student's elliptic functions with another's elastic solids? was a question often asked.

It was keenly felt in the University that subjects like heat, electricity, and magnetism could not with propriety be omitted from the course systematically studied by candidates for mathematical honours. On the other hand, it was universally admitted that, by the extension of the range of subjects, the severe strain of the competition had been intensified to an injurious extent; and not only had the addition of the new subjects aggravated the evils arising from excessive competition, but they had even caused a deterioration in the quality of the work of many of the students, who were led, in the hope of gaining higher places, to attempt matter really beyond their grasp. The opinion was expressed on the syndicate that the only escape from the dilemma was by abandoning the order of merit. The majority, however, preferred to attempt some other remedy without interfering with the final form of the Tripos list, which had been of such immense service to the University in the past, and was connected with so many valued associations. They therefore proposed, as the only method by which the pressure on the mathematical candidates could be relieved, to omit a varying portion of the higher subjects of examination in each year.

The Report of the syndicate was presented to the Senate on March 29, 1878. They recommended that the nine days of the examinations should be divided into three groups of three days each, called Parts I., II., and III. Part I. was to be the same as the first three days in the schemes that came into operation in 1848 and 1873. Part II. was to be conducted according to a schedule of subjects considerably more restricted than the unwritten schedule that ruled the five days from 1848 to 1872. It included the more elementary portions of most of the ordinary subjects, such as differential equations, hydrostatics, rigid dynamics, optics, spherical astronomy, &c, but excluded calculus of variations, thermodynamics, physical optics, &c. It was proposed to move forward the time of examination in these first two parts, from January to the previous June, *i.e.* two years and nine months from the time of coming into residence of the students. After the examination in Parts I. and II. a list of the candidates was to be published, arranged in three classes as before, the senior and junior optimes being placed in order of merit, and the wranglers in alphabetical order. Only the wranglers were to be admitted to Part III., which was to take place at the old time in the following January. A final list was then to be issued in which the wranglers were to be placed in order of merit, the marks obtained by them in all three parts being added together. The most important part of the scheme was the schedule of subjects for Part III. It contained all the subjects which were included in the schedule of the five days of the then existing examination (for the syndicate had decided that they would neither propose the addition of any new subjects nor the omission of any that had been already included), divided into three groups, A, B, C. It was recommended that questions from the subjects in group A should be set every year, and that questions from groups B and C should be set in alternate years. It was thus proposed to establish, as it were, a "rotation of subjects." This scheme was voted upon by the Senate on May 13, 1878, when all its essential features were rejected. The division of the examination into three parts, of which the first two should take place in June and the third in the following January, was agreed to, as also was the limitation of Part III. to wranglers; but the carrying over the marks of the wranglers from June to January and the proposed rotation of subjects were rejected.

It is evident that the acceptance of the scheme, even by those who assented to its principle, depended largely upon the manner in which the subjects were divided into the three groups A, B, C. Whether a satisfactory division of the subjects was possible is very doubtful; but it is certain that the grouping of the subjects proposed by the syndicate was extremely unsatisfactory.

This scheme, though it never came into operation, will be memorable in the history of the Tripos as the final attempt made to retain the order of merit in its old form. With its rejection there passed away all hope of expressing the results of the whole examination by means of a single order of merit. The scheme also deserves notice for its own sake, if only on account of the influential mathematicians who supported it.

The syndicate then proceeded to build a new scheme upon the ruins of the old. They considered that the result of the voting on the nineteen graces in which the previous scheme had been submitted to the Senate showed that it was the opinion of the University that the examination in Part III. should be independent of the preceding parts, and that no scheme would be acceptable in which it was not provided that all the subjects should be included in the examinations of each year. They accordingly presented a Report to the Senate in October 1878, in which they proposed that in June, immediately after the examination in Parts I. and II., the complete list of wranglers, senior optimes, and junior optimes should be issued arranged in order of merit, that Part III. should be a separate examination, to which wranglers only should be admissible, and that after the examination in Part III. a list should be issued in which the candidates were arranged in three classes, the names in each class being arranged in alphabetical order.

The schedule of subjects consisted of all the existing subjects divided into four groups, A, B, C, D. Group A contained the pure mathematics; Group B, the astronomical subjects; Group C, hydrodynamics, sound, physical optics, elastic solids, &c.; and Group D, heat, electricity, and magnetism. In order to encourage the candidates to specialise their reading, one of the regulations authorised the Moderators and Examiners to place in the first division a candidate who showed eminent proficiency in any one group; so that it was not absolutely essential for a student, in order to be placed in the first division, to extend his reading beyond the subjects of a single group.

This scheme was approved by the Senate on November 21, 1878, and it came into operation in 1882, the first examination in Part III. taking place in 1883.

Parts I. and II. taken together differed in no essential respects from the Tripos as it had existed from 1848. The five days of the scheme of 1848 were reduced to three, and the range of subjects was more limited; otherwise the examination was exactly the same as in the period 1848–72. But Part III. was a complete novelty, and a great deal of curiosity was felt as to how the first Moderators and Examiners would interpret the regulations. Would the new examination resemble, as regards the character of the questions set, the last three days of the old five days, or was the examination to be one of a distinctly higher order? The result showed that the latter anticipation was the correct one. No longer hampered by the order of merit, the examiners felt themselves free to set difficult and elaborate questions, such as were only appropriate to specialists in the particular subjects; and a new departure was made.

As soon as the new system came into full operation, it was found that it needed amendment in various respects; and this is not to be wondered at, considering that it had been constructed in order to fit in with the few regulations that had escaped the general massacre of May 1878, and that almost every part of it was the result of a compromise. It was found that the interval between June and January—less than seven months, and including a long vacation in which very few lectures were given—was too short for an adequate preparation for Part III. It is true that most of the work for Part III. could be done—and indeed was done—before the examination in Parts I. and II.; but the competition in these two parts remained as keen as ever, and, as the examination became imminent, the candidates were tempted to neglect the higher work, and give their whole attention to the more elementary subjects, upon which the list in order of merit depended. As a consequence there was a diminution in the numbers of students attending the higher mathematical lectures in the University. With respect to the actual conduct of the examination, it was found that the strain upon the Moderators and Examiners was very serious, and general regret was expressed that under the new scheme no provision had been made for the annual appointment of an Additional Examiner, as in the previous scheme which had been in operation from 1873 to 1882. Under the new system the candidates devoted themselves to special branches of the higher mathematics, and there was even greater difficulty in adequately representing all the subjects of examination. Accordingly, on June 12, 1884, the Senate confirmed a Report of the Mathematical Board recommending that the examination in Part III. should take place in June, exactly a year after that in Parts I. and II., and that the Moderators and Examiners, with the Chairman of the Mathematical Board, should nominate an Additional Examiner, the first nomination being made in the Easter term, 1885, and having reference to the examination in January 1886. It was considered that the Moderators and Examiners were themselves the best judges of the branches of mathematics in which they most desired assistance, and were therefore the most suitable body to nominate the Additional Examiner.

The last time that the whole examination took place in January was in 1882. This year (1886) the examination in Part III. has taken place in January for the last time, so that the historic connection between the Tripos and the month of January has now finally ended. Henceforth the examination in all three parts will take place in the middle of the year.

(*To be continued.*)

EARTHQUAKE AT SEA

We have received the following communication from Mr. R. H. Scott, F.R.S., Secretary, Meteorological Office:—

British Consulate, St. John's, Porto Rico, November 4, 1886

Sir,—I have the honour to inform you that Mr. J. Simmons, master of the British brigantine *Wilhelmina*, of Lunenburg, now loading in this port, has reported to me that, on October 20 last, at 4.30 p.m., while in latitude 19° 21′ N., and longitude 64° 22′ W., he felt a shock of earthquake which caused the ship to tremble. The shock lasted one minute, and was accompanied by a loud rumbling noise like distant thunder. Capt. Simmons states further that, were it not that he believed the depth of water at the spot to be no less than two thousand fathoms, he could have imagined that his vessel was running upon the rocks, so great was the vibration and so loud the noise. I have thought it my duty to report this occurrence officially, as it seems not improbable that some volcanic disturbance is in operation in the locality herein referred to.

I have the honour to be, Sir, your most obedient humble servant,

Reginald H. Hertslet,
H.M. Consul

The Assistant Secretary, Marine Department,
Board of Trade

NOTES

We regret to hear of the death at Calcutta of Father Scortechini from dysentery. He has succumbed to his extraordinary exertions in the botanical exploration of Perak, where he had made very large and valuable collections. These he intended to make the basis of a flora of this native State in collaboration with Dr. King, the Superintendent of the Royal Botanic Garden, Calcutta. His collections will, as far as possible, be made use of by Sir Joseph Hooker in the portions of the flora of British India now in progress at Kew.

One of the severest storms of recent years swept over the country in the middle of last week, being indeed a storm seldom paralleled for its wide-spread destructiveness. The damage to property and the loss of life have been exceptionally great, and each morning newspaper has been adding to the long tale of losses and disasters. Another peculiarity of the storm is that it was heralded with only the slightest premonitions of its approach. It was at Valencia only that the observations of the previous evening indicated a storm, and these even seemed to foreshadow no more than a subsidiary cyclone. But on Wednesday morning last week the centre of the storm had already advanced on the north-west of Ireland, where at Belmullet, at 8 a.m., the barometer had fallen, at 32° and sea-level, to 27·580 inches. In the course of the day the cyclone moved eastward at the rather slow rate of 20 miles an hour, and by 6 p.m. its centre was near Barrow-in-Furness, where the barometer is stated to have fallen to 27·410 inches. The centre passed somewhat to the south of Edinburgh, about half-past seven, pressure being then 27·650 inches, and the wind easterly. The greatest interest is attached to the observations that may have been made in the north of England and the south of Scotland during the evening of Wednesday week, from which the path of the cyclone may be traced; and particularly, if the low reading at Barrow-in-Furness be confirmed, what lower readings of the barometer were made to the eastward. But in any case it is plain that in this part of Great Britain, on the evening of Wednesday week, pressure fell nearly as low as it did on January 26, 1884, at Ochtertyre, Perthshire, where it fell to 27·333 inches; and it is remarkable that these two low barometers, hitherto the lowest observed by man anywhere on the land surfaces of the globe after being reduced to sea-level, have occurred in the British Islands, and within three years of each other. It is noteworthy that the lowest pressure on Ben Nevis was 23·451 inches at 2h. 31m. p.m., and that at the height of the storm, at 6 p.m., the wind was south-east, and blowing at the rate of fully 120 miles an hour—thus indicating that the storm was not only wide-spread, but that it also, as regards direction and force of wind, extended to a greater altitude than the Ben Nevis Observatory.

MR. T. H. COX, of the firm of Cox Brothers, manufacturers, Camperdown Linenworks, Lochee, has given a donation of 12,000*l.* for the endowment and equipment of a Chair of Anatomy in connection with the Medical School it is proposed to establish in University College, Dundee.

WE are glad to notice that in the new French Ministry M. Berthelot, the eminent chemist, takes the portfolio of Education.

AN electrical metronome has been established at the Paris Opera House, which enables the *chef d'orchestre* to conduct choruses at any distance from his chair. The working is very satisfactory, and the effect really admirable.

THE late Prof. Morris at the time of his death had made considerable progress with a third edition of his "Catalogue of British Fossils." Some of his friends, reluctant that so valuable a work should be lost to science, have arranged to revise and complete the manuscript, and the necessary expenses of preparing it for the press have been guaranteed by his nearest surviving relative, who rightly holds that this will be the best monument to his memory. The editor-in-chief is Dr. H. Woodward, of the British Museum, and he is assisted by a number of eminent specialists, among whom are Drs. Hinde and Traquair, Profs. Duncan, Rupert Jones, Lapworth, Nicholson, and H. G. Seeley, Messrs. Carruthers, Etheridge, Hudleston, and Lydekker. The Syndics of the Cambridge University Press have now undertaken the publication of the work, which it is hoped may appear in the course of the coming year.

THE annual distribution of prizes and certificates to the successful students at the City and Guilds of London Institute was held on Monday night, when the Lord Chancellor gave an address in which he contrasted the restrictions which hampered industrial progress in the past with the complete freedom and publicity of the present day.

A VIOLENT shock of earthquake occurred at Smyrna and also at Chios on the morning of December 11. Frequent oscillations have been felt at Smyrna during the past fortnight, causing fissures in the walls and fronts of many houses in the town. A shock was felt on the 8th in Missouri City and in Missouri State, and a shock is also reported from Columbia, South Carolina. On the night of November 1, at 12.15 p.m., a sharp shock was felt at Nordheinsund, on the west coast of Norway. Houses and windows shook, whilst a man walking in the road felt the earth slowly rock under him. The shock, which was accompanied by a heavy rumbling noise, was from north-west to south-east.

A CORRESPONDENT in South Africa writes:—"*Rogeria longiflora*, the Martynia-like plant, has capsules which pierce the lips of the gnu or 'wildebeest,' and are rubbed to pieces in their efforts to get rid of them. Truly, what with *Uncaria*, costing the life of a springbok for every capsule trodden out, and *Rogeria* festering in the poor 'wildebeest's' mouth, the beneficent 'Nature' of the teleologist is in Africa a remarkably cruel divinity."

IN an interesting recent paper on Siberia as a colony, Prof. Petrie points out that there are two classes of colonists there—those attracted by the immense wealth of the country in furred animals and minerals, and an industrious people from the Russian peasant class engaged in agriculture. The number of wild animals taken in the boundless forests of Siberia shows a great reduction from year to year. The fisheries are capable of great development, and multitudes of fish are thrown away because the art of salting and preserving is not understood. In Ural, the southern steppes, Altai, and other places, there is immense mineral wealth in silver, gold, iron, lead, copper, anthracite, graphite, &c. The steppes (quite different from the Central Asiatic and Kirghisian) are well suited for cattle-breeding; they have excellent grass and numerous birch woods, and also many lakes, large and small. In Western Siberia, about 32 per cent. of the whole land is arable. With her four rivers of the first rank, three of them flowing north and the other east, Siberia is well off for intercommunication by water and for transport of commerce to neighbouring countries. Notwithstanding three hundred years of occupation, the Russians in Siberia only amount to 4,800,000, and there are nearly as many natives. The Russian colonist in Siberia diverges from the Sclav type, as the Yankee does from the Englishman. At present, farming and cattle-breeding in Siberia are carried on in an irrational way, commerce is in absolute dependence on European Russia, and the roads are dreadfully bad, so that, *e.g.*, people commonly make circuits rather than use the post route from Tomsk to Irkutsk. There is, however, a party of intelligent Siberians bent on gaining the liberties and advantages of the mother country, stopping the deportation of criminals, and promoting education, &c. Many thousand roubles have been contributed by Siberian merchants to found the Tomsk University and other institutions.

MR. J. B. MEDLAND, of 12, Borough, has sent us a specimen of his new portable cabinet for microscope-slides. The cabinet has sixteen trays to hold nine objects each, contained in a well-made polished pine case. When closed, it is the same height and width, and only two inches and a half longer than the ordinary case holding only half the number. Each glass slip is held at its ends by the projecting side flap of the tray, which is held down by the succeeding tray, and so on, the lid holding the whole firmly down. When open, the lid and front fall back, forming a stand or table to place the trays upon, keeping them together and less liable to get displaced or upset, as when placed among other apparatus or upon the desk or work-table. The advantages of the cabinet will be obvious to microscopists.

A WORK by Mr. J. Allen Brown will appear early in January, published by Messrs. Macmillan and Co., entitled "Palæolithic Man in North-West Middlesex; the Evidence of his Existence, and the Physical Conditions under which he lived in Ealing and its Neighbourhood, illustrated by the Condition and Culture presented by certain existing Savage Races."

THE Council of the Essex Field Club has determined in future to issue the *Transactions* and *Proceedings* of the Club combined in the form of a monthly periodical, entitled *The Essex Naturalist; being the Journal of the Essex Field Club.* The journal will contain papers read before the Club, reports of past and announcements of future meetings, and, as space allows, notes and communications upon any matters of interest connected with the natural history, botany, geology, and prehistoric archæology of Essex. We believe that this is a new departure in the policy of local societies, at least in the south of England, but the plan has been adopted by the Essex Club from a rapidly growing conviction that, if local societies are to flourish and do useful work, it is necessary to devise some means of "keeping touch" with their members, and encouraging intercommunication among them. The first number of the *Essex Naturalist* will appear in January next, and will be conducted by Mr. W. Cole, who has edited the publications of the Club since its establishment seven years ago.

THE Japanese Government has despatched an official of the Ministry of Commerce to Norway, in order to study the cod-fisheries, the preparation of oil, &c., in that country, the object being to develop these industries in Northern Japan, where large numbers of cod appear at certain seasons.

SOME important geological work has just been carried out at Landsort, near Stockholm. Close to the coast, pipes have been driven through the rock to the sea, by which sea-water will be carried up into a specially constructed kiosk for examination and registration, the object being to measure the elevation of the shore in course of time. It is intended to establish similar stations at various places on the coast.

BETWEEN 8 and 9 o'clock on November 3 a remarkable phenomenon was observed at Hamar, in Norway. At the time there was perfect darkness, when, suddenly, a bright white cloud appeared in the sky, drifting in a north-easterly direction, and from time to time emitting brilliant rays of light in various directions. The cloud retained throughout its original form, and disappeared at last in the darkness.

FISH-HATCHING operations have now commenced at the establishment of the National Fish Culture Association. The new hatchery that has lately been constructed is completed, and a batch of ova has already been laid down for incubation. These were taken from *Salmo fontinalis* located in the ponds of the establishment. A large number of rainbow trout (*S. iridens*), of California, hatched out two years ago by the Association, from ova sent by the American Government, will be ready to spawn at the end of the year, which is six weeks earlier than in their native waters. This shows to what extent fish alter their natures and habits according to the climatic and other conditions of their locations. The *S. iridens* is a late spawner in its native country, which is accounted for by the hardness of the water and the low temperature that prevails. It is hoped to secure a large quantity of ova from these fish. The American Government have announced their intention of forwarding consignments of ova from Transatlantic Salmonidæ. A feature is to be made this year of hatching ova for Fishery Boards and other public bodies, who will collect ova from their respective waters and forward them to the Association for incubation. When hatched, the fry will be turned into the parts from whence they came.

ACCORDING to the *Colonies and India*, a discovery of much geological interest has just been made at Cockatoo Island, Sydney. A large fossil shell of the genus Planorbis was found in the excavation for a new Government dock at Cockatoo Island, and was forwarded to Mr. Wilkinson, the Government Geologist of New South Wales. This being the first fossil shell found in the Hawkesbury formation, he took the opportunity of examining the rocks, but only obtained some fossil plants. As, however, the rocks looked promising for fossil remains, he sent the collector, Mr. Cullen, to make a further search, which was rewarded by the discovery of a most interesting fossil, which Prof. W. J. Stephen has identified as *Mastodon aurus*, of which a similar fossil specimen from Stuttgart is in the collection of the Sydney University. This being the first discovery in Australia of Labyrinthodon, is of much scientific importance, as proving the Triassic age of the Hawkesbury sandstone formation.

THE first number is to hand of the *Proceedings* of the Camera Club, the President of which is Capt. Abney. It is nicely printed, and will no doubt prove useful to members and to photographers generally.

THE additions to the Zoological Society's Gardens during the past week include a Sclater's Curassow (*Crax sclateri* ♀) from South America, a Razor-billed Curassow (*Mitua tuberosa*), a Lesser Razor-billed Curassow (*Mitua tomentosa*) from Guiana, presented by Rear-Admiral Fairfax, R.N., F.Z.S.; a Spanish Terrapin (*Clemmys leprosa*) from Spain, presented by Miss Eden; eighteen Brown Newts (*Spelerpes fuscus*), South European, presented by Prof. H. H. Giglioli, C.M.Z.S.; two European Phyllodactyles (*Phyllodactylus europæus*) from Cannes, presented by Mr. J. C. Warburg; two Peruvian Thicknees (*Œdicnemus superciliaris*) from Peru, an Allied Saltator (*Saltator assimilis*) from Brazil, an Australian Sheldrake (*Tadorna tadornoides*) from Australia, received in exchange; a Common Zebra (*Equus zebra* ♂) from South Africa, two Shore Larks (*Octocorys alpestris*), British, purchased.

OUR ASTRONOMICAL COLUMN

PUBLICATIONS OF THE WASHBURN OBSERVATORY, VOL. IV. —In the month of March 1884, Prof. Holden offered to Prof. Auwers to undertake the observation at Madison of the 303 fundamental stars required for the southern zones of the Astronomische Gesellschaft. In view, however, of the smallness of the staff of the Observatory, Prof. Holden would only pledge himself to secure four complete observations of each star; but, with his assistants, Mr. Comstock worked with so much zeal and energy that on his appointment to the Lick Observatory in the autumn of 1885, the stars from 0h. to 6h. of R.A., and from 12h. to 24h. had all been completely observed six times, the number Prof. Auwers had desired, in each element. Mr. Updegraff and Miss Lamb, who had latterly been Prof. Holden's assistants, succeeded in bringing the entire work to completion by the close of 1885, no fewer than 6444 observations of stars, irrespective of observations of the nadir point, having been secured in the course of its carrying out. The observations were always kept in a forward state of reduction, and thus the present volume contains the results of the entire work. Prof. Holden was not, however, able to give the observations so full a discussion as he had intended, and as they themselves seemed to merit by their accuracy. The probable error of a single R.A. of stars of the 303 list, observed in 1884, he found to be ± 0·037s. for himself, ± 0·031s. for Mr. Comstock; and for a single declination, for himself ± 0″·400, for Mr. Comstock ± 0″·436.

The results of these observations, which were made with the Repsold meridian-circle of 4·8 aperture, an instrument of essentially perfect optical and mechanical quality, naturally occupy the greater part of the present volume. It also contains some other matters of interest, amongst which may be noted a series of observations with wire screens before the object-glass of the meridian telescope, for the purpose of ascertaining the effect of magnitude on the recorded time of transit, and the determination of the longitude of a station near the western boundary of Dakota. It has been Prof. Holden's effort also to make the collection of star catalogues in the library of the Observatory as complete as possible, and for that purpose he has bought most of the principal catalogues attainable, and marked in them, so far as possible, all the errata which were known to him. A list of the sources from whence these corrections have been derived is here given, and will doubtless be of considerable use to other astronomers.

THE SECOND ARMAGH CATALOGUE OF 3300 STARS.—Dr. Dreyer, on his appointment to the direction of the Armagh Observatory after the death of Dr. Robinson, found a great mass of unpublished meridian observations which had been accumulating since 1859, the date of the publication of the first Armagh Catalogue. On the completion of that great work, Dr. Robinson had formed the plan of re-observing a number of stars occurring in Baily's Catalogue from Lalande's "Histoire Celeste," and the observations were commenced in 1859, but the work was interrupted at the end of the following year, the Primate, Lord John George Beresford, having generously provided a new telescope of 7 inches aperture for the mural circle, instead of the old one of 3¾ inches aperture. The idea of Dr. Robinson, of converting the mural circle into a transit instrument by the addition of a second pier, was not, however, carried out. The observations were recommenced in April 1863, the Rev. W. H. Rambaut being the observer from August 1864 to July 1868, and the Rev. C. Faris from November 1868 to the beginning of 1882. Dr. Dreyer himself observed during 1883, with the end of which year the observations close. Considering that the majority of the stars had, in the course of late years, been observed in the zones of the Astronomische Gesellschafte, and that nearly all might be expected to be included in the forthcoming great Paris Catalogue, Dr. Dreyer thought it important to publish the Armagh results as speedily as possible, and the Government Grant Committee of the Royal Society having promised to meet the cost of publication, the present Catalogue was prepared. It contains the results of the whole of the meridian work carried on at the Observatory since 1859;

containing thus, with the first Armagh Catalogue, a complete record of all the meridian work accomplished at the Observatory since 1827; for the results published in the *Transactions* of the Royal Dublin Society in 1872, and forming a catalogue of 1000 stars, have been incorporated in the present work, as there were numerous unpublished observations of many of the stars there given.

The R.A.'s of the present Catalogue depend on the standard stars of the *Nautical Almanac*, four or five of which were observed on each night, whilst the N.P.D.'s depend upon observations of the nadir point, the adopted being 54° 21′ 12″·70. Dr. Robinson's investigation of the division-errors of the circle (*Mem. R.A.S.*, vol. ix.), and also his refraction-tables (Armagh Catalogue, pp. 834–35) have been used. The details of the construction of the refraction-tables, which may be considered as identical with Bessel's, are given in the *Transactions* of the Royal Irish Academy, vol. xix. The places of the stars are reduced to the epoch 1875·0, with Struve's constant, but proper motions were never taken into account. The Catalogue, which is very clearly printed, and forms a very compact and neat-looking volume, contains for each star its number in Lalande, its magnitude, generally from the DM., its mean R.A. and N.P.D. for 1875·0, together with the annual precession, the number of observations, the epoch and references to other modern star catalogues, this last column being very complete. The secular variation has been omitted. The introduction also contains a comparison between the present Catalogue and Prof. Grant's Glasgow Catalogue of 6415 stars, not only because it was deduced from observations made nearly at the same time as the Armagh observations and depended in R.A. on the *Nautical Almanac* stars, but also because it had already been rigorously compared by Prof. Auwers with his "Fundamental Catalogue." From the comparison of 539 which the two catalogues have in common, it would appear that the Armagh and Glasgow Catalogues, though perfectly independent of each other, are in fair agreement, so far as N.P.D.'s are concerned. But the R.A.'s appear less satisfactory, as considerable discordances are evident. These Dr. Dreyer thinks may be readily accounted for, partly by the one-sided character of the instrument, partly by the conjecture that perhaps the azimuth found by observing the meridian mark may not be strictly applicable on the opposite (south) side of the zenith. The comparison with Auwer's "Fundamental System" gives a similar result, the N.P.D.'s agreeing much better than the R.A.'s. The probable error of a single observation found from 400 observations of 80 stars between 30° and 100° N.P.D. was R.A. ± 0·081s., N.P.D. ± 0″·85.

Great credit is due to Mr. Faris for his perseverance in continuing and reducing the observations during thirteen years, and to the present Director for his energy in completing and publishing the entire results, which will not fail to be a useful addition to our star catalogues.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *DECEMBER* 19–25

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on December 19

Sun rises, 8h. 4m.; souths, 11h. 57m. 21·5s.; sets, 15h. 50m.; decl. on meridian, 23° 26′ S.: Sidereal Time at Sunset, 21h. 43m.

Moon (one day after Last Quarter) rises, 0h. 42m.; souths, 6h. 52m.; sets, 12h. 51m.; decl. on meridian, 1° 8′ S.

Planet	Rises h. m.		Souths h. m.		Sets h. m.		Decl. on meridian ° ′
Mercury ...	... 6 3	...	10 26	...	14 49	...	18 54 S.
Venus ...	... 8 25	...	12 14	...	16 3	...	23 58 S.
Mars ...	... 10 0	...	14 2	...	18 4	...	22 4 S.
Jupiter ...	... 2 53	...	8 3	...	13 13	...	10 31 S.
Saturn ...	... 17 35*	...	1 39	...	9 43	...	21 38 N.

* Indicates that the rising is that of the preceding evening.

Occultations of Stars by the Moon (visible at Greenwich)

Dec.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
19 ...	γ Virginis ...	... 2½ ...	1 50 ...	2 34	... 74 170
19 ...	B.A.C. 4277	... 6 ...	2 55 ...	3 21	... 100 148

Dec.	h.	
20 ...	15 ...	Jupiter in conjunction with and 3° 24′ south of the Moon.
21 ...	— ...	Sun at greatest declination south; shortest day in northern latitudes.
22 ...	14 ...	Mercury at greatest elongation from the Sun, 22° west.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.
U Cephei	0 52·2 ...	81 16 N. ...	Dec. 23,	0 44 *m*
Algol	3 0·8 ...	40 31 N. ...	,, 24,	4 9 *m*
λ Tauri	3 54·4 ...	12 10 N. ...	,, 20,	6 42 *m*
			,, 24,	5 35 *m*
U Monocerotis ...	7 25·4 ...	9 32 S. ...	,, 22,	*M*
W Virginis	13 20·2 ...	2 47 S. ...	,, 24,	21 30 *m*
δ Libræ	14 54·9 ...	8 4 S. ...	,, 20,	20 33 *m*
			,, 23,	4 24 *m*
U Coronæ	15 13·6 ...	32 4 N. ...	,, 20,	19 57 *m*
			,, 24,	6 48 *m*
V Ophiuchi ...	16 20·4 ...	12 10 S. ...	,, 24,	*M*
R Scuti	18 41·4 ...	5 50 N. ...	,, 22,	*M*
δ Cephei	22 24·9 ...	57 50 N. ...	,, 23,	2 20 *M*

M signifies maximum; *m* minimum.

Meteor-Showers

Ursa Major supplies a couple of radiants at this season—one near ι, R.A. 131°, Decl. 48° N., the other near α, R.A. 157°, Decl. 64° N. December 19 and 21 are fireball dates.

SANITARY PROGRESS DURING THE REIGN OF THE QUEEN[1]

IN opening the meetings of the One Hundred and Thirty-third Session, it appeared to me that, as we are entering upon the jubilee year of the Queen's reign, it might be interesting to take stock, as it were, of the progress which has been made by the nation in some one of the branches of usefulness to which the proceedings of this Society have contributed; and it occurred to me that the most fitting subject to select would be that of the progress which has been made in sanitation during Her Majesty's reign.

The year 1838 was the first complete year of registration.

The first report of the Registrar-General brought forward the sanitary condition of different parts of the country, and of different classes of the population. Disease was as prevalent amongst the labouring population in rural villages as it was in the most crowded and filthy districts in towns, and, on the motion of the Bishop of London, the House of Lords, in August 1839, presented an address to the Queen, begging her to direct an inquiry into this prevalence of disease. From this period may be said to date that great social and sanitary movement which has tended so largely to ameliorate the moral as well as the physical condition of the people of this island, and which forms one of the most prominent features of the Queen's reign.

The Poor-Law Commissioners were directed to report upon the condition of the labouring classes; and the direct evidence of much preventable disease, which the records of disease and death furnished from all parts of the country, formed the basis on which the Commission founded their recommendations. In towns, the people were crowded in courts and alleys; they swarmed in cellars which were neither ventilated nor drained. In 1837, it was calculated that one-tenth of the population of Manchester, and one-seventh of the population of Liverpool, lived in cellars.

The dead were buried in overcrowded churches, chapels, and churchyards in the middle of towns. The rural districts were no better.

In the towns this condition of things arose from the great increase of population which had been taking place for some years previously, coincident with the rapid expansion of our trade and manufactures, coupled with the absence of legislative provisions to meet the new exigencies which had arisen, and with which the older laws, in consequence of that increase, were unable to cope.

But there were other active causes. For instance, the Commissioners state that parochial administration operated mischievously in degrading the habitations of the labouring classes,

[1] Abstract of Address by Capt. Douglas Galton, C.B., F.R.S., at the opening of the Session of the Society of Arts.

and in checking tendencies to improvement. The depression of the tenement depressed the habits and condition of the inhabitants.

In speaking of the insanitary condition of houses, we must not forget the effect of the window tax. This tax had been established for 150 years. Air and sunshine are the first requirements of healthy dwellings, and the window tax induced every builder to shut out the sun and exclude the air, so that poor men were unable to afford the luxury of adequate windows for their dwelling-rooms, or of any windows for their closets. Darkness and dirt go hand in hand, and in the class of houses above the cottages, darkness and want of ventilation were much fostered by the window tax. This tax was not abolished till 1851.

At the commencement of the Queen's reign, drainage over the whole country was provided for by various Commissions of Sewers. Their duty was limited to causing "to be made, corrected, or repaired, amended, put down or reformed, as the case shall require, walls, ditches, banks, gutters, sewers, gates, cullises, bridges, streams, and other defences by the coasts of the sea and marsh ground."

The Highway Acts provided for road cleansing and road structure; and there was a law for cleansing of ditches, which forbade throwing offal and foul refuse into the ditches which might lead to the pollution of streams.

The most important, perhaps, because the most cheap and accessible, authority for enforcing the execution of the law for the protection of the subject against nuisances, and for punishing particular violations of it, was vested in the Courts Leet. The juries, commonly called "annoyance juries," impanelled to serve on courts leet in towns, perambulated their districts to judge of nuisances upon the view; but the Commissioners reported that, with all this legal strength, there was scarcely one town in England found in a low sanitary condition, or scarcely one village marked as the abode of fever, that did not present an example of standing violations of the law, and of the infliction of public and common as well as of private injuries, the tenements over-crowded, streets replete with injurious nuisances, the air rendered noisome by these and by the smoke from factory chimneys, and the streams of pure water polluted.

As regards smoke, most of the then modern private Acts contained penalties on gas companies, prohibiting their washings to contaminate streams, or using for steam-engines furnaces which did not consume their own smoke. The general statute, 1 and 2 Geo. IV., c. 41, empowered the Court to award costs to the prosecutor of those who used such furnaces; but the duty of informing was not placed on public officers, and private individuals were unwilling to become informers.

The provision of pure water, and the disposal of the water after it had been fouled, had scarcely been thought about. No doubt, in London, and in some large towns, water was provided by public companies or by the corporation; but in almost every country town the water supply was defective.

The report on the sanitary condition of the labouring classes states that it was difficult to conceive the great extent to which the labouring classes are subjected to privations, not only of water for the purpose of ablution, house-cleansing, and sewerage, but of wholesome water for drinking and culinary purposes. Whilst, however, the water supply was insufficient even in London, on the other hand the necessity for providing means for getting rid of the fouled water was generally ignored.

It is stated, in the report of 1842, that the courts inhabited by the poorer classes in towns are generally not flagged; they are paved with a sort of pebbles; they are always wet and dirty. The people, having no convenience in their houses for getting rid of waste water, throw it down at the doors; that scarcely one house for the working classes will be found in which there is such a thing as a sink for getting rid of the water. It mentions, in a typical case, that, where in one locality a large sewer had recently been made, the landlords are not compelled, and do not go to the expense of making any communication from the courts to the sewer; the courts are as wet and dirty, and in as bad a condition as they were before the sewer was constructed; and it is added that this miserable accommodation in the wretched courts pays a better percentage than any other description of property; it pays as much as 20 per cent. in many instances.

With regard to fæcal matter, the general practice had been for each house to have its cesspit, which was emptied at intervals by night men; but in the poor districts the soil was allowed by the occupiers to accumulate for years to avoid the expense of emptying. Within the preceding twenty years water-closets had been introduced into the better class of houses. The refuse from these was generally allowed to flow into the cesspits; but, to avoid the expense of frequent emptying, an overflow was made, where practicable, into sewers or adjacent ditches; in other cases the refuse was turned directly into the sewers, and created a dangerous deposit.

The danger had begun to be noticed long before; for in 1834 one medical witness stated to a Committee of the House of Commons that of all cases of severe typhus that he had seen, eight-tenths were either in houses of which the drains from the sewers were untrapped, or which, being trapped, were situated opposite gully holes; and the report of the Poor-Law Commissioners remarks that this recent mode of cleansing adopted in wealthy and newly-built districts by the use of water-closets, which discharge all refuse *at once* from the house through the drain into the sewers, whilst it saves delay, prevents accumulation, and also saves the expense of hand labour; yet has the objection that if much extended it may pollute the water of the river into which the sewers are discharged. They, however, recommend that this danger should be incurred, as a lesser evil than the retention of the refuse in houses; adding that—

"It is possible to remove the refuse in such a mode as to avoid the pollution of the river, and at the same time avoid the culpable waste of this most important manure."

The conditions under which the drains had been constructed were entirely different from those which became necessary with the increase of population. The sewers had been constructed for land drainage, and only with reference to the wants of the immediate locality, so as just to drain it to the nearest outlet, without any reference to any general plan of sewerage. The sewers were generally flat at the bottom, of stone or brick; the joints were not specially water-tight, so that much of the liquid passed into the surrounding soil, and the floor of the sewers was covered with deposit, which had to be removed at much expense by hand, and in many cases the size and form of the sewers were adapted to enable the workmen to enter for cleansing purposes. When new lines of houses were built, new sewers were required for which outlets into the old sewers did not afford sufficient fall, and they then became choked with deposit. The cleansing of streets was not performed with uniformity or rapidity; and the condition of many of the back streets and courts was deplorable. They were not properly paved, and had no conveniences.

The Poor-Law Commissioners recommended, in the report already mentioned, that the expensive and slow process of the removal of the surface refuse of the streets by cartage might be dispensed with, and the whole at once carried away by the mode which is proved, in the case of the refuse of houses, to be the most rapid, cheap, and convenient, namely, by sweeping it at once into the sewers, and discharging it by water. This recommendation was largely adopted.

In order to convey some idea to your minds of the difficulties which would necessarily be caused by turning the street sweepings, which consisted largely of mud from macadamised roads directly into the sewers, I may mention that at the present time in London every effort is made to stop the road material from passing into the sewers by sweeping the streets, and by placing catchpits at the gullies and cleansing them frequently, and that in the metropolis the quantity of dirt from roads and gullies, and of deposits from sewers, removed annually, amounts to nearly 1,000,000 tons, and the annual quantity in those days cannot have fallen far short of 350,000 tons. The combined effect of turning the street sweepings and the water-closet refuse into sewers, with uneven falls and flat bottoms, naturally added to the deposit, and intensified the evils in such a manner as finally to force on improvements in the construction of the sewers.

The difficulties as to drainage and the removal of refuse were principally entailed by the absence of any legal machinery to enable the inhabitants of a locality to combine for sanitary purposes, and to share the expenditure necessary for improvements.

Another important insanitary condition was caused by the fact that the vagrant population of the kingdom resorted to common lodging-houses, which were under no sort of supervision, and which were *foci* for the propagation of epidemic disease, as well as of moral depravity.

The general conclusions at which the Poor-Law Commissioners arrived in their report on the condition of the working classes were that disease originating in, or propagated by means of, decomposing refuse and other filth, and damp, close, and overcrowded dwellings, prevailed generally among the working classes in all parts of the kingdom; and that whilst these diseases could be abated by improved sanitary conditions, they were not removed by high wages and abundant food if sanitary conditions were absent. They also pointed out that owing to the defective water-supply cleanly habits were impossible.

In illustration of the loss caused to the nation by these preventable diseases, they mentioned that out of 43,000 widows and 112,000 destitute orphans relieved from the poor-rates, the greater number had lost their husbands or fathers from preventable diseases; and that the youthful population of either sex brought up in crowded, unwholesome dwellings, and under the adverse circumstances described, were deficient in physical strength and moral conduct, and grew up improvident, reckless, and intemperate, caring for nothing but sensual gratification. They pointed out that the expenses of local public works were unequally and unfairly assessed, oppressively and uneconomically collected by separate collections, and wastefully expended by unskilled and irresponsible officers, and that the existing law for the protection of the public health, and the constitutional machinery for its execution, such as the Courts Leet, have fallen into desuetude.

The Commission then went on to state the conditions required for improving the sanitary condition of the labouring classes.

This report was thus one of the early fruits of the system of vital statistics which commenced at the accession of the Queen, under the able supervision of our late eminent member, Dr. Farr. The report itself was drawn up by another eminent member of this Society, Mr. Edwin Chadwick, C.B. It is a remarkable tribute to the foresight of Mr. Chadwick that, during the last half-century, almost all the sanitary principles laid down in the report have been recognised by the Legislature as necessary to the welfare of the community, and have become matters of ordinary practice. The conclusions of the Poor-Law Commissioners, and the general interest awakened in the subject, led to various sanitary investigations, both by Royal Commissions and Committees of the Houses of Parliament.

When the Registration Act came into operation, an epidemic of small-pox was advancing over this island. It attained its maximum in the spring of 1838, and destroyed 30,819 persons. Dr. Farr mentions that vaccination protected a part of the population, but that there is reason to believe that inoculation led to the extension of the epidemic by diffusing the infection artificially. In 1840 and 1841, the first Vaccination Acts were passed. These prohibited inoculation, and empowered the Guardians to provide means for vaccination, and to charge the expense on the rates; and enacted that vaccination was not to be considered parochial relief, thus recognising the fact that the community should bear the cost of measures which are found necessary to secure the public health. It was not, however, till 1853 that vaccination was made compulsory.

The reports of the various Commissions and Committees of Parliament which inquired into the condition of the people showed the great importance of cleanliness of person and clothing to health, and the difficulties which the poor suffered in respect of it; and in 1844, private associations, not only in London, but in Manchester, Liverpool, and other large towns, were formed to encourage cleanliness amongst the working classes by establishing public baths and wash-houses, and lending out pails, brushes, and whitewash to the poor to cleanse their dwellings; and in 1846, the Bishop of London brought in a general Act empowering local authorities to establish public baths and wash-houses, the expense of which was to be defrayed out of the rates.

As regards general sanitary legislation, it is probable that the recommendations in the Poor-Law Commissioners' report and in the reports of these several Royal Commissions and Committees of the Houses of Parliament, would have remained long in abeyance had it not happened that the nation was threatened with an epidemic of cholera.

In 1832-33, the cholera had visited our shores and snatched 16,437 victims. It again appeared in London on September 22, 1848, and in Edinburgh in the beginning of October, 1848. So long as the insanitary conditions remain, epidemics invariably haunt the same localities, and the first appearance of the cholera in Bermondsey in 1848 was close to the same ditch in which the earliest fatal cases occurred in 1832. The first case of cholera that occurred in the town of Leith took place in the same house and within a few feet of the very spot from whence the previous epidemic of 1832 commenced its course. On its reappearance in 1848 in the town of Pollockshaws, it snatched its first victim from the same room and the very bed in which it broke out in 1832. It did not, however, attain its full intensity until 1849, and it ceased on December 22, 1849. Its progress fully corroborated the report of the Poor-Law Commissioners. It attacked those towns and houses which offered to it the best inducements to visit them, in their filth, decaying refuse, crowded and dirty population, bad water, damp polluted subsoil, or any other of those conditions which lead to bad health in a population, and which, when cholera is absent, afford an evidence of their existence by the prevalence of scarlet fever, small-pox, typhoid and other fevers, measles, whooping-cough, &c. The total number of victims was 53,293.

The near approach of the cholera led Parliament, in 1848, to the conclusion that—

"Further and more effectual provision ought to be made for improving the sanitary condition of towns and populous places in England and Wales, and it is expedient that the supply of water to such towns and places, and the sewerage, drainage, cleansing, and paving thereof, should, as far as practicable, be placed under one and the same local management and control, subject to general supervision."

An Act was passed creating a General Board of Health. The main feature of this Act was, that when the Registrar-General's returns showed that the number of deaths on an average of the preceding seven years exceeded 23 per 1000, the General Board of Health were empowered to send an inspector to make a public inquiry as to the sewerage, drainage, water supply, burial-grounds, number and sanitary condition of inhabitants, and local Sanitary Acts in force; also as to natural drainage areas, the existing local boundaries, and whether others might be advantageously adopted. The General Board were empowered to issue provisional orders, creating a system of local administration by means of Local Boards of Health, consisting partly of municipal authorities and partly of elected members. These Local Boards were empowered to appoint necessary officers, including medical officers of health, surveyors, and inspectors of nuisances. The public sewers were vested in the Local Board, and they were to maintain, cleanse, and regulate the use of sewers. All houses rebuilt were required to be provided with drains approved by the surveyor; and, before any new house was commenced, the levels of the cellars or lowest floors, and the position and character of the drains or cesspools, were to be approved by the surveyor. The occupation of cellars as dwellings was prohibited. Water-closets, or privies, and ash-pits were to be provided to all houses and workshops. The Local Board was also required to manage, repair, and clean the streets, and to provide for removal of refuse. They were to abate nuisances, regulate slaughter-houses, register and make by-laws to regulate common lodging-houses. The local authorities were empowered to provide public recreation-grounds, and to provide a water supply, except where a water company would supply on reasonable terms. They were also to provide mortuaries; to obtain power to close burial-grounds which they considered to be unhealthy, and to open new ones.

The Local Boards were empowered to make by-laws and impose penalties, subject to confirmation by the Secretary of State, and to levy rates, to mortgage the rates, and to borrow from the Public Works Loan Commission. The Act also provided for sewers, wells, pumps, &c., to be made where desired by the inhabitants in parishes containing less than 2000 persons. The metropolis was exempted from the operation of this Act.

The General Board of Health came into existence in 1848, just before the outbreak of cholera in this country, and it took measures at once to check the disease, and proclaimed the principles upon which the preventive and other measures for meeting the epidemic ought to be conducted. Amongst these measures, probably the one which had the greatest effect in promoting subsequently a general feeling of the necessity for sanitary improvements, and which awoke in the nation the needs of moral improvement, was that requiring house-to-house visitation, and the cleansing of the houses and streets, and obtaining an adequate water supply.

This epidemic also brought into notice the necessity of appointing efficient medical officers to supervise the sanitary condition of the different towns and districts.

Further Acts for regulating the public health were passed in 1858, 1861, and subsequent years; and all their provisions were embodied in a General Act in 1875, from the operation of which the metropolis was exempted. Subsidiary to these may be mentioned the Acts regulating rural water supply, the Artisans' and Labourers' Dwellings Acts, or what have been more recently termed the housing of the working classes, and also Acts for checking the adulteration of food, as well as other Acts relating to the diseases of animals. This general legislation has been largely supplemented by by-laws issued by local authorities, with the sanction of the Local Government Board, and by means of Local Acts obtained by various towns.

The Act of 1848 initiated the system which subsequent legislation has supplemented, under which many towns and rural districts have borrowed money for and have executed public sanitary works during the last forty years. The importance of this measure may be gauged by the fact that the money borrowed since that time for sanitary works, and not yet repaid, amounts to over 130,000,000*l.*, in addition to very large sums spent out of current rates; and in addition to an enormous private expenditure, which is beyond the reach of calculation, for the reconstruction of house drains. This legislation and expenditure have caused a complete revolution in that branch of engineering science connected with public health, viz. drainage and water supply, and has gradually established it on a scientific basis.

Modern sewerage may be said to date from the introduction of oval forms in sewers, by Mr. Roe and Mr. Phillips,[1] under the Commissioners of Sewers, in 1845; the construction of impervious clay pipes for smaller drains; the recognition of the necessity that sewers and drains should be water-tight and self-cleansing; and that junctions should be carefully made. Ventilation of the sewers followed a severe outbreak of typhoid fever, consequent upon the construction of a new unventilated sewer at Croydon. In 1849-50, Sir Robert Rawlinson introduced the system of constructing sewers and drains in right lines from point to point, with lamp-holes or man-holes at every change of direction or of gradient; this is now the recognised method of construction among all English-speaking races. The reconstruction of the sewers led to a reform in house drainage, of which the leading characteristics are imperviousness of material, free aëration, and facility of inspection at all points.

The disposal of water-carried sewage began by leading to the widespread pollution of our streams and rivers, and the serious injury of the sea beach in many of our seaside health resorts. The problem was complicated by the doctrine that as the pollution was caused by a vast amount of fertilising matter, large profits might be made out of its removal. But those who made this assertion generally overlooked the fact that the conveyance of the refuse would have to be paid for just like any other work. The subject has been repeatedly discussed in this hall, but it is far too extensive for me to enter into here.

Let us now turn from the community generally to the metropolis, which was excluded from the operation of the Sanitary Acts of 1848 and 1875. The population of London was 960,000 in 1801. At the Queen's accession it had more than doubled, and amounted to about 1,900,000. At the present time it is very nearly 4,000,000. The metropolis has, from its situation, all the attributes of a healthy city. It lies in a valley through the centre of which the Thames sweeps from west to east, and the winds rushing over its water afford a continuous supply of fresh air to the middle of the City. But the advantages of this situation had been largely frustrated by the unopposed efforts of the landowners to accumulate the greatest possible number of houses on the least possible space, by which the free circulation of air was impeded in some districts, and the families of artisans were crowded in small, low, close rooms, without space for the safe retention of refuse; and there was no adequate machinery for its rapid removal.

London is now, undoubtedly, the finest capital in the world. It was far from being so at the beginning of the Queen's reign. Among other things, there were deplorable deficiencies in the sewerage. The drainage found its way through badly-formed, leaky drains into the old water-courses, and thence to the river; the sewage was floated up and down by the tide in the heart of London, until it was deposited on the shore at low water in fetid banks, which covered the foreshore from Blackfriars to Battersea.

One of the early effects on the metropolis of the report of the Poor-Law Commission, was a Metropolitan Building Act for improvement of drainage, and for securing a sufficient width of streets and alleys, and due ventilation of buildings, and to regulate the construction of buildings, authorising the vestries to appoint district surveyors.

[1] Mr. Phillips is at present employed in superintending the reconstruction of the drainage of the Houses of Parliament.

In 1846, a new Commission of Sewers was formed, and charged with the duty of revising the metropolitan drainage. The Commissioners applied for an Ordnance survey of the metropolis, which was commenced in 1847.

The water supply of London was furnished by water companies, who trenched upon each other's districts. Its volume may be assumed, at the Queen's accession, to have been about 36,000,000 gallons per twenty-four hours. It was estimated by Mr. Wicksteed, in 1845, at 45,000,000 gallons. Some was derived from the tidal part of the Thames, and was more or less filtered; but, from its doubtful purity, pumps in surface-wells, often adjacent to churchyards, were frequently preferred for drinking-water. In many of the courts and smaller streets water was obtained only from a small stand-pipe, where the water was turned on for an hour or less daily, when the inhabitants stood around waiting with whatever vessels they might have at hand for their turn to procure a portion of a miserably scanty supply, which was then stored for use in probably the only room occupied by a whole family. Amongst the poorer classes, almost the only receptacles that existed were wooden butts, frequently in a state of decay; and, as they were for the most part without covers, the water was placed under favourable circumstances for the reception of dirt and refuse and for the development of animal and vegetable growths.

After the cholera epidemic, the question of the purity and quantity of the water supply attracted notice; and in 1852, Parliament passed an Act forbidding the supply of water from the tidal part of the Thames or its tributaries, and requiring all river water to be filtered and to be kept covered after filtration; also requiring a constant service when demanded by four-fifths of the houses in a district. In 1858, the average daily supply had risen to 75,000,000 gallons. In 1871, another general Act was passed, to make further provisions for securing to the metropolis a constant supply of pure water; this Act defined the sources of supply of the several companies, and required, amongst other matters, efficient filtration, and the application of tests of purity.

The amount of water delivered into London by the water companies for September last was 178,196,597 gallons in twenty-four hours, of which about 90,000,000 gallons came from the Thames above Teddington Lock; its purity is ascertained by continual analysis; and it may now be said that the water supplied to London rivals that of any other city in purity.

It was not till 1852 that the Secretary of State was authorised to prohibit burials within the metropolis.

A new era in metropolitan sanitation was inaugurated in 1855. In that year the Metropolitan Board of Works was created. In this body was vested the main drainage of the metropolis, but the charge of the subsidiary parish sewers was left to the vestries, who were also charged with the care of the streets and roads, the Metropolitan Roads Commission being abolished, and all duties of lighting, control of removal of refuse, &c., were placed on the vestries.

Thus the formation of this new Board was somewhat of a retrogade movement, because the concentration of functions, which had been commenced under the Metropolitan Roads Commission and Metropolitan Sewers Commission, instead of being strengthened in the new Board, was abandoned, and something approaching chaos was introduced. This Board has, however, by degrees had remitted to it the care of London improvements, and certain other general municipal functions, as well as power to levy general rates. The City retained its individuality, excepting as to the main sewers, and effected improvements and opened out thoroughfares in the part under its jurisdiction. The improvements in the other parts of London are mainly due to the action of the Metropolitan Board of Works. Great alterations have taken place in our thoroughfares. Many of those large tracts of London which were occupied by dwellings of the most wretched description, are now traversed by wide thoroughfares, and covered by artisans' dwellings erected by private enterprise. But there is no diminution of the rate at which the vast aggregation of population in London still continues to progress; and, unfortunately, many of the wretched crowded dwellings still remain, where those born in close rooms, brought up in narrow streets, and early made familiar with vice, are deteriorated in physique, and grow poorer from inability to work.

The reconstruction of the drains, the removal of the sewage from the midst of the population, the opening out of thoroughfares so as to admit ventilation into crowded districts, have all tended to improve the sanitary condition of London.

I have some interesting tables, prepared for me by the kindness of Mr. A. J. Mundy, of the Registrar-General's Office, which show the remarkable sanitary results of these various efforts. The death-rate of London in the five years 1838-42 was 25·57 per 1000. In the five years 1880-84 it was 21·01 per 1000; and the deaths from zymotic diseases, which in the decade 1841-50 had averaged annually 5·29 per 1000, were reduced in the years 1880-84 to 3·4 per 1000. If, however, we assume that there had been no change in sanitary conditions, and therefore that the death-rate had gone on increasing according to Dr. Farr's formula of increase due to density of population when the sanitary conditions remain unchanged, the death-rate of 1880-84 would have averaged 26·62 per 1000; that is, a saving of 5·61 per 1000 has been effected by sanitary measures.

If upon this basis we compare the saving in life which has resulted from sanitary improvements at different periods since 1838-42, we find that it amounted to an annual saving of 4604 lives during 1860-70; of 13,929 lives annually during 1870-80; and of 21,847 lives annually between 1880-84. The main drainage works were commenced about 1860, and terminated in 1878, and the increase in the saving of life in these consecutive periods may to some extent be taken as a gauge of the effect of the gradual construction and completion of these works. No doubt this London death-rate is far too high, and is an evidence that insanitary conditions still prevail all round us, that the housing of the working classes is still far from satisfactory, and that we are too careless about infectious disease. The Metropolitan Board of Works has never had a clear field for municipal action; yet when we compare the present condition of London with what it was at the Queen's accession, the Metropolitan Board of Works, in spite of the disadvantages of its constitution, will have a grand record to show, in the jubilee year of the Queen's reign, of metropolitan improvements and metropolitan sanitation.

The main principle which guided public administration, both before and during the earlier years of the Queen's reign, may be said to have been that of non-interference, and of allowing free competition to prevail; although, no doubt, some efforts had been previously made to regulate the labour of females and children in Factory Acts.

The practical application of the knowledge derived from the Registrar-General's statistics led to further investigation in particular cases by such men as Dr. Simon, Dr. Buchanan, Sir Robert Rawlinson, and others, and gradually caused a reaction from what may be called the *laissez-faire* system, to the spread of opinion in the direction of control over individual action in the interest of the community generally; and the result was the enactment of the successive laws, for regulating the sanitary condition of the people, which I have enumerated above.

This large amount of legislation is practically little more than the interpretation required by the increase of population, and by the complicated exigencies of modern life, of the common-law maxims, *Prohibetur ne quis faciet in suo quod nocere possit alieno;* and *Sic utere tuo ut alienum non lædas:* that is to say, no man shall do anything by which his neighbour may be injuriously affected, and each person must so use his property and his rights as not to harm any one else.

This common-law doctrine had become practically obsolete, because there was no machinery in existence to enforce it; and the present generation inherited a legacy of misery amongst the poorer classes, owing to the absence of regulations in the building of houses as the towns increased in size, absence of water supply and drainage, and other matters which I have mentioned.

Mr. Mundy's calculations show us what have been the general results of the sanitary improvement of the nation. The death-rate of 1838-42 for England and Wales was 22·07 per 1000; that of 1880-84 was 19·62 per 1000; and the deaths from zymotic disease, which averaged 4·52 per 1000 in the decade 1841-50, were reduced to 2·71 per 1000 in the years 1880-84. It is, however, curious to note that the improvement in urban districts does not appear to have kept pace with that in rural districts, for it appears that whilst the deaths from zymotic disease in certain urban districts have declined from 5·89 per 1000 in the decade 1851-60 to 5·12 per 1000 in the decade 1871-80, the deaths from zymotic disease in rural districts in the same interval have declined from 2·77 to 1·67 per 1000.

In order to form an estimate of the saving of life due to sanitary measures, we may assume that sanitation remained in abeyance, and calculate what the death-rate, according to Dr. Farr's formula, would have been in consequence of increased density of population, and compare that with the actual death-rate; upon this assumption we find that the sanitary improvements only began to tell after the cholera epidemic of 1848-49. In the decade 1841-50, indeed, it appears that the death-rate was actually larger than that due to the increased density of population. But in the following decade, the sanitary improvements began to produce their effect, and this effect has gradually increased. In the decade 1850-60, the annual average saving of lives in England and Wales from sanitary improvements was 7789; in the decade 1860-70, it rose to 10,481; in the decade 1870-80, it was 48,443; and in the five years 1880-84, the average annual number of lives saved by sanitary improvements have been 102,240.

The present social condition of the people affords an equally striking evidence of general improvement. Food and clothing are cheap; the construction of streets and new buildings in our towns are regulated; houses are improved; overcrowding and cellar dwellings are prohibited; the common lodging-houses are controlled. Petroleum affords a brilliant light to the poor in country districts which are beyond the reach of gas or of the electric light, and who were formerly dependent on rushlights. Water supply is rarely deficient; removal of refuse is enforced. But there remains much still to be done. Numbers of the people are still crowded in wretched dwellings; our rivers are polluted and subject to floods; our infectious diseases are not properly cared for.

The main feature of the legislation of the past half-century is the recognition of the principle that when large numbers are congregated together in communities, the duty of preventing injury from this aggregation rests on the community; and if this principle is duly acted on, if in all aggregations of population free circulation of air is encouraged by preventing the crowding together of buildings; if refuse is immediately disposed of, so as to cause no injury to any one; if pure water be provided; if we isolate infectious diseases; and, above all, if we are fortunate enough to retain the blessing of cheap food and clothing, we shall not transmit to our posterity a similar legacy of misery to that which we inherited.

ON THE FORMS OF CLOUDS[1]

THE object of the paper was to explain a theory with regard to the principles that may have the greatest effect in producing the leading cloud-forms. Neglecting occasional and exceptional influences, the author stated that the causes with which his paper dealt might be classed under three heads: (1) the diminished specific gravity of the air when more or less charged with invisible vapour, (2) the differential horizontal motion of the atmosphere, (3) the vertical motion in the atmosphere produced by the heat of the sun expanding the lower air. The first of these was universally recognised as the initial cause of the cumulus, or first-born primary cloud. It was produced when there was so much vapour generated in the lower atmosphere that the vapour-laden layer projected up within the limit of condensation. Of course the vapour below this limit would itself become condensed if cooled in the course of its travels. During the formation of the cumulus, calm was supposed to prevail. When the atmosphere was in motion, its differential horizontal movement produced the first important modification. Retarded by friction and other causes, the lower portion of the cumulus moved more slowly than the upper, and the cloud sheared over into a slanting position, and ultimately became the cumulo-stratus. A young cloud was thus distinguishable from those that had travelled even a short distance. In this climate large well-developed cumuli, though common in summer, were seldom seen in the cold season. The majority of the clouds of the first stage seen here were born in warm latitudes, and, coming as travelled cumuli, showed more or less the condition of the cumulo-stratus. The invisible vapour was subject to this same shearing motion, and far-travelled water-vapour would, on its rising, as it soon does in this climate, to the height necessary for condensation, at once take the shape of the stratus. In the next stratum above, Mr. Glaisher's investigations in his balloon ascents showed a rather rapid change to a drier atmosphere. Here were found the cirro-cumulus, and cirro-stratus. The differential motion of the atmosphere, though diminished, was still an important agent, and produced results that were not possible in the more bulky and dense clouds of the lowest range. When the sun's

[1] Abstract of a Paper read at the Birmingham meeting, 1886, of the British Association, by A. F. Osler, F.R.S. Communicated by Prof. Balfour Stewart, F.R.S.

heat expanded the lower atmosphere, the upper cloud-stratum would be lifted, flattened, and broken into patches, the result being a mackerel sky. Should, however, the expansion in the lower atmosphere take place very slowly, it was possible that the cloud, though thinned, would remain unbroken. Rapid motion of the atmosphere would elongate the cloud in the direction of motion; and, if accompanied by expansion from below, would rupture the cloud into ribs or bars at right angles to the current. If the mass of the cloud were stationary or moving slowly, prominent parts might be drawn out into "mares'-tails."

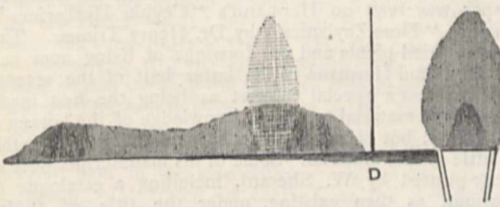
FURTHER EXPERIMENTS ON FLAME

IN my former paper, published in NATURE, vol. xxxi. p. 272, I showed that there are two classes of continuous spectra, viz. those due to an incandescent precipitate, in which case the flame has the power of reflecting and polarising light; and, secondly, flames that possess no reflecting power, but give a soft continuous spectrum without maxima or minima.

Of this second class is carbonic oxide, which gives, at normal pressures, a fairly bright, and at increased pressure, according to Dr. Frankland, a very bright, continuous spectrum. I have observed its spectrum recently under reduced pressure, using an apparatus similar to that described by Dr. Frankland in his "Experimental Researches," p. 884 *et seq.*

I had considerable difficulty at first in keeping the flame alight at anything like low pressures, and finally adopted a glass jet, of a trumpet shape, increasing very gradually from 1 millimetre to 3 millimetres in diameter, the flame being farther shielded from draughts by a wide disk of cork 10 millimetres below the mouth of the jet.

Experiment 1.—Carbonic oxide was burnt in oxygen. The flame was densest close to the jet, and diminished in brightness



Flame of carbonic oxide burning in oxygen at 60 mm. pressure, with spectrum showing maxima. The continuous spectrum at the bottom is given by the red-hot top of the glass jet.

to the tip, without any definite separation into mantles with a space between. At normal pressure every part of it gave a continuous spectrum.

At about 260 millimetres there began to be a noticeable concentration of the light in the violet and the green in the position of the principal bands of the carbon spectrum. At 120 millimetres the concentration was unmistakable, but the spectrum was still continuous. At 60 millimetres it presented the appearance shown in the sketch. There appeared to be a second maximum in the green—not, however, at all well defined—but the principal maximum was continued upwards into a faint green cloud corresponding to the very faint tip of the flame; this cloud was perfectly isolated, but, unlike the carbon bands, was brightest in the middle.[1] I failed to see a similar cloud over the maximum in the violet, but this might be owing to insufficient light, my pumps being only able to maintain so high a vacuum against a very small flame. Mr. T. Legge, of Trinity, who was with me, observed that the comparative absence of the blue was very remarkable.

My supply of oxygen becoming exhausted, I had to use air. The flame became less bright, and the maxima less marked. By turning it very low, we brought the gauge down to 40 millimetres. The flame still burnt steadily.

Finally, at 60 millimetres pressure, I adjusted the flame to a height of three-quarters of an inch, opened the air-taps, and checked the pumps. The flame increased in brightness and decreased in size to rather more than a quarter of an inch at normal pressure, the spectrum becoming again perfectly continuous.

[1] It is impossible in a woodcut to give a true idea of the extreme faintness of this isolated cloud. It is only visible when the brighter part of the spectrum is hidden from the eye, and the room is perfectly dark.

Experiment 2.—Having the apparatus ready, I repeated Dr. Frankland's experiment of burning coal-gas in air under reduced pressure. He says that "finally, at 6 inches pressure, the last trace of yellow disappears from the summit of the flame, leaving the latter an almost perfect globe of a peculiar greenish-blue tint."

He used a jet contracted at the mouth to 1·5 millimetres. With my much wider trumpet-shaped jet, by turning on more gas I could produce smoke at 160 millimetres so as to blacken the glass chimney. At 120 millimetres the light was noticeably less vivid, the flame having a diluted appearance, but the spectrum showed the usual carbon lines much more sharply defined, the mantles being very much thicker than at normal pressure. With this exception there was no difference caused by the reduction of the pressure to 60 millimetres, and even then, on turning up the gas a little, the ellipsoidal flame became pointed, and the yellow light, giving the incandescence spectrum, re-appeared in the tip of it. It is evident that the trumpet-shaped jet allows carbon to be precipitated in the flame at much lower pressures than the contracted jet. In the same way alcohol heated in a bulb tube burns from the mouth of it with a bright and even smoky flame, whereas it burns from a wick with a blue one.

One phenomenon observed by Dr. Frankland I was disappointed not to see. He says: "Just before the disappearance of the yellow portion of the flame there comes into view a splendid halo of pinkish light forming a shell half an inch thick around the blue-green nucleus; . . . the colour of this luminous shell closely resembles that first noticed by Gassiot in the stratified electrical discharge passing through a nearly vacuous tube containing a trace of nitrogen." He does not speak of having used the spectroscope to determine the nature of this pink glow.

I went considerably below the lowest pressure mentioned in his paper, viz. 4·6 inches, but entirely failed to reproduce it. But I have noticed that very small flames from capillary tubes, observed under a power of 100 in the microscope, are sometimes tinged with rose-colour in the outer mantle, from a very faint trace of sodium orange light mingling with the blue of the soft outer mantle; and I think that the jet he used or the glass chimney may have been sufficiently heated to give a rosy tinge to the flame.

One other point I would call attention to. The appearance of the gas-flame at low pressures is precisely like that of a very small gas-flame under the microscope. The inner mantle appears to be bordered with bright green light, due to the principal green band of the carbon spectrum extending slightly beyond the others. Beyond this, again, comes a zone of violet light due to the band in the violet, and in most cases this extends nearly, if not quite, to the outer mantle. At ordinary pressures this can only be seen with a magnifying-glass, except with a special burner; but the *in vacuo* flame is, as it were, magnified as to its structure, which is thus visible to the naked eye. This fact suggests that flames may in a sense obey Boyle's law, *i.e.* that the space required for complete combustion under given conditions varies inversely as the pressure. I am continuing my experiments. GEORGE J. BURCH

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 18.—"The Coefficient of Viscosity of Air. Appendix." By Herbert Tomlinson, B.A. Communicated by Prof. G. G. Stokes, P.R.S.

In the previous experiments by the author on this subject, the coefficient of viscosity of air was determined from observations of the logarithmic decrement of amplitude of a torsionally vibrating wire, the lower extremity of which was soldered to the centre of a horizontal bar. From the bar were suspended vertically and at equal distances from the wire a pair of cylinders, or a pair of spheres. The distances of the cylinders or spheres from the wire were such that the *main* part of the loss of energy resulting from the friction of the air may be characterised as being due to the *pushing* of the air.

Acting on a suggestion of Prof. Stokes, the author proceeded to determine the coefficient of viscosity of air by suspending a hollow paper cylinder about 2 feet in length and half a foot in diameter, so that its axis should coincide as to its direction with the axis of rotation. The cylinder was supported by a light hollow horizontal bar, about 7 inches in length, to the centre of which the vertically suspended wire was soldered. The wire was set in torsional vibration, and the logarithmic decrement determined with the same precautions as before.

The following were the results:—

Vibration-period in seconds		Coefficient of viscosity of air in C.G.S. units, μ		Temperature in degrees Centigrade
3·6038	...	0·00017708	...	12·225
8·8656	...	0·00017783	...	13·075

In these experiments the loss of energy arising from the friction of the air may be characterised as being due to the *dragging* of the air, and it is very remarkable that there should be such close agreement in the values of μ as determined by this and the previous methods. The mean value of the coefficient of viscosity of air obtained by this method is 0·00017746 at a temperature of 12°·650 C., and the mean value deduced from the previous experiments when proper correction has been made for the rotation of the spheres and cylinders about their axes is 0·00017711 at a temperature of 11°·79 C.

November 25.—"On the Structure and Life-History of *Entyloma Ranunculi* (Bonorden)." By H. Marshall Ward, M.A., F.L.S., Fellow of Christ's College, Cambridge, and Professor of Botany in the Forestry School, Royal Indian College, Cooper's Hill.

The author found plants of *Ranunculus Ficaria*, the leaves of which were spotted with white patches; the white patches spread from leaf to leaf, and the disease assumed the nature of an epidemic over a given area under examination. The rise, progress, and climax of the disease were observed both on isolated plants and in the open country, and the nature of the lesions in the leaves was made out. Some plants were found to succumb more rapidly; the evidence supporting this conclusion was given, and the circumstances to which the differences are due explained.

The white disease-spots contain the mycelium of *Entyloma Ranunculi*, and the resting-spores of this fungus (one of the Ustilagineæ) were observed on it. The mycelium is very delicate and septate, and runs in the middle lamellæ between contiguous cells. The white powder on the outside of the disease-spot consists of conidia, very like those of some Ascomycetes. The author examined the anatomical connection between the conidia and the resting-spores, and showed that the conidia really belong to the same mycelium—in other words, the conidia are a second kind of spore of the *Entyloma*.

Even more important is the germination of these conidia: this has not been before observed in any *Entyloma*. The germination was traced step by step, not only on glass slips, but also on the living plant. Artificial infections were made, and it was shown how the germinal hyphæ entered the stomata, and produced a mycelium exactly like that in the disease-spots first investigated; not only so, but the *resting-spores of the Entyloma were produced on this mycelium*, thus placing beyond doubt the connection of the two spores. The time occupied in infection was also determined in many cases. Moreover, all the symptoms of the disease produced by infection with the conidia were as before. The paper was illustrated by diagrams, and specimens of the fungus were exhibited under the microscope.

Mathematical Society, December 9.—Sir J. Cockle, F.R.S., President, in the chair.—Prof. D. Y. Kikuchi, of Tokio, was elected a Member, and Mr. F. S. Macaulay admitted into the Society.—The following communications were made:—The linear partial differential equations satisfied by pure ternary reciprocants, by E. B. Elliott.—Circular notes, by R. Tucker.—The problem of the duration of play, by Capt. Macmahon, R.A.—Note on two annihilators in the theory of elliptic functions, by J. Griffiths.—Mr. Hammond spoke upon the subject of Capt. Macmahon's communication at the November meeting.

Linnean Society, December 2.—William Carruthers, F.R.S., President, in the chair.—The following gentlemen were elected Fellows of the Society, Messrs. J. W. Willis Bund, Arthur Dendy, Anthony Gepp, Tokutaro Ito, F. Krause, F. M. Lascelles, Fred Sander, R. von Lendenfeld, John Samson, Harry S. Burton, A. W. Sutton, and Chas. W. Wilson; afterwards Mr. Geo. Sim was elected an Associate.—The President read a letter from the Rev. M. J. Berkeley, concerning the death of his old and respected co-worker on fungi, Mr. C. E. Broome.—Mr. G. Maw exhibited ten photos of living Narcissi, made in the Riviera in 1870. He afterwards gave a short account of the North African and South Spanish Narcissi as observed by him on a recent visit thither. The *Narcissus papyraceus* extends as far as Fez, in Morocco; south of that *N. sub-Broussoneti* takes its place, and is found from Saffi to Mogador. Incidental allusion was made to the smallest of the white forms of *N. Tazzetta* in the Island of Teneriffe. Of the autumnal species, reference was made to *N. nudiflorus*, which had been lost sight of for half a century, but was re-discovered by Mr. Maw in 1883 in the neighbourhood of Gibraltar, and again recently near Tangier. A hybrid between *N. viridiflorus* and *N. serotinus* was found by him close to Gibraltar, and a series of hybrids between *N. viridiflorus* and *N. elegans* were got in North Morocco. Mr. Maw stated that *N. serotinus* was limited to the south of Spain, and *N. elegans* to the Morocco coast, the latter plant bearing true leaves. He mentioned the abundance in flower and fruit of a small Amaryllid, *Tapeinanthus humilis*, Herbert, as occurring eight miles south of Tangier.—Dr. Day read a paper on the Lochleven trout, which is the form that has been utilised by Sir James Maitland at Howietoun, where the elevation is similar to that of their original home, distant about 25 miles. These fish are known by their numerous cæcal appendages, and up to their fourth or fifth year they are of a silvery gray, with black, but no red, spots. Subsequently they become of a golden purple with numerous black and red spots. Undergrown ones take on the colour of the burn trout. Remove these fish to a new locality, and they assume the form and colour of the indigenous trout. In 1883 a salmon parr and Lochleven trout were crossed, and the young have assumed the red adipose dorsal fin, and the white-edged margins to the dorsal and ventral, also the orange edges to both sides of the caudal—all colours found in the brook trout, but not in the salmon or Lochleven trout. The maxilla in this form not extending to behind the eye, the absence of a knob on the lower jaw in old breeding males and the difference in the fins from those of *Salmo fario* were shown to have been erroneous statements.—A paper was read on Hermann's "Ceylon Herbarium" and Linnæus's "Flora Zeylanica," by Dr. Henry Trimen. The collection of dried plants and the drawings of living ones made in Ceylon by Paul Hermann in the latter half of the seventeenth century possess a special interest as being the first important instalment of material towards a knowledge of the botany of the East Indies; but Hermann himself, who died in 1695, published very little of this material. Some of his manuscripts were subsequently printed by W. Sherard, including a catalogue of the herbarium, as then existing, under the title of "Museum Zeylanica" (1717). This herbarium was lost sight of till 1744, when it was recognised by Linnæus in a collection sent to him from Copenhagen. After two years work at it, Linnæus produced in 1747 his "Flora Zeylanica," in which all the plants that he could determine are arranged under his genera. At that date Linnæus had not initiated his binomial system of nomenclature; but in his subsequent systematic works he quoted the numbers of the "Flora Zeylanica," and thus Hermann's specimens became the types of a number of Linnæus's species, for the most part additional to those in his own herbarium in the possession of the Linnean Society.

Zoological Society, December 7.—Prof. W. H. Flower, F.R.S., President, in the chair.—Prof. Bell exhibited and made remarks on a specimen of a rare Entozoon (*Tænia nana*) from the human subject.—Mr. Tegetmeier exhibited and made remarks on a pair of antlers of a Deer, said to have been recently obtained in the Galtee Mountains in Ireland. They appeared to be those of the Elk (*Alces machlis*).—Mr. Frank E. Beddard read a paper on the development and structure of the ovum in the Dipnoan fishes. The present communication was a continuation of a research into the structure of the ovary in *Protopterus*. The author, besides being able to give a more complete account of the ovarian ova of *Protopterus*, was also able to supplement this account with some further notes respecting the structures observed in the ovary of *Ceratodus*.—Mr. A. Smith-Woodward read a paper on the anatomy and systematic position of the Liassic Selachian, *Squaloraja polyspondyla*. After a brief notice of previous researches, the author attempted an almost complete description of the skeletal parts of *Squaloraja*, as revealed by a fine series of fossils in the British Museum. He confirmed Davies's determination of the absence of the cephalic spine in certain individuals (presumably females), and added further evidence of its prehensile character, suggesting also that the various detached examples afforded indications of one or more new species. The author concluded with some general remarks on the affinities of the genus, and proposed to institute a new family, "Squalorajidæ," which might be placed near the Pristiophoridæ and Rhinobatidæ.—Mr. Sclater, F.R.S., pointed out the characters of an apparently new Parrot of the genus *Conurus*, from a specimen living in the Society's Gardens. The species was proposed to be called *Conurus rubritorquis*.—Mr. F. Day, F.Z.S., communicated (on the part of Mr. J. Douglas Ogilby, of the Australian Museum, Sydney) a paper on an undescribed fish of the genus *Pimelopterus* from Port Jackson, N.S.W., proposed to be named *P. meridionalis*.—Mr. G. A. Boulenger read a paper on the South African Tortoises allied to *Testudo geometrica*, and pointed out the characters of three new species of this group, which he proposed to call *Testudo trimeni*, *T. smithii*, and *T. fiski*.—A second paper by Mr. Boulenger contained some criticisms on Prof. W. K. Parker's paper "On the Skull of the Chameleons," read at a previous meeting of the Society.—Mr. Oldfield Thomas read a paper on the Wallaby, commonly known as *Lagorchestes fasciatus*, and showed that the dentition of this animal was entirely different in character, not only from that of the typical species of *Lagorchestes*, but even from that of all the other members of the sub-family Macropodinæ. He therefore proposed to form a new genus for its reception, to which he gave the name of *Lagostrophus*.—A communication was read from Prof. R. Collett, C.M.Z.S., containing the description of a new Pouched Mouse from Northern Queensland, which he proposed to name *Antechinus thomasi*.

Geological Society, November 17.—Prof. J. W. Judd, F.R.S., President, in the chair.—The following communications were read:—A letter from the Lieutenant-Governor of the Falkland Islands, communicated by H.M. Secretary of State for the Colonies, and printed in NATURE, vol. xxxiv. p. 440.—On the drifts of the Vale of Clwyd, and their relation to the caves and cave-deposits, by Prof. T. McKenny Hughes, M.A., F.G.S. The author divided his subject as follows:—I. Introductory remarks; II. the Drifts, viz. (i.) the Arenig Drift, (ii.) the St. Asaph Drift, (iii.) the Surface Drifts; III. the caves, viz. (i.) the caves themselves, (ii.) the cave-deposits; IV. conclusion. He exhibited a table showing the tentative classification he proposed. II. (i.) The Arenig Drift, he said, might be called the *Western Drift*, as all the material of which it was composed came from the mountains of Wales; or the *Great Ice-Drift*, as it was the only drift in the vale which contained evidence of direct ice-action. He traced its course from the Arenig and Snowdon ranges by striæ on the solid rock and by the included fragments, a large proportion of which were glaciated. There are no shells in this drift. II. (ii.) The St. Asaph Drift might, he said, be called the *Northern Drift*, as it was the deposit in which fragments of north-country rocks first appeared; or the *Marine Drift*, as it was, excepting the recent deposits at the mouth of the estuary, the only drift in the vale which showed by its character and contents that it was a sea-deposit. It contained north-country granites, flints, and sea-shells, of which he gave lists. Most of them are common on the adjoining coast at the present day; a few are more northern forms. None of the rocks are striated, except those derived from the Arenig Drift (i.). II. (iii.) The Surface-Drifts included the older and newer alluvia of the rivers, the Morfa Rhuddlan Beds or estuarine silt, the recent shore-deposits or Rhyl Beds, and all the various kinds of deposits known as talus, trail, rain-wash, head, run-of-the-hill, &c., of which, in so long a time, very thick masses have accumulated in many places. He explained some methods of distinguishing gravels according to their origin. Turning to the subject of caves, he thought they should be careful not to confound (III. i.) the question of the age and origin of the caves themselves with (III. ii.) that of the deposits in the caves. He then described some of the more important caves of the district, explaining the evidence upon which he founded the opinion that the deposits in Pontnewydd Cave were post-glacial palæolithic. He arrived at the same conclusion with regard to the deposits in the Ffynnon Beuno Caves. Combating the objections to this view which had recently been urged, he pointed out that the drifts associated with the deposits in those caves cannot have been formed before the submergence described under II. (ii.), because they contained north-country fragments and flints, and that, even if they were of the age of the submergence, they would not be pre-glacial; that they cannot have been formed during the submergence, as the sea would have washed away the bones, &c., from the mouth of the cave, and its contents must have shown some evidence of having been sorted by the sea. He considered that the greater part of the material that blocked the upper entrance of the upper cave belonged to the surface-drifts described under II. (iii.), and were, as they stood, almost all sub-aërial. He further pointed out that, so far as palæontologists had been able to lay before them any chronological divisions founded on the Mammalia, the fauna of the Ffynnon Beuno Caves agreed with the later rather than with the earlier Pleistocene groups.

Middlesex County Natural History Society, November 16.—Dr. Archibald Geikie, F.R.S., in the chair.—A paper was read by Mr. Sydney T. Klein, entitled "Thirty-six Hours' Hunting amongst the Lepidoptera and Hymenoptera of Middlesex, with Notes on the Methods adopted for their Capture." The especial object of the paper was to show how much good work could be done in a short time and within a small space—the time being made up by an hour or so each evening, and the space being the author's garden at Willesden. Detailed observations on the methods of enticement and capture—such as the rearing of special food-plants, sugaring, bright lights, &c.,—were entered into, and a list of the Noctuæ captured was read. Mr. Klein stated that he had taken over 170 species in the short time at his disposal, and had noticed, on an average, 500 or more moths on each occasion. With regard to the Hymenoptera, both mason and leaf-cutter bees had established themselves in his garden, and some interesting observations on their habits and economy were given. A large collection, containing specimens of every insect taken, was exhibited, together with the ichneumons peculiar to several of the species; a torpid mason-bee, which was restored to activity by breathing; and cells of the queen of the Ligurian honey-bee. A discussion followed, in which the Chairman joined; and, with a few remarks by the other members who had brought exhibits, a vote of thanks to Dr. Geikie brought the meeting to a close. Another paper, "On the Flora met with on the occasion of the Highgate Excursion," by Dr. Henry Wharton, was postponed till the December meeting.

CAMBRIDGE

Philosophical Society. Oct. 25.—Annual General Meeting.—Prof. Foster in the chair.—The following were elected Officers and new Members of Council for the year:—President: Mr. Trotter; Vice-Presidents: Prof. Babington, Prof. Adams, Prof. Foster; Secretaries: Mr. Glazebrook, Mr. Vines, Mr. Larmor; new Members of Council: Prof. Liveing, Mr. Forsyth, Mr. Marr, Mr. Pattison Muir.—Mr. Trotter then took the chair, and the following communications were made to the Society:—On Lagrange's equations of motion, by Mr. J. C. McConnel. The paper contains a proof of Lagrange's equations founded on that in Lord Rayleigh's "Theory of Sound," with some remarks on the proof given in Maxwell's "Electricity and Magnetism."—On the potentials of surfaces formed by the revolution of limaçons and cardioids about their axes, by Mr. A. B. Basset. The potential of a spheroid can be expressed in terms of a series of spheroidal harmonics. From this by inversion with respect to a focus the potential of limaçon is found, while that of a cardioid is obtained from a paraboloid either in a similar manner or by treating it as the limiting case of the spheroid.—An attempt to explain certain geological phenomena by the application to a liquid substratum of Henry's law of the absorption of gases by liquids, by Rev. O. Fisher. The author supposes that a liquid substratum exists beneath the earth's crust, and that this consists of fused rock holding gas, chiefly water above its critical temperature, in solution. This water is supposed to be that which is given off so largely in volcanic eruptions. If such be the constitution of the substratum, the reactions between it and the crust will largely depend on it, and also the tidal effects. The problem is worked out in the paper, and numerical results, which accord fairly with observed facts, are obtained.—A new method of determining specific inductive capacity, by Mr. L. R. Wilberforce. The author briefly described the method, which consisted in the comparison of the directive couples upon two spheroids, the one made of the dielectric to be investigated, and the other of some conducting material, when they were placed in a uniform electric field. He further indicated certain theoretical considerations with regard to the eccentricities of the spheroids and their manner of suspension, and stated a general theorem relating to the mechanical effect due to such a field upon a body of any material or form.

PARIS

Academy of Sciences, December 6.—M. Daubrée in the chair.—Reply to M. de Lapparent's note of November 22, on the conditions determining the form and density of the earth's crust, by M. Faye. The conclusions of modern physicists regarding the uniform flattening of both terrestrial poles are vindicated against M. de Lapparent's captious objections. The general charge that the work of geodesy is far from completed is admitted; but it is pointed out that, in order to continue this work, it is not necessary to sweep away the secure results already obtained; it will be safe to prosecute it on the safe lines already laid down by Sabine, Freycinet, Foster, Clarke, Lütke, and other eminent men of science.—Action of manganese on the phosphorescent property of carbonate of lime, by M. Edmond Becquerel. The experiments here described place in a clear light the action of manganese, explaining how the carbonate of lime derived from the solution of Iceland-spar in pure hydrochloric acid always leads to preparations of orange phosphorescent sulphurets, while the phosphorescent matter is always bright green when the carbonate of lime used in the preparation is aragonite.—On the nitric substances of vegetable soil, by MM. Berthelot and André. A first series of experiments is here described, which have been carried out in the presence of diluted hydrochloric acid for the purpose of determining the chemical constitution of the nitric substances found in all vegetable soils in association with carbon, hydrogen, and oxygen, and almost absolutely insoluble.—On the composition of cider, by M. G. Lechartier. A quantitative analysis is given of the various ciders at present consumed in Paris, and coming chiefly from Normandy and Brittany. The results show an average proportion of alcohol lying between 5·1 and 9·40 per cent.—On the red fluorescence of alumina, by M. Lecoq de Boisbaudran. These experiments show that the presence of chromium appears to be indispensable for the production of the red fluorescence of alumina. There seems to be a complete analogy between the parts played by chromium and all other active substances, such as Mn, Bi, *Zα*, *Zβ* or Sm.—Report made, in the name of the Section of Physics, in reply to a letter of the Minister of Public Instruction, Fine Arts, and Worship on sundry questions connected with the establishment of lightning-conductors on the buildings of the Lyceums (Commissioners: MM. Becquerel, Berthelot, Cornu, Mascart, Lippmann, and Fizeau). The report considers it indispensable for complete safety to have all iron roofs, doors, sashes, pipes, &c., carefully connected with the general apparatus usually attached to these buildings as protections against electric discharges.—On the fundamental principles of the higher geometry, by M. A. Mouchot. To generalise the figures of geometry by assigning them well-defined imaginary points, and then to prove that the algebraic symbols express all the relations of magnitude or position between the elements of these figures, is the double problem which has engaged the attention of the author for the last thirty years, and a rational and complete solution of which is now submitted to the Academy.—On certain problems in which are considered, on a plane curve, arcs of the same origin traversed in the same time as the corresponding chords, by M. G. Fouret.—On a new testing exploder ("exploseur-vérificateur") of quantity and tension, by MM. Louis de Place and Bassée-Crosse. This apparatus consists of a moist pile of the Place-Germain system, an induction bobbin, and a telephone. It is described as very handy, portable, and durable, advantageously replacing the exploders of quantity and the exploders of tension. It also verifies the circuits at any given moment without danger of premature explosion.—Calorimetric researches on the specific heats and changes of state at high temperatures, by M. Pionchon. In this first communication the author gives, in tabulated form, the results of his calorimetric studies for silver, tin, iron, nickel, and cobalt. His experiments fully confirm the opinion already announced by M. Berthelot on the so-called law of Dulong and Petit.—On the tensions of vapour of solutions made in ether, by M. Em. Raoult. The tensions of vapour for the solutions here determined by Dalton's method show that the molecular diminutions of tension are always comprised between 0·67 and 0·74, with a general average of 0·71, whatever be the composition, chemical function, and molecular weight of the substances held in solution.—Researches on the bi-metallic phosphates and allied salts, and on their transformations, by M. A. Joly.—Saturation of normal arsenic acid by magnesia, and formation of ammoniaco-magnesian arseniate, by M. Ch. Blarez. These researches on the formation of the arseniates of magnesia and of ammoniaco-magnesian arseniate have been undertaken for the purpose of completing the author's studies on the saturation of normal arsenic acid.—On the phenomena attending the heating and cooling of cast steel, by M. Osmond. In continuation of his studies of these phenomena between the normal temperature and 800° C. the author here gives the results of his researches brought up to 1200° C.—On the influence of silicium on the state of the carbon in pig-iron, by M. Ferdinand Gautier. The experiments already carried out by Messrs. Stead and Wood, of Middlesbrough, are here repeated under somewhat altered conditions and with analogous results.—On the water of combination of the alums, by M. E. J. Maumené.—Heat of neutralisation of the meconic and mellic acids, by MM. H. Gal and E. Werner.—A contribution to the study of the fossil fruits of the Eocene flora in the west of France, by M. Louis Crié.—On the diseases of the olive, especially tuberculosis, by M. L. Savastano.—On the phenomenon of the green ray, by M. de Maubeuge. The author's repeated observations of this well-known phenomenon, both at sunset and sunrise under varying atmospheric conditions, lead him to conclude that it is really objective, and not merely a subjective sensation.—The Indo-European Canal and the navigation of the Euphrates and Tigris, by M. Emile Eude. It is suggested that with a capital of about 60,000,000*l.* a canal available both for navigation and irrigation might be constructed from the Mediterranean to the Persian Gulf, shortening the route to India by six days.

BOOKS AND PAMPHLETS RECEIVED

The History of Howietoun, and also of the Fish-Cultural Work: Sir J. R. G. Maitland (Guy, Stirling).—Mitteilungen des Vereins für Erdkunde zu Halle, 1886 (Halle).—Traité de Zoologie Agricole: P. Brocchi (Baillière et Fils, Paris).—Pearls and Pearling Life: E. Streeter (G. Bell and Sons).—The Owens College: J. Thompson (Cornish, Manchester.)—Journal of the Royal Society of New South Wales, vol. xix. (Sydney).—The Pre-History of the North: J. J. A. Worsaae, translated by H. F. M. Simpson (Trübner).—The Age of Electricity: P. Benjamin (Cassells).—Journal of the Royal Microscopical Society, December (Williams and Norgate).—Hydraulic Power and Hydraulic Machinery: H. Robinson (Griffin).—Education Exhibits, part 1 (Washington).—Elementary Course of Practical Zoology: B. P. Colton (Heath, Boston).—Old and New Chemistry: S. E. Phillips (Wertheimer, Lea, and Co.).—Calendar of the University College of Wales, Aberystwith, 1886-87 (Cornish, Manchester).—A Treatise on Chemistry, vol. iii. part 3: Sir H. Roscoe and Prof. C. Schorlemmer (Macmillan).—A Text-Book of Pathological Anatomy and Pathogenesis, part 2, sections ix.-xii.: Prof. E. Ziegler, translated by Dr. D. Macalister (Macmillan).

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