THURSDAY, MARCH 4, 1875

SIR CHARLES LYELL, BART., F.R.S.

BORN NOV. 14, 1797, DIED FEB. 22, 1875.

See vol. xii. 325

LYELL'S life was uneventful. Great changes in thought, great scientific discoveries, are not called events. Yet, as might have been expected in the case of a man so active, so famous, so far travelled, his life was full of incident, and groups of incidents lead to or make up events. We are indeed in the habit of looking upon Sir Charles Lyell as representing an idea, a theory, a principle —and rightly so. We cannot say exactly that he originated a new method of investigation, but by the use of the right methods, and in the determination to follow fairly each established fact to its logical consequences, he has taught us the laws which have governed the changes of which we can observe the results in the crust of the earth.

We hear of him as a boy making a collection of insects in the New Forest, to which his father removed soon after he was born. At Oxford we find him studying under Buckland. When called to the bar we hear of him on circuit, but already known as a student of nature; for the story goes that he was often missed, and in reply to the question "Where's Lyell?" the answer was, "Oh! he's sure to be somewhere at the bottom of a well, seeking for truth."

The list of his various papers shows how much original work he did in the earlier part of his career: on the older and newer deposits of his native county, Forfarshire; on various beds in Hampshire; the results of observations as to earth movements and other phenomena in Scandinavia; on denudation and volcanoes in the Auvergne; many papers on the Tertiary deposits at home and abroad, and many on various parts of America. Sixteen years ago he published an elaborate memoir on Mount Etna; but latterly the result of his work has appeared in his larger books instead of in separate papers, and it is wonderful how far he was able to carry out his determination to verify on the ground all the observations upon which any important reasoning was founded.

No mind more quick to realise the bearing of the new facts continually being brought before it; no judgment more sound to decide whether the evidence was as yet sufficient. Hence, as work after work and edition after edition came out, the geological world turned anxiously to read his judgment on the vexed questions of the day, knowing that no prejudice would prevent his reversing his own former decision if new light had been thrown upon the subject. Doubtful inferences, which depended upon long inductions and incomplete evidence, were always given with such a clear statement of the sources of error still remaining, that many brilliant but too hasty generalisers complained of his tardy acceptance of their ingenious theories; but the public benefited by his caution and care.

There were many great workers and grand reasoners in the field of geological research when Lyell began his course. But his work did not clash with theirs. The chief of them were collecting evidence among the older rocks; Lyell's work was at first among the newer and, as we have seen, even among living forms of life. He at first watched active or quite recent volcanoes, while others were searching among the older records of the rocks what really were the facts that had to be interpreted.

For the general question, most of those who had got beyond the Wernerian theory were contented to adopt the views of Hutton, with more or less stress laid upon the periodic catastrophes to destroy the old order of things and to bring new land surfaces within reach of the agencies which Hutton held would then gradually mould and carve them into the varying outlines of hill and valley.

But Lyell's line of investigation soon taught him that there were forces in action sufficient not only to chisel and carve the rocks when thrown up by unexplained convulsions, but that this successive bringing of portions of the earth's crust within reach of the graving tool was also part of the ordinary operations of nature.

This was, in fact, the true theory of evolution applied fully to the crust of the earth, and this paved the way for a rational explanation of the origin of species by Darwin, as the continuity of life is not consistent with the Huttonian theory of periodic interruptions of universal extent. Lyell pointed out that it was a matter of observation that variations occurred—variations of level, variations of texture, of hardness, or solubility—that a process of natural selection determined which should stand and which perish. He was at least as successful as the naturalist in giving a satisfactory reason for the occurrence of many of the variations by reference to observed surroundings and known laws. His views commended themselves to the judgment of thinking men, and Cuvier's "Theory of the Earth" was never reproduced in England after the appearance of Lyell's "Principles" in 1829-30. He steadily opposed the views of Lamarck, who explained the origin of species chiefly by some not very clearly defined adaptability in organic nature which enabled it to develop from time to time such varieties of structure as the changes of external circumstances required; much-used organs were strengthened and developed; unused organs were reduced to a rudimentary state. Lamarck's theory was the suggestion of a method by which results such as those observed might have been produced, but he did not show that it was one of the ordinary operations of nature to produce such results in that way. Therefore, the evidence brought forward by Lamarck being faulty, Lyell denied his conclusion, and opposed Lamarck's view as to the continuity of life. When, however, Darwin applied to natural history the methods which Lyell had long used to explain the phenomena of the crust of the earth, and again brought forward the theory of continuity of life, but explained it by variation and natural selection, Lyell accepted the conclusion because now founded on sound reasoning.

Darwin's theory of the evolution of life by the survival of the fittest holds, though we might possibly have to limit our application of it. Lamarck's notion of the development of new forms by dependent modification is not supported by sufficient direct evidence, even when we allow the continuity of life.

Lyell's claim to fame lies in this, that he organised the whole method of inquiry into the history of the formation of the crust of the earth, and established on a sound footing the true principles of geological science; his theory being, that by the uniform action of forces such as are now in operation, the visible crust of the earth has been evolved from previous states.

Lyell was not only a keen investigator of natural phenomena; he was also a shrewd observer of human nature, and his four interesting volumes of travel in America are full of clever criticism and sagacious forecasts. His mind, always fresh and open to new impressions, by sympathy drew towards it and quickened the enthusiasm of all who studied nature. Had he done nothing himself, he would have helped science on by the warmth with which he hailed each new discovery. How many a young geologist has been braced up for new efforts by the encouraging words he heard from Sir Charles, and how many a one has felt exaggeration checked and the faculty of seeing things as they are strengthened by a conversation with that keen sifter of the true from the false!

Though by nature most sociable and genial, yet Sir Charles often withdrew from society where the object of his life, the pursuit of science, was not promoted; but when anything interesting turned up he always tried to share his pleasure with all around. Many of us will remember the cheerful and hearty "Look here"—"Have you shown it to so and so?"—"Capital, capital."

The little wayside flower, and, from early happy associations, still more, the passing butterfly, for the moment seemed to engross his every thought. But the grandeur of the sea impressed him most; he never tired of wandering along the shore, now speaking of the great problems of earth's history, now of the little weed the wave left at his feet. His mind was like the lens that gathers the great sun into a speck and also magnifies the little grain we could not see before. He loved all nature, great and small.

Much we owe to Leonard Horner, himself a good geologist, for having inspired the young Charles Lyell. In after years, when already well known, Charles Lyell chose as his wife the eldest daughter of his teacher and friend. Many have felt the charm of her presence—many have felt the influence of the soul that shone out in her face; but few know how much science directly owes to her. As the companion of his life, sharing his labour, thinking his success her own, Sir Charles had an accomplished linguist who braved with him the dangers and difficulties of travel, no matter how rough; the ever-ready prompter when memory failed, the constant adviser in all cases of difficulty. Had she not been part of him she would herself have been better known to fame. The word of encouragement that he wished to give lost none of its warmth when conveyed by her; the welcome to fellow-workers of foreign lands had a grace added when offered through her. She was taken from him when the long shadows began to cross his path; but it was not then he needed her most. When in the vigour of unimpaired strength he struggled amongst the foremost in the fight for truth, then she stood by and handed him his spear or threw forward his shield. He had not her hand to smooth his pillow at the last, but the loving wife was spared the pain of seeing him die.

It doubtless occurred to many a one among the crowd who saw him laid to rest among the great in thought and action, that he might have been eminent in many a line besides that he chose.

His was a well-balanced judicial mind, which weighed carefully all brought before it. A large type of intellect—too rare not to be missed. But it was well that circumstances did not combine to keep the young laird on his paternal lands among the hills of Forfarshire: it was well for science that he was induced to prefer the quieter study of nature to the subtle bandying of words or the excitement of forensic strife. Failing health had for some time removed him from debates. Still to the last his interest in all that was going on in the scientific world never failed, and nothing pleased him more than an account of the last discussion at the Geological Society, or of any new work done. As a man of science his place cannot be easily filled; while many have lost a kind, good friend.

THE "BESSEMER"

THIS novel steamer, upon the construction of which so much care and ingenuity have been expended, is expected to leave Hull for the Thames this week, and shortly will proceed upon her service between Dover and Calais. By experiments recently made at Hull, the power of the apparatus to put the ponderous saloon in motion alternately in opposite directions, has been fully established. It will no doubt be interesting to our readers if we place before them the following observations connected with the design of this vessel.

The chief objects of her designers, Mr. Bessemer and Mr. Reed, were—

1. To reduce the discomfort of the journey to a minimum.

2. To make her very swift, so that the time spent on the sea by her passengers should be as short as possible.

3. To ensure great steadiness among waves, both as to rolling and pitching.

Finally, to provide her with everything that can contribute to the comfort and convenience of the passengers.

All these points were carefully worked out and considered in connection with the limit imposed on her draught of water by the shallow harbour of Calais.

The *Bessemer* is a double-ended vessel, propelled by four large paddle wheels, two on each side. Each end for a length of about 48 ft. is kept low for the purpose of reducing the motions produced by the action of the wind and of the sea, while the middle portion (about 254 ft.) of her length is built sufficiently high to enable her to steam at a high speed against the worst seas she will meet. A rudder is fitted at each end with efficient means for locking, so that the *Bessemer* will be able to steam in either direction, and will not require to be turned round in harbour, and each rudder is worked by means of Messrs. Brown's patent hydraulic steering gear.

Her great peculiarity, however, is that she contains a large saloon 70 ft. long, designed by Mr. Bessemer, suspended in the middle of the ship in such a manner that it can be moved about a longitudinal axis parallel to the keel. The motion of this saloon, which would be set up if left free to move, when the ship rolled, will be governed by an hydraulic apparatus (the invention of Mr. Bessemer), so that the floor of the saloon will, under all circumstances, be very nearly level.

The *Bessemer* is 350 ft. long, 40 ft. wide along the deck-beam, and 64 ft. wide across the paddle-boxes. She will be propelled at a speed of eighteen to twenty miles an hour by two pairs of engines of the collective indicated power of 4,600 horses. The centres of the two pairs of paddle wheels will be about 106 ft. apart.

The *Bessemer* saloon contains the main saloon, which is about 40 ft. long by 29 ft. wide, and 20 ft. high, six spacious retiring rooms, a refreshment room, lavatories, store rooms, &c. The decorations and fittings of the main saloon will be of the very best description, Mr. Bessemer having given this branch of the design his most careful attention. The retiring rooms, as well as the main saloon, are ventilated and heated by a very ingenious arrangement of fans, pipes, &c., which supply and exhaust air in an almost imperceptible manner.

Between the paddle-boxes on either side, and on the upper deck at the middle of the vessel, there are numerous private cabins for the accommodation of first-class passengers, and all of these cabins will be fitted up in a manner that will help to make the journey across the Channel as pleasant as possible. In addition to these, at one end of the vessel between the decks there is a fixed saloon about 52 ft. long, for second-class passengers. The luggage will be stowed in the hold at the opposite end of the ship to this fixed saloon, and two very ingeniously contrived hydraulic luggage cranes, fitted by Messrs. Brown, Bros., will be employed for lifting luggage off the pier and depositing it in the luggage hold, and *vice versâ*, in a very expeditious manner.

The *Bessemer* saloon, however, will be by far the finest cabin that has ever been fitted in a ship. Its great size and height enables it to be ventilated imperceptibly, and will prevent passengers who use it from feeling the unpleasant sensations usually connected with going below. But one of the great advantages of this saloon is, that whatever motion the ship may take from the waves—and this, from the adaptation of her form to passivity among Channel waves, will be slight—the saloon will be practically free from it. It is in the middle of the ship as regards length and breadth, and the axis of rotation is at a height where there is least motion, so that as regards its position it is one in which the vertical and lateral motions produced in every part of the ship by the pitching and rolling will be small, and usually scarcely appreciable. The saloon also will have very little pitching motion, for the form of the vessel renders it impossible for the sea of the Straits of Dover to raise her low freeboard ends very considerably; and even the small effects produced at the ends of the ship will be reduced to about one-seventh at the extremities of the saloon.

From the foregoing remarks it is evident that everything that promises to secure the passengers immunity from sea-sickness has been provided. In the saloon rolling and pitching motions will not be inconveniently felt, and any lateral or vertical movements that may be set up in the ship (and these must be obviously small when the main features of the design for preventing them are taken into account) will only be communicated to the saloon to the extent to which they exist at that part of the vessel where they are necessarily small.

It was intended by Mr. Bessemer to keep the floor of the suspended saloon level by means of an automatic apparatus which involved both the principle of the gyroscope and of Barker's mill. Certain practical difficulties, however, have led him to abandon that idea for the more simple and less costly plan which we will now attempt to describe. Immediately outside one of the ends of the saloon, and attached to the frames of the vessel, there is a pair of powerful pumping-engines. These engines keep up a constant supply of water to a large cylindrical accumulator. The hydraulic pressure so obtained is transmitted through pipes which pass through the hollow axle supporting the nearest end of the saloon to a very ingeniously contrived cylindrical slide balanced valve, which is placed on the athwartship floor girders near the middle of the saloon. The hydraulic pressure is next transmitted through the valve and through another system of pipes to two tipping cylinders, which are fitted one on each side of the vessel at the middle of the length of the saloon. These cylinders have their lower ends attached to two very strong athwart-ship girders, while the upper ends of the piston-rods are connected to the lower side of the upper deck. It will be readily perceived that the forces necessary to keep the floor of the saloon level are exerted on the ends of the athwartship girders just mentioned by means of the two sets of tipping gear. The direction of application of the hydraulic pressure on the pistons in the tipping cylinders is governed by means of a system of levers connected with the equilibrium valve. Near the end of the primary lever, and on its upper side, is fixed a spirit-level, and the man whose duty it is to work this lever regulates the distance through which he elevates or depresses the primary lever, so as to keep the air-bubble as near as possible coincident with the central mark on the level. It is assumed by this arrangement that when the spirit-level is "well" the floor of the saloon will be level, whatever rolling motion the vessel herself may have; and since this level is placed near the centre of gravity of the vessel where the angular motion is generally least, there can be no doubt that the saloon will at all times be pretty uniformly level.

THE ENCYCLOPÆDIA BRITANNICA

The Encyclopædia Britannica. Ninth Edition. Edited by Prof. Spencer Baynes. Vol. I. A to ANA. (Edinburgh: Adam and Charles Black.)

THE first volume of the ninth edition of the "Encyclopædia Britannica" has just been issued, handsomely printed and copiously illustrated.

The first edition of this venerable work was announced rather more than a century ago, as it began to be published in parts in the year 1771. The projector of the work was an Edinburgh printer of the time, Mr. Colin M'Farquhar, and the editor and chief compiler was Mr. Smellie, also a printer. Another gentleman associated in the production of the work was Mr. Andrew Bell, a well-known Edinburgh engraver of the period.

The first edition ignored biographical, historical, and geographical matters; but these subjects were effectively introduced in the second edition, and have formed an important feature in subsequent issues. The second edition was in every respect an improvement on its predecessor, and being extended to ten volumes, room was found for the extension and elaboration of many important topics.

The second edition was not, like the first edition, a mere compilation. The proprietors had early seen the necessity of employing the most talented men they could find to contribute the results of their special studies in literature and philosophy, and several eminent men of the period earned honourable remuneration by writing for the work; indeed, it is to the earlier editors of the "Encyclopædia Britannica" that scientific men owe it that their literary labours came so early to have a recognised money value. In the third edition, which was commenced early in 1788, the system of obtaining the best articles in physical science and literature from those who had made these subjects a special study was continued and extended, adding greatly to the value of the work. Mr. M'Farquhar, the proprietor, contributed very largely to its success by the unremitting attention which he bestowed on the editorial department. His labour in connection with the third edition, all the earlier portions of which he edited himself, had such an effect upon his health that he died in the fiftieth year of his age. Dr. Gleig, of Stirling, afterwards Bishop of Brechin, who had been a voluminous contributor, was offered and accepted the editorship after the third edition had been begun. This learned gentleman aided in giving that high tone to the "Encyclopædia" which it afterwards maintained under the editorial supervision of Mr. Macvey Napier and Dr. Traill, and which, judging from the first volume, it is likely to maintain under the editorial superintendence of Prof. Spencer Baynes.

The services of Prof. John Robison, of the University of Edinburgh, were secured at an early stage, and that gentleman ultimately became a very voluminous contributor to the third edition. He *renewed* the article on *Optics*, and jointly with the editor produced the article on *Philosophy*. He also contributed the articles on *Physics*, *Resistance*, *Specific Gravity*, *Tides*, *Telescopes*, and numerous others. To a supplement of two volumes which was ultimately added to the third edition Robison was also a voluminous contributor; for this portion of the work he wrote many of the scientific articles, including *Astronomy*, *Dynamics*, *Electricity*, *Magnetism*, *Thunder*, *Trumpet*, and *Watch-work*. Prof. Robison undoubtedly did much to render the "Encyclopædia Britannica" the great work which it has become.

The issue of the third edition of the "Britannica" was completed in 1797 in eighteen volumes. Constable, at that time rising into fame as a great publisher, acquired the copyright of the supplement to that edition for the sum of 100*l*. Before long a fourth edition was called for, which was published in twenty volumes and completed in thirteen years from the time at which the third edition was finished. This edition was quite as successful as any of those which preceded it. It was edited by Dr. James Miller, and under his auspices the system of having the greater portion of the matter supplied by specialists was largely extended, and with the greatest possible advantage to the work.

After this time a new chapter in the history of the "Encyclopædia" begins. Mr. Constable ultimately acquired the copyright, and at once set to work with his usual enthusiasm to improve the book, beginning with preparations for the issue of a "great" supplement, in emulation of the French work which had been the literary sensation of its time. This supplement was placed under the editorial charge of Mr. Macvey Napier, and the aid of Dugald Stewart was obtained as a contributor of one of the celebrated preliminary dissertations. His was on the History of Metaphysics and Ethical and Political Philosophy; the other dissertation was, if we mistake not, left unfinished by Playfair; it was upon Mathematics and Physical Science. This work was completed by Sir James Mackintosh and Prof. Leslie. Constable felt, when he had obtained the services of an eminent man like Stewart, and also of Davy, that he was entitled to ask all the great literary and scientific men of the day to aid him in his undertaking. He did so, and among the splendid list of contributors which he gathered around him were to be found the names of Arago and Biot.

A large sum of money in addition to the amount paid for the Dissertations was expended on the supplement; and there is no doubt that the public owe to the liberality and energy of Archibald Constable all the best features of the great work as it now exists. The supplement was ultimately and properly incorporated into the future editions of the work, the sixth and seventh editions of which were edited by Mr. Macvey Napier. It is unnecessary further to follow the literary fortunes of the book. Archbishop Whately and Prof. Forbes contributed each an additional dissertation. It would take up too much of our space to give a list of all the distinguished contributors to the seventh and eighth editions of the "Encyclopædia Britannica," many of whom were of world-wide celebrity at the time when they wrote, and many more of whom, then comparatively obscure, have since become famous.

Coming now to the ninth edition, it would not, we think, be any exaggeration to say that the first volume contains as much matter as the three "ill-furnished" quartos which embraced the whole contents of the work as originally projected. From being a mere compilation, the "Britannica" under previous editors had become a work of national importance, containing original treatises on science, art, and literature, by famous literary and scientific men. A glance at the first instalment of this issue warrants us in declaring that the work will lose nothing from having been entrusted to Prof. Baynes. Although he possesses what may be called a perfect mine of art, science, and philosophy in the preceding edition, it must not be forgotten that twenty years have elapsed since it began to be issued. During that period science and art have made vast strides, and history has not been standing still. In biography there are many new names to add to the list of the illustrious dead; and in geography, and trade and manufactures, many radical changes have taken place.

The two previous editions of the work began with the celebrated "Dissertations" to which allusion has already been made; but the present issue commences at once, if we except a brief and well-written preface, with the proper matter of the book in alphabetical sequence, All mere dictionary "words" have now been excluded from the "Britannica" by Prof. Baynes, who has thus gained a great deal of space for the illustration of more important matter. Those who have an opportunity of comparing the present with former editions will note the advantage of this plan. In the matter of biography great changes will doubtless be introduced, and mere locality will now cease to have an influence in this department; already, we observe that the account of Dr. Adam, an eminent Scotchman of the olden time, has been compressed into a few lines, and a similar plan will doubtless be adopted throughout the work—(though parenthetically let us ask why Aberdour on the Forth, an insignificant watering-place, should have a place, while Aberdour in the north of Aberdeenshire, notable in early Scottish history, and in "the grand old ballad of Sir Patrick Spence," be ignored?) On the other hand, subjects that have become important in our day are discussed at sufficient length, and a fair balance is kept up in the allocation of space. *Adulteration* may be cited as an example of what we mean. The article on that subject has been entrusted to Dr. Letheby, and it very profitably occupies seven times the space formerly allotted to it. The article *Æsthetics* has grown from a few lines into an excellent treatise, occupying no less than twelve pages of the new edition. Prof. Huxley has had over twenty pages allotted to his masterly article on *Amphibia;* he also contributes *Actinozoa. Agriculture* is discussed at a length suited to its importance; the article is divided into twenty-one chapters, and occupies 125 pages, and it is needless to say that it embraces an account of the latest discoveries and improvements in farming, including descriptions of what has been achieved by steam power. The article on *America* occupies forty-eight pages, and seventeen pages besides have been devoted to a disquisition on *American Literature*, by Prof. Nichol, of Glasgow, the son of the author of the "Architecture of the Heavens." The fact that the article *Alps* is by Mr. John Ball is a guarantee of its completeness and accuracy; the names and heights of all the chief peaks of the different ranges and groups are given. A most elaborate dissertation, by Prof. Turner, on *Anatomy*, occupies 109 pages of the volume, which concludes with that subject. There is an interesting biographical sketch of *Agassiz. Afghanistan* and *Africa* are, of course, brought up to the latest date. The treatise on *Algebra* has been revised—re-written, indeed—by Kelland; and in a recent number we alluded to Mr. Wallace's careful paper on *Acclimatisation.*

Prof. Baynes has taken the only safe method of securing articles that shall embody the fullest, and highest, and most accurate knowledge; viz., by obtaining the services of those who have proved themselves to be at the summit in their particular departments. To the present and to future generations, therefore, this ninth edition of the "Encyclopædia Britannica" must be regarded as indicating the highest tide-mark of the science, literature, and art of the time; and from this point of view the successive editions of the book are peculiarly interesting as showing the progress of knowledge during the periods that have elapsed between the times of their publication. We suspect that no edition will have required more modifications to bring it abreast of the time than the present one; and, as we have said, Prof. Baynes has taken the best possible means to accomplish this purpose. In whatever other light it may be viewed, it must, when complete, be regarded as a magnificent collection of masterly treatises in every department of human learning.

This is scarcely the place, nor have we the space, to criticise the plan of the work. For mere purposes of ready reference, we suspect that less gigantic works will be found more useful. A really useful encyclopædia, one that would serve the first and chief purpose of such a work—a book of reference that may with the utmost facility be consulted at any time for information concerning any topic—should have its headings subdivided to the utmost possible limits. This will by many be considered the weak point of the "Britannica," and must be so, so long as the publishers insist on its being mainly a collection of elaborate treatises. This objection may to some extent be obviated by a thoroughly exhaustive index; but if an index is to be the chief apparatus for consulting an encyclopædia, then why not base the subdivision of the work on a logical and not on the alphabetical method?

But in view of the value of the "Britannica" as a treasury of the highest science and learning of our time, —and the publishers, we think, are justified in still retaining this as its chief characteristic—these objections may be considered as of minor importance; and of its value from this point of view there can be no manner of doubt. Prof. Baynes has already justified the choice made of him as editor, and shown himself in all respects competent to be the leader of such a splendid undertaking. We congratulate him on the success he has achieved, and wish him health and strength to carry on the work to its conclusion.

BROWN'S "MANUAL OF BOTANY"

A Manual of Botany, Anatomical and Physiological, for the use of Students. By Robert Brown, M.A., Ph.D., F.L.S., F.R.G.S. (Edinburgh: Blackwood, 1874.)

AT the present time there is a manifest want of an English text-book *au courant* with the modern state of those branches of botanical science which have to do with the minute structure, morphology, and physiology proper of plant-forms. The best that we have are often little more than introductions to the classificatory study of flowering plants. They give copious definitions and illustrations of the technical language which is needed in drawing up descriptions for the purposes of what are known as "systematic" works, but they have little to say —and that little is altogether out of date—about the important and various types which are lumped together as Cryptogams.

This state of things is obviously unsatisfactory. If the study of Biology proper is ever to make any progress amongst us, it must base its principles upon a comprehensive study of all living forms, and draw its illustrations from a wide survey of the vegetable as well as of the animal kingdom. If evolution is to be as fertile a principle in the investigation of vegetable as it has been in the case of animal development, it must take, in its own domain, as wide a scope. Lastly, if we are to turn to any useful account the knowledge which is gradually accumulating of the part played by the simplest vegetable organisms in such phenomena as fermentation, putrefaction, and disease, a study of these and kindred organisms must play a much larger part than it has hitherto done in the botanical instruction given in the country.

Bearing in mind considerations of this kind, the publication of a new botanical text-book is a matter of considerable interest. It must, however, be at once confessed that the hopes which the admirable typography and attractive exterior of Dr. Brown's book at first sight excited have been most thoroughly dissipated by a somewhat cursory scrutiny of his pages.

The task which we feel it is absolutely necessary to undertake, of pointing out the signal badness of this book, is one of the most distasteful which anyone can assign to himself. The mere labour which is necessitated by the composition of some six hundred octavo pages of printed matter seems a sort of guarantee that the work will be in some degree genuine. And at first sight the plan which Dr. Brown has adopted is one which one cannot fail to approve. Instead of attempting, as most English manuals do, to treat the whole art and mystery of the subject in one volume, giving between the same boards a grammar of technical language, the elements of morphology, of taxonomy, of physiology proper, of distribution both in time and space, he has limited his subject in the present volume to all that concerns the higher plants alone. But the leaven cleaves to him still, and in each chapter, besides the description of the structure and functions of each several part, we have the old and tedious lists of technical terms, of which even systematic botanists trouble themselves now to use but a few.

It is, however, with respect to the detailed execution of the task that Dr. Brown has imposed upon himself that we feel obliged to speak in terms of unqualified condemnation. A book more utterly untrustworthy has probably never been issued for the use of confiding and uninstructed students; and as there is a species of singular cruelty in placing in the hands of those who have to learn stores of knowledge which, to say the least, will prove bitterly deceitful when offered as the currency of a modern examination-room, it is to be hoped that some excuse may be accepted for a degree of indignation which may seem unusual even a review.

We will simply give a few extracts from Dr. Brown's pages in order that at least our botanical readers may form their own opinion as to how far what is said above admits of justification.

Here, for example, is a description of the red snow plant (*Hæmatococcus*) which will be a hopeless stumbling-block at the very outset (p. 14):—

"Each of these plants consists of a minute globule, distinct and separate, composed of a thin membrane perfectly closed in all its parts, colourless, but containing in the interior a red liquid. By-and-by granules appear in this red liquid, which grow and soon tear the envelope, and after a time give birth to other globular vesicles exactly resembling the mother cells."

Hæmatococcus is only a form of *Protococcus* — red, instead of green. Dr. Brown's account of its life-history is behind the age altogether.

On page 16 we are told of the cell-wall: "In its original form the membrane is thin, transparent, and colourless with a pearly lustre." A pearly lustre (not that it exists in this case) accompanies opacity, not transparency. Nor when we have disposed of the cell-wall in this self-contradictory fashion, can it be considered an altogether adequate treatment of protoplasm to mention it incidentally *amongst the liquids contained in cells* as "a granular viscid substance, composed of proteine and rich in nitrogen, and surrounding the nucleus" (p. 20). It is hardly necessary to observe that the nucleus is not independent of the protoplasm, but part of it.

The account of the nucleus itself is simply apocryphal:—

"In the leaves of *Orontium japonicum* it [the nucleus] is sufficient to cause elevated markings on the epidermis, each subjacent cell having a well-marked nucleus. It can be easily seen, especially if a little iodine is applied. In that case it takes a marked brown colour, and shows distinctly that it is composed of irregularly round transparent globules, though we do not yet know whether they are really globules or little cells—solid or empty" (p. 22).

Further on (p. 23) we learn that "alcohol decolorises chlorophyll by dissolving the resinous matter,"—the fact being that alcohol dissolves the chlorophyll itself from the protoplasmic granules which it colours. On p. 25 we have the astounding suggestion that chlorophyll is derived from the nucleus "in a manner analogous to that in which starch is."

On p. 50 we learn that "vessels by their union form vascular bundles often called fibres"—a statement erroneous from beginning to end. In the account of the structure of the stem of ferns (p. 99) the masses of sclerenchyma are confounded with the fibro-vascular bundles. The account of the stem of *Lycopodiaceæ* conveys no real information at all.

The sweet galingale (*Acorus Calamus*) is called (p. 103) *Calamus aromaticus*—*Calamus* being a genus of Palms. As further instances of slovenliness which could hardly be exceeded:—

"This point [*i.e.* the growing point of the root] is called the spongeole or spongelet, from a mistaken idea of its absorbent function. It was at one time commonly taught that this [*i.e.* the growing point] was the growing and absorbing point of the root" (p. 133).

A *Euphorbia* is given as an example of *Cactaceæ* (p. 146). The whole plant of *Lemna* is alluded to as representing a leaf (p. 147).

"In *Broussonetia papyrifera*, out of the pith of which paper is made, and out of the liber of which the Polynesians weave their cloth, Duchartre notices the extreme diversity of the leaves" (p. 173). These irrelevant statements would be accurate were not the paper made from the bark and not the pith, and were not Tappa cloth a "felt" made by beating, and not a woven material at all.

Even the tedious lists of technical terms are not more accurate. The surface of the leaf, we are told (p. 205), may be "plain," to which *planum* is given as the equivalent; lower down *velvetinum* is given as the equivalent of villose.

It is sad to contemplate the fate of an unhappy examinee who should venture, trusting in Dr. Brown, to say it has been shown (p. 409) "that in many plants the pollen-tubes found at the micropyle at the time of impregnation really originated there, and were not derived from the pollen."

Equally deplorable would be the result of affirming with Dr. Brown (p. 230) that "Turnip leaves contain 3 to 10 per cent. [of silica], oat 11 to 58 per cent. (especially in the stem), lettuce 20 per cent., oak-leaves 31 per cent., and beech-leaves 26 per cent."

It is unjust to the memory of Grew to assert that he ever disputed the discovery of the sexuality of flowering plants with Millington. Anyone who will refer to Grew's "Anatomy of Plants," p. 171, will see that he does perfect justice to Millington.

We had noted down a number of other passages equally open to criticism, but it is sincerely to be hoped in the interests of real botanical study that the specimens of this book which have been given will have some deterrent effect upon its possible readers. It is in vain that the author assures us that he has perused, for the purpose of his book, no less than 1,200 papers in almost every European language. A tithe of this literature properly selected and properly digested would have produced a manual of some value, instead of a mere chaotic dust-heap of all kinds of views belonging to all kinds of authors, as if scientific literature were in a way canonical, and the date of an author's views made no sort of difference, a common authenticity—like inspiration—embracing them all.

The blunders in the names of plants all through the book are quite as remarkable as the statements about their structure. *Chamæoparinus* (p. 101) is something more than a misprint for *Chamæcyparissus*, and it is astonishing to read about the "*Brownonian*" movements in a book whose author bears the honoured name of Robert Brown.

OUR BOOK SHELF

Telegraph and Travel. By Colonel Sir F. J. Goldsmid, C.B., K.C.S.I., &c. (London: Macmillan and Co., 1874.)

DURING the time of the late Bengal famine we were familiarised with seeing in the morning papers telegrams that had been despatched from Calcutta on the previous evening. Ten years ago telegraphic communication with India was but just completed *viâ* Constantinople, the Persian Gulf, and Karāchi: but it was some years after that before rapid through communication was arranged. The delays occurred mostly between Persia and England, and much organisation of European lines was needed before it was possible to converse with Teheran as the Shah did on his arrival at Buckingham Palace.

Those who are interested in the subject of telegraphic communication with our Indian Empire (and who is not?) will find much information in Sir F. J. Goldsmid's "Telegraph and Travel." He gives an account of the origin and development of the schemes, the troublesome diplomatic delays, and the physical difficulties that had to be overcome, as well as the arrangements that had to be made in some districts to protect the overland lines from destruction by wandering tribes. An officer of experience among Turks of Europe and Asia expressed his opinion at the outset that every convention with the Arabs in the interest of telegraph companies would be uncertain of execution, and that all wire within reach would be torn down from the poles to make heel-ropes for their horses. Instances of wilful damage unhappily were found by experience to be not rare, so that in some districts mounted guards were needed along wide tracts, adding, of course, considerably to the working cost of the lines.

The first part of the book the author feels is likely to be "found painfully practical and matter of fact, overburdened with official details and wanting in the zest which keeps the eye willingly open and the hand steady to the book," and he pleads in excuse "the necessarily monotonous character of the subject." The accomplishment of such a communication between the two countries, however, is so momentously important an event, that the history of its progress is of interest, however it is told. Sir F. J. Goldsmid's arrangement of his materials certainly does make it rather difficult to follow the thread of the history, but then it is enlivened with many interesting little sketches, descriptions of Persian diplomatists, their manner of conducting business, and so forth.

The first part of the book is illustrated with two maps which indicate the route of the different telegraphic lines between England and India, the dates being affixed to the different sections. Sir F. J. Goldsmid writes from his own experiences and from blue-books, and gives a mass of information which could not well be compiled by anyone not practically acquainted with the work.

LETTERS TO THE EDITOR

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

Sir J. Herschel on the Endowment of Research

THE following extract from a letter from Sir John Herschel bears so directly on the distinction between the needs of theoretical and practical science insisted on in your recent leading article (vol. xi. p. 301), that I need offer no apology for communicating it. As the present value of the opinions which it expresses is intrinsic, it is unnecessary to particularise the circumstances under which the letter was written more than thirty years ago. But I may remark that it is supported by many passages in other letters in which the distinction in question, and that between research which *can* and research which *cannot* be readily effected by private means, is dwelt on (with all the scrupulous care of one than whom no responsible guardian of the public purse was ever more opposed to dependence on State aid as a principle), in a sense emphatically favourable to the demands of science for help in certain clearly indicated directions. I am sorry that I have not the papers at hand to quote from, but one instance in particular occurs to me, in which the extending and perfecting of various Physical Tables in a thoroughly satisfactory manner is declared to be altogether outside of the field of work of the individual investigator, and to be labour to be *paid for* by the community. J. H.

Biarritz, Feb. 22

". . . There is a remark which possibly it may be deemed presumptuous in me to make, relative to the general subject of scientific expenditure touched on [in your letter], but which I trust may be pardoned, as I have reason to believe my impressions on the subject are those of the whole body of British men of science, with hardly an exception. Large as the sum expended on objects officially classed as 'scientific' may appear it would not, I think, be considered as excessive if devoted to the prosecution of scientific objects in the highest and strictest sense of that word. I mean such as would be recommended for prosecution by men of science the most eminent, each in his several department, and responsible for their recommendations to the opinion of the public and of the scientific world. Under such objects I should certainly not include hydrographical, industrial, or military surveys, experiments merely technical, or many other objects, which, however indisputably necessary and requiring for their due execution scientific and refined processes and the superintendence of scientific men of high qualifications, are yet, properly speaking, rather applications of scientific views and acquired skill to particular objects of national importance, than undertakings of research having in view as their primary object the advancement of science itself. It is true, that as practice makes perfect, science *does* gain by such applications, and that by going somewhat out of the way in their execution, and seizing opportunities, most valuable theoretical results and data are occasionally elicited at an additional cost incomparably less than would be incurred by instituting operations for the purpose *ab initio*. But when I consider the pregnant nature of scientific truth, and how upon occasion of every well-grounded accession to, or extension of, theoretical knowledge, *a new practice* has arisen founded thereon, and old methods have been abandoned as *inefficient* and *uneconomical* in comparison, I should feel prepared to advocate or defend a very large and liberal devotion indeed of the public means to setting on foot undertakings, and maintaining establishments, in which the investigation of physical laws and data should be the avowed and primary object, and practical application the secondary, incidental, and collateral one.

"This, however, has hitherto been the fortunate lot of Astronomy only. And the result has been, *not only* the establishment of a complete theory—*not only* the perfection of nautical tables and observation—but an universal impulse given to every other branch of exact inquiry—a higher standard erected everywhere, a precision in every determination rendered practicable, which would have never before been dreamed of as attainable without the requirements of Astronomy. Is it hoping too much that the day may not be far distant when Physical Science in all its exacter branches shall participate in these advantages, and when the establishment of 'Physical Observatories' in our own and distant lands shall give that impulse to many other sciences (as for example Magnetism, Meteorology, &c.) of which they stand so much in need?" . . . . "J. F. W. H."

Trade Winds

MAURY, in his "Physical Geography of the Sea," maintains that the surface trade wind of the northern hemisphere becomes the upper counter current of the south, and *vice versâ*. That the trade winds, in fact, cross each other so—

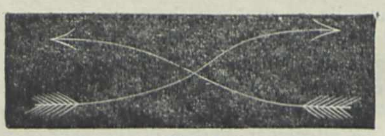


FIG. 1.

instead of meeting and turning back over themselves so—

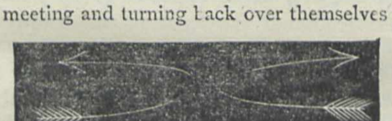


FIG. 2.

Subsequent writers on physical geography have repeated this statement without apparently reflecting on its extreme improbability.

Maury's arguments for this strange theory are partly connected with the hygrometric state of certain of these currents, partly with terrestrial magnetism, and partly with the nature of the air-dust. It would take up too much of your space to discuss these points fully. The arguments founded on terrestrial magnetism are, however, purely hypothetical and very fanciful. Those on the hygrometric state of the currents are not very convincing. It is, however, to the latter of Maury's arguments I wish to draw your readers' attention. Maury seems to believe in this almost incredible direction of the air currents because Ehrenberg identified certain South American infusorial forms in the red dust which often falls at sea near the West Coast of Africa and in South Europe. Did Ehrenberg simply identify certain South American forms in the dust, or did he identify the dust as South American on account of the presence of these forms? If the former, the argument goes for little; South American forms may be found in Africa also. If the latter, then a new difficulty arises. Every microscopist knows the curious diversity of infusorial forms in all climates at all similar. It would be the height of presumption even to question the conclusions of Ehrenberg in microscopy; and yet to be able to identify infusorial forms in such a way as to say that dust containing them comes from such and such a locality is certainly very wonderful.

Maury, from some of his remarks, does not seem to be fully alive to the utter inconsistency of his theory with what we know of the laws of fluid motion. That two broad flat rapid currents should encounter or flow into the same rising current and then cross through each other in alternate strips, or *curdles*, as Maury calls them, is scarcely within the bounds of physical possibility. On the other hand, Maury's opinions are certainly entitled to consideration, and this is one which he found with so much deliberation, and entertained so firmly, that I should gladly learn what competent physicists of the present day think of it.

Graeff Reinet College, Nov. 13 F. GUTHRIE

The Arctic Expedition

THE absence of sunlight during the Arctic winter is said to have an injurious effect on the health of both men and dogs; yet it does not appear that the best substitute for solar light has ever been employed for illuminating purposes during the dark season. It occurs to me that the occasional use of the electric-light would be likely to mitigate the evils due to the absence of solar radiation, and the constant use of oil lamps. If Gramme's electro-magnetic apparatus could be conveniently used on board ship, it would appear to offer the additional advantage of giving employment to the men at a time when it is difficult to find occupation for them.

Dublin, Feb. 23 R. J. MOSS

Herapath's Balance

CAN any of your readers inform me whether Herapath completed his balance, in which he suspended the beam from a magnet; also whether the idea was taken up by balance makers? He gives an account of this form of balance in a paper dated 1821. E. W. P.

OUR ASTRONOMICAL COLUMN

THE BINARY STAR μ^2 BOOTIS.—Dr. W. Doberck, of Col. Cooper's Observatory, Markree Castle, Sligo, has communicated to the Royal Irish Academy, and also published in *Ast. Nach.* No. 2026, an orbit of this binary founded upon a very complete discussion of the measures from 1782 when the duplicity was detected by Sir W. Herschel, to 1873. The resulting period of revolution is 290 years, and the true peri-astron passage is found to have occurred about 1863·5. Dr. Doberck does not append an ephemeris of angles and distances according to his orbit, but we supply them for the next eighteen months for comparison with any measures that may be made in the interval:—

1875·25	Angle	144°·79	Distance	0″·632
75·75	„	142·83	„	0·634
76·25	„	140·89	„	0·637
76·75	„	138·96	„	0·640

FALB'S NEW VARIABLE IN ORION.—The star to which reference was made in NATURE last week, appears to be the preceding component of the double star Σ 747, or that which was the smaller star during Struve's measures 1825-36. Herr Falb has given some particulars relating to this object in No. 2,026 of the *Astronomische Nachrichten*, but we suspect he has inadvertently reversed the order in which the magnitudes of the Dorpat Catalogue should be assigned. Struve's mean is

1833·59 Angle 223°·06 Distance 35″·85

whence the smaller star was in the south-preceding quadrant. In addition to the authorities for magnitude quoted by Herr Falb, it may be mentioned that both components are found in the last Greenwich Catalogue (1864); the preceding star is there called 8 mag., and the following one 7. If we transform the differences of R.A. and N.P.D. in this catalogue into angle and distance, there results for about

1866·95 Angle 224°·5 Distance 36″·4

agreeing as closely with Struve's measures as could be expected. The principal or following component of Σ 747 is Bradley 801, and its position for the beginning of the present year is in R.A. 5h. 28m. 54s·4, and N.P.D. 96° 5′ 39″; it is 8′ distant from ι Orionis, on an angle of 225°.

THE VARIABLE STAR R HYDRÆ.—Observations of this star in southern latitudes are much needed for affording a better insight into the law of variation than we yet possess. That the period has greatly diminished since the time of Maraldi is beyond doubt; Schönfeld makes it about 500 days for the year 1708, 487 days for 1785, and 437 days for 1870. It was pointed out by Argelander that good comparison stars are too low for favourable observation in central European latitudes. According to the formula involving E^2 and E^3, given in Schönfeld's last catalogue, a maximum would occur on the 25th of February, and the following one falls 1876, May 10. The minimum, which by Schmidt's observations occurs 200 days before the maximum, will not be observable in the present year. At greatest brightness the star is found to vary from 4·0 to 5·5. Its position for 1875 is in R.A. 13h. 22m. 53s., and N.P.D. 112° 38′·0.

WINNECKE'S COMET.—This body is now beyond reach and it is probable that the observations which have been secured will be few in number. It is nevertheless evident that the elements are very well determined, a very small acceleration which is also indicated in previous revolutions being sufficient to produce an exact agreement between Prof. Oppolzer's calculations and the result of the first Marseilles observation. Reference was lately made to the Vienna astronomer's suspicion of identity of this comet with one of the imperfectly observed comets of 1808—that which was discovered by Pons on Feb. 6th and seen again on the 9th. On examining the matter more closely there appears to be strong reasons to doubt this inference, upon which we may enter in a future notice.

THE ZODIACAL LIGHT.—Another conspicuous exhibition of this phenomenon was observable in the neighbourhood of London on the evening of February 25. The sky was very vaporous, and the smaller stars usually visible without a telescope were not discerned, but soon after 8 P.M. the light was quite a marked object in the heavens: it did not present the lemon tinge which is commonly the case when the sky is clear, but rather resembled the light of the Milky Way, except that it was of much greater intensity. It could not be traced that evening beyond the constellation Musca.

NEW MINOR PLANET.—Le Verrier's *Bulletin* of Feb. 27 announces the discovery of a new member of the minor planet group by Herr Palisa at the Observatory of Pola on the 23rd. Its position at 8h. 42m. local time was in R.A. 9h. 57m. 56s., N.P.D. 76° 14′. The planet is of the twelfth magnitude.

SCIENCE AT THE NEW PARIS OPERA

THE New Paris Opera has excited a great deal of attention among all classes, both on the Continent and in England. Every effort has been made to make the building perfect in all respects, and to carry out its construction in harmony with the latest scientific principles. Some recent numbers of *La Nature* contain a series of articles by M. G. Tissandier on the new building, to show in what manner the principles of science have been made to conduce to the welfare and comfort of art. A few of the points in these articles we shall bring before our readers, as also some of the illustrations, which have been obligingly lent us by the proprietors of our sister journal. M. Tissandier deals first with the subject of Warming and Ventilation.

It is not astonishing that the ventilation of theatres has been effected in a very incomplete fashion, when we consider the difficulties which stand in the way of a complete solution. "A theatre is composed not of a single compartment, like every other place of assembly, but of three vast contiguous compartments: the hall (or auditorium), the corridors, and the stage, all which, at certain times are separated, at others connected by vast openings. To this first difficulty must be added the action of the lustre, which causes a strong current of sonorous waves towards the ceiling, greatly to the detriment of the acoustics and to the equality of temperature in the various parts of the auditorium. The position of the spectators in tiers rising one above the other along the walls, and not horizontally, adds a new obstacle to the efficacious renewal of the air. Moreover, the conditions of the problem are constantly changing. Thus, before the entrance of the public the heating may have taken place downwards and by the ordinary means; but, once the public have been admitted and the curtain raised, a considerable mass of air, that of the stage, is put into communication with the body of the theatre. Between the acts this communication ceases; but, on the other hand, there are from 1,000 to 1,500 persons, just so many living stoves, and some hundreds of gas-jets, which heat and gradually vitiate the atmosphere. Hence a change must be introduced in the ventilation; still another change when the curtain is raised; and all this to be modified according to the season." *

At the commencement of the present century the Marquis de Chavannes devised a system, which was tried at Covent Garden Theatre, and which contained the principle of all the methods since invented.

The heating of the stage was effected by steam cylinders, shown at M, in Fig. 1. Ventilation took place at N above. The auditorium was heated by the large stove B, which by cylindrical pipes sends warm air under the flooring of the boxes and into the staircases. At R the vitiated air of the boxes met, drawn off by the openings A A A. The vitiated air of the body of the theatre drawn upwards by the lustre, reached O, after having traversed the openings P P.

In 1828 a commission, composed of Bérard, Cadet de Gassicourt, Marc, and d'Arcet, was entrusted in France with an investigation into the principles of the ventilation of theatres. Fig. 2 represents the arrangement devised by d'Arcet, who took advantage of the lustre to convey outside the air vitiated by the combustion and by the breath of the audience. The warm air is introduced into the corridors by the openings C C C; it enters the auditorium by passing under the flooring of the boxes, in the direction of the arrows. The exit of the air takes place at U; it may be regulated above the lustre by means of the movable traps at T. It is also accomplished at V, by passages which are united in the central chimney.

These systems had serious drawbacks. An attempt at improvement was made in 1861, during the construction of the new theatres in the Place du Châtelet. For the purpose of investigating the question a commission was nominated, presided over by M. Dumas, Perpetual Secretary of the Academy of Sciences, and having for reporter General Morin, Director of the Conservatoire des Arts et Métiers. After many experiments and many contra-

* "Traité pratique du chauffage et de la ventilation," by V. Ch. Joly.

dictory advices, they fixed on the arrangements advocated since 1860 by M. Trélat.* The system was found, however, to be ineffective.

The question was in this state when M. C. Garnier was called upon to construct the new theatre, which at present justly attracts the attention of all.

The arrangements adopted in the New Opera, without being exactly new, are remarkably improved; if the principles upon which they are founded are almost the same as those referred to above, an effort has been made to apply them under the conditions best calulated to ensure a favourable result.

Of fourteen large stoves fixed in the underground part of the building, some, by means of hot water, heat the administrative department, the stage, and the rooms of the artistes; others, by hot air, the auditorium, the green rooms, and the staircases. The daily consumption of these fires has been estimated at 10,000 kilogrammes of coal—nearly ten tons.

The water and air heated by the stoves are distributed by brass pipes, the heating surface of which is about 2,250 square metres, their length nearly five kilometres. Those filled with hot water are contained in grooves in the masonry; the air coming from without circulates around their surface, is heated, and escapes by 650 orifices.

For the auditorium and its approaches recourse has been had to water-stoves, which give a very considerable renewal of air. "The apparatus to the number of ten," says M. Nuitter, "are supplied by twelve furnaces, whose power represents a steam-engine of 120-horse-power. It was necessary to employ apparatus of this power, for as they are only used in the days of performance, they are not kept constantly lighted, and they must rapidly raise the temperature of spaces whose capacity is not less than 90,000 metres. They must, moreover, provide in the auditorium for a renewal of air which may reach 80,000 cubic metres per hour; thus we must reckon

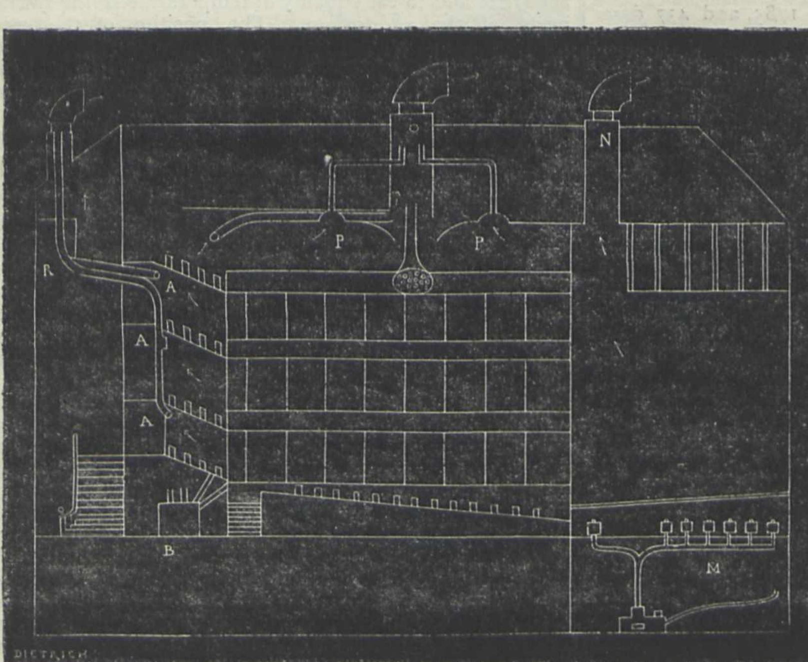


FIG. 1.—Ventilation of a Theatre (Chavannes' system).

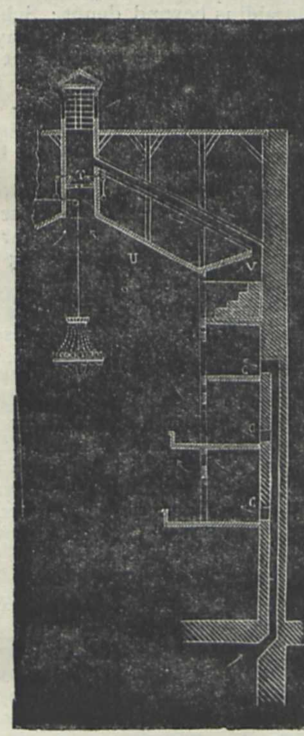


FIG. 2.—The System of d'Arcet.

the warm air heaters at from 600 to 700 square metres, and the hot water ones at from 1,200 to 1,300 square metres."

Ventilation is effected by means of supplies of air, the openings for which measure from twenty-four to thirty square metres. The cupola of the auditorium is pierced by bulls'-eyes, and is also supplied with openings arranged above the lateral galleries. Fig. 3 shows the cupola seen from above; it shows the vast conduits which carry off the internal air by means of the draught of the lustre. The supplies of air are regulated by thirty-four registers, large valves of $1\frac{2}{3}$ metres long and $\frac{2}{3}$ metre high, placed around the cupola. A large sheet-iron chimney, eight metres in diameter, surmounts the ventilating erection, and leads to the lantern which surmounts the cupola.

Thanks to these excellent arrangements, thanks also to the large proportions of the corridors, there is reason to hope that in the new Opera aëration will be accomplished under satisfactory conditions, and that in this new building the constructors will have approached as nearly as possible to that solution of a problem whose difficulties have been pointed out above.

The lighting of the New Opera has been accomplished with considerable ingenuity. The whole of the gas-pipes represent a length of twenty-five kilometres, on which are adjusted 714 cocks. The dangers attendant on the ordinary method of lighting a stage by naked footlights are well known. The footlights of the New Opera are formed of gas jets with reversed flames, each flame being completely enclosed, so that only the light escapes, the heat being conveyed outside. Each jet is so constructed that if the glass which encloses it is broken, the flame becomes extinguished by an automatic arrangement. In Fig. 4, E is the conducting tube of the gas. It is lighted by raising it at D, above its vertical glass. When it is placed upon

* "La Theatre et l'Architecte."

its glass the flame is drawn downwards by a powerful current of air which circulates in a lower pipe to which

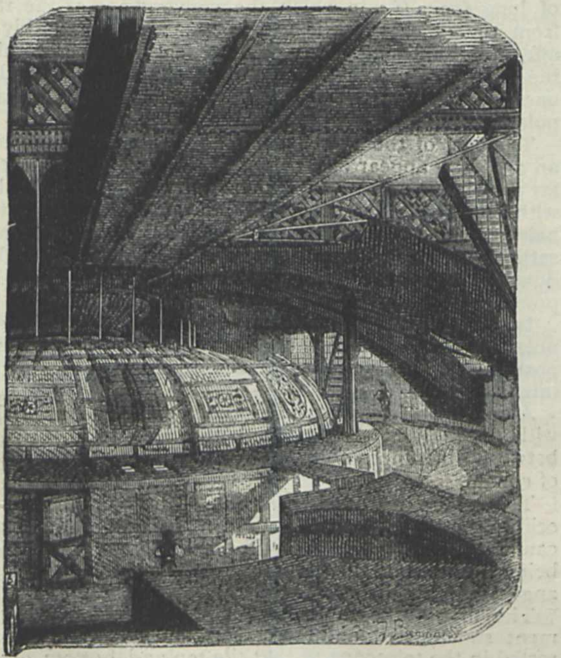


FIG. 3.—Ventilating Apparatus of the New Opera. (From M. Nuitter's work.)

the tube B is fitted. Owing to the draught the burner does not become heated, and the hand may be placed upon it without being burnt; the robe of a dancer may without danger brush it, since the flame is produced in an enclosed space. If the glass A is accidentally broken, the burner E, mounted on a pivot, is lowered at C, and by this movement sets in motion a small valve, which shuts off the gas, and the light is thus put out. The jets of the footlights are arranged in series of twelve, and number in all 120. These 120 lights may be raised to the height of the stage, or lowered underneath the prompter's hole, below the flooring of the front stage, by a mechanism which draws them all together, and which two men can easily move.

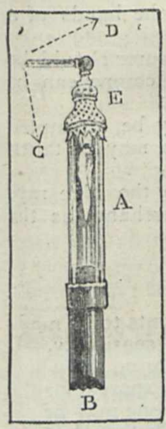


FIG. 4.—Gas-jet, with reversed flame, used in the footlights of the New Opera

By a very ingenious arrangement all the lights in the theatre can be lowered suddenly so as to produce a night-effect, without the least danger of any of them being extinguished.

One of the most important applications of science in the New Opera is the use made of electricity, which we shall describe in another article.

(*To be continued.*)

ENGLISH GOVERNMENT ECLIPSE EXPEDITION, 1875

INSTRUCTIONS TO OBSERVERS.*

1.—*Spectroscopic Observations—Objects to be attained.*

THE objects to be attained are mainly the determination, so far as may be possible, of the chemical constitution of the chromosphere and of the coronal atmosphere; of the height to which the various vapours extend from the photosphere, and of the order in which they thin out. It is anticipated that the chromosphere, at all events, may be very rich in ultra-violet rays. The solar spectrum has already been photographically compared with metallic vapours from G some distance outwards. The operations, therefore, will be mainly photographic, glass being employed as little as possible to produce the necessary dispersion, and replaced by quartz. The attack is twofold, spectroscopes being used in conjunction with telescopes for obtaining line spectra, and prismatic cameras being employed for the purpose of obtaining images of the chromosphere and coronal atmosphere built up by the rays emitted by its various constituents. The prismatic camera will probably give the best results with regard to the height and order of the various layers, while the general nature of the spectrum beyond H, *i.e.* whether it is continuous, channel-spaced, or lined, will be best determined by the ordinary spectroscopes.

Adjustment of Spectroscopes.

Take out camera, and determine focal point for blue rays by receiving image of sun on ground glass, and by using solution of sulphate of copper in ammonia in front of object-glass. (The strength of solution to be determined beforehand such that no light less refrangible than G should pass at all, and that the centre of gravity of spectrum is H, or outside it.)

To determine focus of collimator, reinsert camera and move sliding portion of collimator attached to slit-plate till the lines of the spectrum at or outside H are clearly defined.

All prisms to be set for minimum deviation of H.

To find proper distance of slit-plate from telescope, throw image of sun on, so as to cover half the slit, and adjust the spectroscope to such a distance that the boundary of the spectrum of the photosphere at H is perfectly hard.

Photographs should be employed for ascertaining the focus; the slits to be clean, and adjusted so that at least three lines be seen between the two H's. No photograph need be examined which will not bear a magnifying power of ten times. It must be remembered that a difference of 1-1000th of an inch is of importance in such adjustments. The best definition with the dispersion employed will be attained when the line in the middle between the H lines is seen double.

The hardness of the sun's limb to be determined photographically in the same manner.

If power to incline the plate is obtained, the part of the plate to receive the more refrangible rays will, of course, be nearer to objective of camera, as in the case of all non-achromatic lenses. The angle to be determined by experiment. The spectrum should fall on the plate so that G falls close to one edge, the central and other portions of the plate being reserved for the more refrangible end of the spectrum.

Care must be taken that the axes of the collimator and of the telescope be coincident.

Adjustment of Prismatic Camera.

This instrument is to be adjusted like an ordinary spectroscope by means of collimator placed in front of its prism. By application of external collimator, the prism is to be set to minimum deviation of H, the hydrogen line near G falling near one edge of the plate.

Before this instrument is put on the telescope, the prism thus adjusted should be taken off and perfect parallelism of the tubes obtained by observing the images of the sun or star.

The subsequent inclination of the two axes will be determined by taking photographs of spectrum with or without a collimator, so that ring corona near G will be the least refrangible portion of spectrum on plate, while the sun falls on the steel plate of the telescope to which

* Drawn up by the Eclipse Committee of the Royal Society.

the prismatic camera is attached. Care should be taken that the least refrangible part of the ring corona should be recorded. The axis of the camera should *cut* the axis of the declination axis.

Observations to be made with Telespectroscopes.

Before and after totality the *cusps* should be continually thrown on the slit and the spectrum photographed; long exposures should be at first employed. At least one spectrum of the sun should be obtained before totality, with the ordinary position of the plate, in order to indicate the parts of the plate on which the various parts of the spectrum falls with the angle of deviation and the orientation adopted.

In all instruments just previous to totality, the vanishing portion of sun is to be used to obtain a scale on the plate on which the attempt will be made to obtain the spectrum of Young's stratum, and the other phenomena at the beginning of totality.

For this purpose one of the end windows will be opened, and all the others closed in the first instance, the open part of the slit being arranged radially over that portion of the sun's light which will be the last to disappear. Immediately before totality all the windows are to be opened without deranging the instrument.

The time for which the plates are to be exposed after the commencement of totality will be subsequently referred to.

For observation at end of totality all windows except one at the end of slit to be opened. The part of the sun which will first reappear should lie on the slit just outside the closed shutter (the motion of the moon being taken into account), so that the phenomena at moment of reappearance may be photographed. Immediately after reappearance the previously opened shutters should be closed, and the previously closed shutter should be opened to obtain the solar spectrum as a scale. Care should be taken not to confound the brighter parts of the chromosphere, at reappearance, with the sun itself.

Observations with the Prismatic Camera.

A trial photograph can be made when 1-100th part of sun's diameter is still visible. The results of development of the spectrum of the two cusps should determine the time of exposure before totality; as many photographs should be obtained as possible before totality, being rapidly multiplied just before disappearance. The number of plates to be taken during totality to be subsequently referred to. The number of plates to be obtained after totality will depend on results of development before totality.

2. *Observations on the Polarisation of the Corona.*

The primary object of these observations was to furnish evidence on the question whether the corona was a true solar phenomenon, or in some way due to a glare in the terrestrial atmosphere. In the former case the position of the plane of polarisation (if the light were polarised at all) would have reference to the sun's centre, and would be parallel or perpendicular to a line joining the centre to the point observed. In other words, the polarisation would be radial. In the latter case it would have reference to the general direction of the observers' view; *i.e.* it would be uniform over the whole area of the corona.

Former observations appear to show that the total light from the corona is partly polarised; and that the polarisation is in part radial, and in part unidirectional. In addition to this, spectroscopic observations have connected the corona with the sun. But, although the main question may consequently be considered as already settled, the polariscopic observations have been found so delicate as to justify their repetition. The details of polarisation, if sufficiently well defined, may tell us something of the condition of the matter emitting coronal light; and if to former eye observations photographic pictures be added, our information may be extended to regions further from the sun's surface than any of which we have at present cognisance.

If a Nicol's prism be placed in the tube of a telescope of long focus (*i.e.* in which the convergence of the rays from the object-glass is not so great as perceptibly to affect the analysing power of the Nicol), then, on turning the Nicol so as to cut off the part of the light polarised in one plane, we shall see only that which is radially polarised together with the unpolarised light.

The part of the light polarised radially would, without an analyser, appear as a complete ring of light, except so far as it is interrupted by rifts or other irregularities; but with the Nicol the ring will appear divided into two halves, brightest at the points where the radial polarisation coincides with that due to the Nicol, and shading down to the intensity of the unpolarised light alone at points situated 90° from the former.

In other positions of the Nicol the atmospheric polarisation will be less and less suppressed; and at a position 90° from its first, it will retain its full relative intensity.

A quartz or a biquartz might, of course, be used, but with feeble light the eye is better able to distinguish between differences of intensity than between differences of colour.

To use the instrument sent out. On the day before the eclipse, take out the eye end containing the Nicol and camera and turn the Nicol, till the bottom of the camera being horizontal, the light reflected at the polarising angle, from a polished mahogany surface is cut off.

The first photograph should be taken with the instrument so adjusted, and the camera and Nicol must be inserted in the telescope so that the top and bottom of the plate are horizontal when the telescope is directed to the sun.

The first photograph to be exposed for 25 seconds.

Between each photograph the camera and Nicol to be rotated through 30° in the direction of the hands of a watch.

It is desirable that some of the exposures should be long, as by this means the extent of the corona can be best determined.

If the development shows that it may be attempted with advantage, one or two photographs may be taken with very short exposures.

The adjustment of this instrument to the blue rays must be most carefully determined beforehand, as the object glass is not corrected for them.

General Remarks.

Plates during Totality.

The number will depend upon experiments to be made on the rapidity of drying and decrease of sensibility. If it is found that plates may be exposed during the whole of totality, some plates at least should be exposed for the whole of that time. In prismatic camera, one may be exposed for one minute to begin with. Whether the next plate should be exposed during two or three minutes to depend on results of development.

Width of Slit.

Arrangements should be made for readily securing the opening of slit which gives the best testing effect referred to before, and a wide opening which allows at least one line being seen between the H's, can be readily distinguished. This latter opening should be used in all observations during totality. For scale determinations the first position of slit should be employed. In some instruments a much wider slit may be used than in others. Experiments should be made on this point.

Precautions to be attended to in preliminary experiments.

1. All apertures to be reduced. The slit should not be exposed longer than necessary to the heating power of the sun.

2. Object-glasses and mirrors not to be unscrewed from their cases till telescopes are perfectly mounted.

Precautions to be attended to half an hour before Totality.

1. If an aperture has been reduced for preliminary experiments, take care that full apertures are restored.
2. In case any telescopes are used for eye observations, reminder should be given to take off dark glasses before totality.
3. Wind up all clocks.
4. Let all strangers withdraw.
5. Light lamps.

Arrangement of Photographic Plates.

As the plates are smaller than was intended, the spectrum must be thrown along the length of the plate, and if possible, in the prismatic cameras, from corner to corner.

A shelf should be prepared over the developing table with places marked 1, 2, 3, &c. The backs used in any one instrument should be labelled in large letters on both sides, and a similar label should distinguish each shelf. The plates will then arrange themselves into series, and can be numbered afterwards. Care must be taken to have lamps in the dark room.

The Time Teller.

One person should be detailed at each station to tell the time.

The chief observer at each station will give the signal for commencement for totality, which being done, the time assistant will call out the number of seconds of calculated duration at the locality. If, for instance, the totality is four minutes, he will say "You have 240 seconds," and go on calling out every ten seconds the number of seconds still left for work. A clever man can do this in a very encouraging way. The time counter should take care not to distract himself by losing sight of the face of the watch or chronometer, and it is to be impressed upon him that much of the success of the observations will depend on his undivided attention, as his statement of time will be an order to the observers to do certain work.

Rehearsals.

There must be at least two complete rehearsals of the whole attack on two previous days at the time of the eclipse, and the final written instructions to each observer given by the chief of the party will mainly depend on the experience of these rehearsals, which must be of a very serious character. It must be recollected that the speed and skill in collodionising and developing can only be thus determined.

The going of the clocks and counterpoising of telescopes in the particular position in which they will be employed near the time of totality must be examined with the greatest care, and the best regulation of the clock for this position should be adhered to. In these rehearsals all apertures must be reduced.

The clock weights must also be examined, and increased if necessary to produce an uniform motion of the telescope.

Silence.

Silence must only be broken by the timekeeper. The rehearsals should be utilised for asking any questions touching any part of the duties of each observer during the observations, and each observer should have his programme of work nailed up where it can be easily seen.

In order to prevent noise and interruptions, none but the observers and trained assistants should be allowed to be within fifty yards of the observatories, for an hour before and an hour after totality.

Programme of Work.

The Programme of Work may conveniently be stated in the time called out by the time observers. In which case "200 seconds more," and so on, will become an instruction to one of the observers to do a particular piece of work.

Notes on the Phenomena Observed.

Anything an observer has to record should be done immediately after totality, or the last observation after totality.

Trust nothing to memory; a note made the next day will be comparatively valueless.

Multiplication of Results.

As soon as convenient after the eclipse, before leaving the station, at least four copies of every photograph must be made, and enlargements, if possible, in duplicate on glass. Paper copies of these duplicates should be transmitted by two different mails to the Royal Society. The various copies to be sent home if possible by different mails and different routes. One copy to be left in India and given in charge of the chief of the Indian expedition.

Photographs of the Corona.

It will be very desirable for the observers appointed by the Indian Government to depict photographically the corona as a whole, to take some photographs on plates so placed in the long focus camera (rectilinear lens) that the back of the plate is towards the object-glass and the collodion towards the observer, in order to avoid reflection from the second surface of the glass. Special plate holders will have to be made, and the glass selected as perfect as possible and of nearly the same thickness. Of course the back must be carefully cleaned before the plate is exposed.

Observations to be reduced by the Royal Society.

It is understood that the observations made by the members of the English Expedition are the property of the Royal Society, by which body they will be reduced. It is hoped that the Indian Government will allow duplicates of the observations taken by the Indian parties to be forwarded to the Royal Society to aid in these reductions, and to enable a general account of the whole attempt to be prepared. The English observers detailed to India will co-operate with the Chief of the Indian station to which they may go, and will assist in carrying out the arrangements in accordance with the foregoing instructions.

All experiments made for the furtherance of the objects of the expedition will be carefully recorded and will be considered the property of the Royal Society.

SCHOLARSHIPS AND EXAMINATIONS FOR NATURAL SCIENCE AT CAMBRIDGE, 1875

THE following is a list of the scholarships and exhibitions for proficiency in Natural Science to be offered at the several Colleges and for non-collegiate students in Cambridge during the present year:—

Trinity College.—One or more scholarships of 100*l.*, and one exhibition of 50*l.* The examination for these will commence on March 30. Further information may be obtained from the Rev. E. Blore, Tutor of Trinity College.

St. John's College.—One of the value of 50*l.* per annum. The examination (in Chemistry, Physics and Physiology, with Geology, Comparative Anatomy, and Botany) will commence on April 3, and will be open to all persons who have not completed a term of residence at the University, as well as to all who have entered and have not completed one term of residence. There is a separate examination in Natural Science at the time of the annual College examination at the end of the academical year, in

May; and exhibitions and foundation scholarships will be awarded to students who show an amount of knowledge equivalent to that which in Classics or Mathematics usually gains an exhibition or scholarship in the College. In short, Natural Science is on the same footing with Classics and Mathematics, both as regards teaching and rewards.

Christ's College.—One or more in value from 30*l.* to 70*l.*, according to the number and merits of the candidates, tenable for three-and-a-half years, and for three years longer by those who reside during that period at the College. The examination will be on April 6. There are other exhibitions which are distributed annually among the most deserving students of the College. Further information may be obtained of John Peile, Esq., Tutor of the College.

Gonville and Caius College.—One of the value of 60*l.* per annum. The examination will be on March 18, in Chemistry and Physics, Zoology with Comparative Anatomy and Physiology, and Botany with Vegetable Anatomy and Physiology. Further information may be obtained from the Tutors. Scholarships of the value of 20*l.* each or more are offered annually for Anatomy and Physiology to members of the College. Gentlemen elected to the Tancred Medical Studentships are required to enter at this College; these studentships are five in number, and the annual value of each is 100*l.* Information respecting these may be obtained from B. J. L. Frere, Esq., 28, Lincoln's Inn Fields, London.

Clare College.—One of the value of 60*l.* per annum, tenable for two years at least. The examination (in Chemistry, Chemical Physics, Zoology with Comparative Anatomy and Physiology, Botany with Vegetable Anatomy and Physiology, and Geology) will be on March 16, and will be open to students intending to begin residence in October.

Downing College.—One or more of the value of 60*l.* per annum. The examination (in Chemistry, Comparative Anatomy, and Physiology) will be on April 6, and will be open to all students not members of the University, as well as to all undergraduates in their first term.

Sidney College.—One of the value of 60*l.* and one of the value of 40*l.* per annum. The examination (in Heat, Electricity, Chemistry, Geology, Zoology and Physiology, and Botany) will be on April 6, and will be open to all students who intend to commence residence in October.

Emmanuel College.—One of the value of 70*l.* The examination, on March 24, will be open to students who have not commenced residence.

St. Peter's College.—One scholarship of the value of from 40*l.* to 80*l.* according to the attainments of the candidate. The examination on April 6 will be in Botany, Chemistry and Chemical Physics, Geology, and Comparative Anatomy and Physiology, but no candidate will be allowed to be examined in more than two of these subjects. Application must be made before March 20 to the Tutor.

Non-Collegiate Students.—An exhibition each year is given by the Clothworkers' Company, value 50*l.* per annum, tenable for three years. Examination about Christmas. Information to be obtained from the Rev. R. B. Somerset, Cambridge.

Although several subjects for examination are in each instance given, this is rather to afford the option of one or more to the candidates than to induce them to present a superficial knowledge of several.

Candidates, especially those who are not members of the University, will, in most instances, be required to show a fair knowledge of Classics and Mathematics, such, for example, as would enable them to pass the Previous Examination.

There is no restriction on the ground of religious denominations in the case of these or any of the scholarships or exhibitions in the Colleges or in the University.

Further information may be obtained from the Tutors of the respective Colleges.

Some of the Colleges do not restrict themselves to the number of scholarships here mentioned, but will give additional scholarships if candidates of superior merit present themselves; and other Colleges than those here mentioned, though they do not offer scholarships, are in the habit of rewarding deserving students of Natural Science.

It may be added that Trinity College will give a fellowship for Natural Science, once at least in three years; and that most of the Colleges are understood to be willing to award fellowships for merit in Natural Science equivalent to that for which they are in the habit of giving them for Classics and Mathematics.

The above list shows that Colleges at Cambridge, like those at Oxford, are by no means backward in offering inducements to the study of Natural Science. The scholarships and exhibitions are open to all persons, whether members of the University or not, provided they are willing to enter and become members of the respective Colleges, with the exception of the 100*l.* scholarships at Trinity College, the candidates for which must have passed the Previous Examination at the University.

NOTES

NEWS has been received from the English Eclipse Expedition dated from Suez: all were well. The *Surat* had been delayed a day by the loss of her screw in the canal, doubtless in that narrow rocky part of the canal some miles above Suez, where so many ships have lost their screws, and the Expedition has proceeded to Galle in the *Baroda*. Arrangements have been made with the Indian Government to have a ship waiting at Galle on the 16th inst. to convey the Camorta party from that place. We publish this week the Instructions to the observers, issued by the Royal Society Committee.

THE Astronomer Royal has communicated the following telegram to the press relating to the Transit of Venus observations at Kerguelen's Land:—"Corbet, Coke, Goodridge observed ingress. Perry good egress. All something. Cloudy. Generally, English photography poor. Americans, Germans lost interior contact. Americans have some photographs."

WE have received a letter, dated Jan. 8, from Mr. C. Meldrum, Mauritius, containing the following additional information regarding the transit observations at the Mauritius:—"The new Observatory is seven miles from Port Louis, and by the time the instrument was received and put in place, we were within a few days of the Transit of Venus. You will have heard (I sent you some newspapers by last mail) that owing to the weather, Lord Lindsay and his party, as well as the German Expedition, could only observe the latter half of the Transit, and that they lost the first external and internal contact. Here at this Observatory I had worse weather, the sky being entirely overcast during the greater part of the time. But it so chanced that the weather clearing up for a short time, and the sun appearing, I got the first internal contact just as the sun was emerging from behind a bank of clouds. We had then a long spell of cloudy rainy weather, with occasional glimpses of the sun. Towards the time of second internal contact the weather again cleared up, and I observed that contact under more favourable circumstances than the first internal. On both occasions I saw a dark band or ligament connecting the limbs of the sun and planet, and noted the times of appearance and disappearance. The first internal contact took place some minutes after the computed time, and the second internal contact a little earlier. Our photo-heliograph arrived after the transit. Both Lord

Lindsay and the Germans are satisfied with what they have got. The morning *before* the transit was beautifully clear and in every respect favourable, but the morning *after* was just the reverse, the sky being entirely overcast. Both expeditions should have been at their post earlier. The English expedition to Rodriguez was successful in regard to weather, which is a lucky incident, for the chances in favour of Mauritius were greater. The fact is that there was an atmospheric disturbance, probably a gale, passing to the N. and N.W. of Mauritius and Bourbon on the 9th, which had passed Rodriguez some days sooner. Lord Lindsay has a slight attack of fever. He leaves soon for India *en route* to England. Davies is going to observe the solar eclipse of the 6th April in Burmah. Dr. Copeland will probably go round the Cape in the *Venus*. Mr. Gill left for Aden to-day with his fifty-two chronometers."

THE fitting of the Arctic ships *Alert* and *Discovery* is making rapid progress at Portsmouth, in the hands of the dock-yard shipwrights, who are working extra hours, in order that they may be rigged and out of their hands by the 12th of April. The sledges have all been made, and the tents are in progress. Meanwhile the officers are pursuing their special studies. We understand that Commander Markham, and Lieutenants Archer, Giffard, and Fulford are going through a course of instruction in magnetism. Lieutenants Parr and May are to be initiated into some special astronomical work, and two other lieutenants will receive charge of the pendulum observations. The work connected with spectrum analysis will also be provided for, and one or more of the officers will take up photography. The ships will be commissioned in the middle of April, and will sail early in June.

PROF. ROBERT WILLIS, M.A., F.R.S., Jacksonian Professor of Natural and Experimental Philosophy in the University of Cambridge, died on Sunday night. The late professor graduated at Gonville and Caius College in 1826, coming out ninth wrangler, and was elected a fellow of his College. He was appointed to the above professorship in 1837. He had been President of the British Association, and was member of the Board of Visitors of the Royal Observatory, Greenwich. The professorship vacant by the death of Mr. Willis is worth 300*l*. per annum. The professor is elected by the persons whose names are on the electoral roll of the University.

MR. E. RAY LANKESTER, M.A., Fellow of Exeter College, Oxford, has been elected to the Professorship of Zoology and Comparative Anatomy in University College, London, rendered vacant by the death of Dr. Grant.

MR. J. R. BLAKE, M.A., F.G.S., has been elected to the lectureship on Zoology and Comparative Anatomy at Charing Cross Hospital Medical School.

IN connection with the Loan Exhibition of Scientific Apparatus, meetings have been recently held at the South Kensington Museum, of the sub-committees for the sections of Mechanics, Physics, Chemistry, Geology, and Biology. The limits of the exhibition and various details connected with it were discussed, and recommendations prepared for submission to the General Committee at its next meeting.

IT is announced that the Queen has, on the recommendation of the Prime Minister, granted a pension of 200*l*. a year to Mr. Wood, in recognition of his labours at Ephesus.

THE Queen has been pleased to approve of the following appointments to Companionships of the Order of St. Michael and St. George:—Mr. Augustus Charles Gregory, Surveyor-General of Queensland, who formerly rendered important and valuable services in connection with the exploration at Northern Australia; Mr. Walter Lowry Buller, the well-known ornithologist, author of "The Birds of New Zealand;" and Major Peter Egerton Warburton, of South Australia, who lately conducted important explorations in that colony and Western Australia.

IN his last report of the progress and prospects of the cultivation of various useful trees in India, Dr. King speaks of the caoutchouc-yielding trees and the difficulties attending their cultivation. But his account of the Assam indiarubber tree, *Ficus elastica*, whose large glossy foliage is familiar to almost everybody in this country, excites some surprise. He writes: "The rubber of this country (India) is obtained from fig-trees, most of which (at least in early life) are parasitical [by which he means, of course, *epiphytical*]. These figs begin life by establishing themselves on the tops of other trees, along the trunks of which they send their twining aërial roots, which ultimately reach the ground. In course of time the supporting trees are killed, but the figs remain and grow, often entirely obliterating their predecessors. It is from the long aërial roots that the rubber is mostly got, and not from the branches. After a few severe tappings a fig ceases to yield rubber from its roots. The number of rubber trees, even in a country like Assam, is limited, and it is easy to foresee their early exhaustion. It is true it is also easy to propagate these figs by cuttings, but plants produced from cuttings put into the soil cannot very well have aërial roots, and may consequently be expected to yield little, if any, rubber. The artificial formation of indiarubber plantations on the summits of tall forest trees is obviously impracticable." Now, it has long been known that these indiarubber trees are epiphytical, but it seems far more probable that the mode of growth referred to simply renders it difficult to extract the caoutchouc until the roots come down within reach, not that they represent the principal seat of its secretion. Indeed, if this really be the case, it seems quite inexplicable, for this secretion pervades the whole system. However, it can be only partially true. The aërial roots of *Ficus elastica* are not only produced from the epiphytical examples, but also from those growing in the ground. Mr. Mann and other writers describe them as running along for a distance of thirty or forty feet on the surface of the soil, and mention the fact that the collectors tap the lower parts of the stem and these trailing roots. Looking into Mr. Mann's report on the same subject, he specially mentions the reckless felling of large trees to obtain the caoutchouc more readily; and in reference to the cultivation of the tree in question, he says that planted trees would yield at half the age a naturally grown tree would, as in the latter case several years elapse before an aërial root can reach the ground and establish itself. Dr. King's argument in favour of growing the Parà caoutchouc, *Hevea brasiliensis*, on this ground must fall through; but as the latter is reported to furnish the best quality of caoutchouc, there is a good reason for attempting its cultivation.

DR. KALENDER, of Linderhöhe, near Cologne, gives an elaborate account, in the *Kölnische Zeitung*, of the new enemy to the potato which has caused such ravages in the potato plantations of the United States, namely, the Colorado Beetle (*Doryphora decemlineata*). The general opinion on this beetle is rather uncertain at present, some considering it almost harmless, while others attach great importance to its being prevented from visiting Europe. Dr. Kalender applied to the Prussian Minister for Agriculture, and obtained the most reliable information, which is based upon a report of Mr. C. Riley, in the "Annual Report on the Noxious, Beneficial, and other Insects in the State of Missouri." It appears that the insect passes the winter in the ground, but as soon as the potato plants have developed their first shoots the beetle shows itself. The females then deposit their orange-coloured ova, in lumps of ten to twelve, upon the under surfaces of the leaves; the larvæ appear after five to eight days, and begin their destructive work, which lasts two or three weeks, after which period they transform into nymphæ; ten to fourteen days later the young beetles appear; thus one summer can see three or four generations, of which the last one passes the winter in the ground. The insect does not confine its devastations to the potato only, but has also been found to attack the young shoots and leaves of *Cirsium lanceolatum*, *Amaranthus retroflexus*, *Lisymbrium officinale*, *Polygonum hydropiper*, *Solanum nigrum*, *Chenopodium hybridum* and *album*, and even of *Hyoscyamus niger*. This variety of plants shows that the insect has great powers of adapting itself to its food, and to this it must be ascribed that it can only with the greatest difficulty be got rid of. The home of the insect was in the Rocky Mountains; with the westward progress of agriculture the cultivation of the potato approached the birthplace of the insect, and it transferred its dwelling to the potato fields, which of course were welcome food; thus in a short time it became a general plague. In 1859 it began its eastward progress, and has now reached the coast of the Atlantic; whether it will cross this ocean and begin its devastations in Ireland remains to be seen; much may, however, be done to prevent its appearance in Europe. The means used for its destruction are various; the most successful one has been the so-called Schweinfurt green (arseno-acetate of copper). This is mixed with flour and water, and the plants are sprinkled with the mixture. Although highly poisonous to animal life, the Schweinfurt green does not poison the soil, as it is perfectly insoluble in water, and the destruction of the noxious insect is almost complete. Dr. Kalender finally draws the attention of agriculturists to another potato enemy, the *Brystopha solanella*, a minute moth which has made its appearance in Algeria; its larvæ completely destroy the potatoes themselves, so that they become unfit even for pigs' food. The *Journal de la Société Centrale d'Horticulture en France* warns seriously against the importation of Algerian potatoes.

DON PEDRO, Emperor of Brazil, has been elected a corresponding member of the French Academy of Sciences for the section of Geography and Navigation. Don Pedro is the third emperor who has been a member of the Academy. The first was Peter the Great, elected a geographical correspondent. In that capacity he sent a map of the Caspian Sea, which is still kept in the records of the Academy. The second imperial Academician was Napoleon I., who was a member of the section of Mechanics, but resigned after his abdication at Fontainebleau. Napoleon III. tried to get appointed a member, but was not successful.

THE Academy of Sciences lost one of its most celebrated home correspondents in the same week as it did Lyell—a foreign correspondent. On the 1st inst., M. Frémy, the President, announced the demise of M. Seguin the elder, at the age of eighty-nine. M. Seguin was educated by his elder brother, and was himself a most daring engineer. He was the contractor of the Lyons and Saint Etienne Railway in 1825, a railway which was worked by horses and ropes for years. He is believed in France to have invented suspension bridges. He maintained at his own expense, during twenty years, the publication of *Cosmos*, a scientific periodical in which he expounded his own ideas on the doctrine of the conservation of force, of which he was a keen and active supporter.

AN exploring expedition will shortly leave Marseilles to make researches into the depths and animal organisations of the Mediterranean. Soundings and dredgings similar to those made by the *Challenger* will be made by a steamer specially provided with microscopes, photographic apparatus, and means for preserving new or rare specimens of marine zoology. The expedition is entirely due to private enterprise.

THE International Conference on the Metrical System met at Paris on Monday under the presidency of the Duc Decazes, who explained that the object of the Conference was the conclusion of a Convention between States adopting or permitting the use of the metre as the basis of measurement. The Conference has transferred the solution of the questions to be decided to a Commission composed of delegates of the various Governments. M. Dumas, the Permanent Secretary to the Academy of Sciences, has been appointed President of this Commission, Mr. Chisholm being the English delegate.

M. LEVERRIER has established in the Paris Observatory a registry, where all the scientific facts collected from the several political papers may be cut and labelled. Such a register was kept during the last year of Arago's superintendence, but has been discontinued for years.

ON the 23rd of February the Italian Geographical Society discussed the advisability of sending an Italian expedition *viâ* the Red Sea to the sources of the Nile. The members were unanimous in favour of the scheme, and a programme will be issued shortly.

THE picturesque city of Caub, in Nassau, near Barharach, will very shortly, it is said, be crushed and destroyed by the disintegration of the mountain on which Guterfeld Castle was built in mediæval times. The rocks which threaten Caub are not less than 600 feet in height. Two rows of houses have been deserted, as no human power can prevent the catastrophe.

SEVERAL continental papers note the fall of ponderous rocks caused by the recent frosty weather. Such occurrences as that referred to in our last number as having occurred at Moen are very frequent on the banks of the Seine. *La Nature* publishes a sketch taken at Sainte Adresse, near Havre, illustrating the progressive levelling of these lofty cliffs partly by the action of the waves, and partly by weathering.

ON Feb. 18 Dr. Gerhard Rohlfs delivered a lecture at Cologne on the last part of his journey from Tripoli to the coast of Guinea, which is of particular scientific interest. He treated in detail the state of civilisation of the Empire of Bornu (situated near Lake Tsad) and its capital, Kuka, and it appears that the negro tribes that inhabit those parts are highly civilised, in fact much more so than most other tribes in Northern Africa. From Kuka Dr. Rohlfs went to Mandara, which is situated south of Bornu, and then entered the districts of the Pullo (or Fullo) tribes; he found the inhabitants to be of light yellow, almost white complexion, and surpassing even Europeans with regard to beauty of form and growth. Dr. Rohlfs then descended the Tshadda River, down to where this joins the Niger, and was hospitably received by the English colonists at Lokoja; from here he visited a negro country in a western direction, then passed the Kong Mountains, and successfully traced his way through the thick tropical forests to the coast, which he reached near Lagos.

THE first annual meeting of the Scientific Club was held on Thursday, the 18th inst., Capt. Marshall Hall, F.G.S., in the chair, when a report was presented showing the great progress which has been made since the foundation of the club on the 19th of March last.

THE additions to the Zoological Society's Gardens during the past week include two Wild Boars (*Sus scrofa*), European, presented by Mr. Sebastian Anderson; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Miss R. Barter; a Common Raccoon (*Procyon lotor*) from North America, presented by Miss Julia Jackson; a Herring Gull (*Larus argentatus*), European, presented by Miss Jessie Bovill; two Petz's Conures (*Conurus petzii*) from Peru, presented by Miss Hornby; two Sarus Cranes (*Grus antigone*) from North India; a Mandarin Duck (*Aix galericulata*) from China, received in exchange; three Common Peafowl (*Pavo cristata*) from India, deposited.

ON THE DYNAMICAL EVIDENCE OF THE MOLECULAR CONSTITUTION OF BODIES *

WHEN any phenomenon can be described as an example of some general principle which is applicable to other phenomena, that phenomenon is said to be explained. Explanations, however, are of very various orders, according to the degree of generality of the principle which is made use of. Thus the person who first observed the effect of throwing water into a fire would feel a certain amount of mental satisfaction when he found that the results were always similar, and that they did not depend on any temporary and capricious antipathy between the water and the fire. This is an explanation of the lowest order, in which the class to which the phenomenon is referred consists of other phenomena which can only be distinguished from it by the place and time of their occurrence, and the principle involved is the very general one that place and time are not among the conditions which determine natural processes. On the other hand, when a physical phenomenon can be completely described as a change in the configuration and motion of a material system, the dynamical explanation of that phenomenon is said to be complete. We cannot conceive any further explanation to be either necessary, desirable, or possible, for as soon as we know what is meant by the words configuration, motion, mass, and force, we see that the ideas which they represent are so elementary that they cannot be explained by means of anything else.

The phenomena studied by chemists are, for the most part, such as have not received a complete dynamical explanation.

Many diagrams and models of compound molecules have been constructed. These are the records of the efforts of chemists to imagine configurations of material systems by the geometrical relations of which chemical phenomena may be illustrated or explained. No chemist, however, professes to see in these diagrams anything more than symbolic representations of the various degrees of closeness with which the different components of the molecule are bound together.

In astronomy, on the other hand, the configurations and motions of the heavenly bodies are on such a scale that we can ascertain them by direct observation. Newton proved that the observed motions indicate a continual tendency of all bodies to approach each other, and the doctrine of universal gravitation which he established not only explains the observed motions of our system, but enables us to calculate the motions of a system in which the astronomical elements may have any values whatever.

When we pass from astronomical to electrical science, we can still observe the configuration and motion of electrified bodies, and thence, following the strict Newtonian path, deduce the forces with which they act on each other; but these forces are found to depend on the distribution of what we call electricity. To form what Gauss called a "construirbar Vorstellung" of the invisible process of electric action is the great desideratum in this part of science.

In attempting the extension of dynamical methods to the explanation of chemical phenomena, we have to form an idea of the configuration and motion of a number of material systems, each of which is so small that it cannot be directly observed. We have, in fact, to determine, from the observed external actions of an unseen piece of machinery, its internal construction.

The method which has been for the most part employed in conducting such inquiries is that of forming an hypothesis, and calculating what would happen if the hypothesis were true. If these results agree with the actual phenomena, the hypothesis is said to be verified, so long, at least, as some one else does not invent another hypothesis which agrees still better with the phenomena.

The reason why so many of our physical theories have been built up by the method of hypothesis is that the speculators have not been provided with methods and terms sufficiently general to express the results of their induction in its early stages. They were thus compelled either to leave their ideas vague and therefore useless, or to present them in a form the details of which could be supplied only by the illegitimate use of the imagination.

In the meantime the mathematicians, guided by that instinct which teaches them to store up for others the irrepressible secretions of their own minds, had developed with the utmost generality the dynamical theory of a material system.

* A lecture delivered at the Chemical Society, Feb. 18, by Prof. Clerk-Maxwell, F.R.S.

Of all hypotheses as to the constitution of bodies, that is surely the most warrantable which assumes no more than that they are material systems, and proposes to deduce from the observed phenomena just as much information about the conditions and connections of the material system as these phenomena can legitimately furnish.

When examples of this method of physical speculation have been properly set forth and explained, we shall hear fewer complaints of the looseness of the reasoning of men of science, and the method of inductive philosophy will no longer be derided as mere guess-work.

It is only a small part of the theory of the constitution of bodies which has as yet been reduced to the form of accurate deductions from known facts. To conduct the operations of science in a perfectly legitimate manner, by means of methodised experiment and strict demonstration, requires a strategic skill which we must not look for, even among those to whom science is most indebted for original observations and fertile suggestions. It does not detract from the merit of the pioneers of science that their advances, being made on unknown ground, are often cut off, for a time, from that system of communications with an established base of operations, which is the only security for any permanent extension of science.

In studying the constitution of bodies we are forced from the very beginning to deal with particles which we cannot observe. For whatever may be our ultimate conclusions as to molecules and atoms, we have experimental proof that bodies may be divided into parts so small that we cannot perceive them.

Hence, if we are careful to remember that the word particle means a small part of a body, and that it does not involve any hypothesis as to the ultimate divisibility of matter, we may consider a body as made up of particles, and we may also assert that in bodies or parts of bodies of measurable dimensions, the number of particles is very great indeed.

The next thing required is a dynamical method of studying a material system consisting of an immense number of particles, by forming an idea of their configuration and motion, and of the forces acting on the particles, and deducing from the dynamical theory those phenomena which, though depending on the configuration and motion of the invisible particles, are capable of being observed in visible portions of the system.

The dynamical principles necessary for this study were developed by the fathers of dynamics, from Galileo and Newton to Lagrange and Laplace; but the special adaptation of these principles to molecular studies has been to a great extent the work of Prof. Clausius of Bonn, who has recently laid us under still deeper obligations by giving us, in addition to the results of his elaborate calculations, a new dynamical idea, by the aid of which I hope we shall be able to establish several important conclusions without much symbolical calculation.

The equation of Clausius, to which I must now call your attention, is of the following form :—

$$p\,V = \tfrac{2}{3}\,T - \tfrac{2}{3}\Sigma\Sigma\,(\tfrac{1}{2}\,R\,r).$$

Here p denotes the pressure of a fluid, and V the volume of the vessel which contains it. The product $p\,V$, in the case of gases at constant temperature, remains, as Boyle's Law tells us, nearly constant for different volumes and pressures. This member of the equation, therefore, is the product of two quantities, each of which can be directly measured.

The other member of the equation consists of two terms, the first depending on the motion of the particles, and the second on the forces with which they act on each other.

The quantity T is the kinetic energy of the system, or, in other words, that part of the energy which is due to the motion of the parts of the system.

The kinetic energy of a particle is half the product of its mass into the square of its velocity, and the kinetic energy of the system is the sum of the kinetic energy of its parts.

In the second term, r is the distance between any two particles, and R is the attraction between them. (If the force is a repulsion or a pressure, R is to be reckoned negative.)

The quantity $\frac{1}{2}\,R\,r$, or half the product of the attraction into the distance across which the attraction is exerted, is defined by Clausius as the virial of the attraction. (In the case of pressure or repulsion, the virial is negative.)

The importance of this quantity was first pointed out by Clausius, who, by giving it a name, has greatly facilitated the application of his method to physical exposition.

The virial of the system is the sum of the virials belonging to every pair of particles which exist in the system. This is expressed by the double sum $\Sigma\Sigma(\frac{1}{2}Rr)$, which indicates that the value of $\frac{1}{2}Rr$ is to be found for every pair of particles, and the results added together.

Clausius has established this equation by a very simple mathematical process, with which I need not trouble you, as we are not studying mathematics to-night. We may see, however, that it indicates two causes which may affect the pressure of the fluid on the vessel which contains it: the motion of its particles, which tends to increase the pressure, and the attraction of its particles, which tends to diminish the pressure.

We may therefore attribute the pressure of a fluid either to the motion of its particles or to a repulsion between them.

Let us test by means of this result of Clausius the theory that the pressure of a gas arises entirely from the repulsion which one particle exerts on another, these particles, in the case of gas in a fixed vessel, being really at rest.

In this case the virial must be negative, and since by Boyle's Law the product of pressure and volume is constant, the virial also must be constant, whatever the volume, in the same quantity of gas at constant temperature. It follows from this that Rr, the product of the repulsion of two particles into the distance between them, must be constant, or in other words that the repulsion must be inversely as the distance, a law which Newton has shown to be inadmissible in the case of molecular forces, as it would make the action of the distant parts of bodies greater than that of contiguous parts. In fact, we have only to observe that if Rr is constant, the virial of every pair of particles must be the same, so that the virial of the system must be proportional to the number of pairs of particles in the system—that is, to the square of the number of particles, or in other words to the square of the quantity of gas in the vessel. The pressure, according to this law, would not be the same in different vessels of gas at the same density, but would be greater in a large vessel than in a small one, and greater in the open air than in any ordinary vessel.

The pressure of a gas cannot therefore be explained by assuming repulsive forces between the particles.

It must therefore depend, in whole or in part, on the motion of the particles.

If we suppose the particles not to act on each other at all, there will be no virial, and the equation will be reduced to the form

$$Vp = \frac{2}{3}T.$$

If M is the mass of the whole quantity of gas, and c is the mean square of the velocity of a particle, we may write the equation—

$$Vp = \frac{1}{3}Mc^2$$

or in words, the product of the volume and the pressure is one-third of the mass multiplied by the mean square of the velocity. If we now assume, what we shall afterwards prove by an independent process, that the mean square of the velocity depends only on the temperature, this equation exactly represents Boyle's Law.

But we know that most ordinary gases deviate from Boyle's Law, especially at low temperatures and great densities. Let us see whether the hypothesis of forces between the particles, which we rejected when brought forward as the sole cause of gaseous pressure, may not be consistent with experiment when considered as the cause of this deviation from Boyle's Law.

When a gas is in an extremely rarefied condition, the number of particles within a given distance of any one particle will be proportional to the density of the gas. Hence the virial arising from the action of one particle on the rest will vary as the density, and the whole virial in unit of volume will vary as the square of the density.

Calling the density ρ, and dividing the equation by V, we get—

$$p = \frac{1}{3}\rho c^2 - \frac{2}{3}A\rho^2$$

where A is a quantity which is nearly constant for small densities.

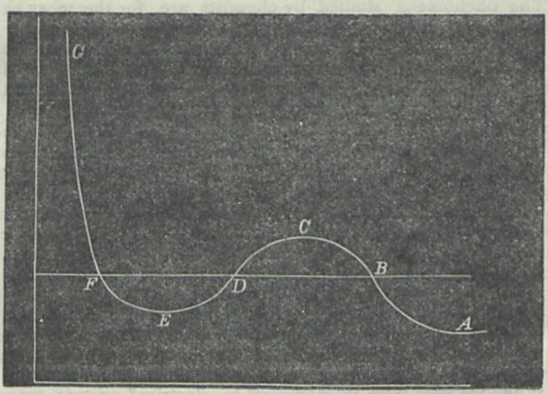
Now, the experiments of Regnault show that in most gases, as the density increases the pressure falls below the value calculated by Boyle's Law. Hence the virial must be positive; that is to say, the mutual action of the particles must be in the main attractive, and the effect of this action in diminishing the pressure must be at first very nearly as the square of the density.

On the other hand, when the pressure is made still greater the substance at length reaches a state in which an enormous increase of pressure produces but a very small increase of density. This indicates that the virial is now negative, or, in other words, the action between the particles is now, in the main, repulsive. We may therefore conclude that the action between two particles at any sensible distance is quite insensible. As the particles approach each other the action first shows itself as an attraction, which reaches a maximum, then diminishes, and at length becomes a repulsion so great that no attainable force can reduce the distance of the particles to zero.

The relation between pressure and density arising from such an action between the particles is of this kind.

As the density increases from zero, the pressure at first depends almost entirely on the motion of the particles, and therefore varies almost exactly as the pressure, according to Boyle's Law. As the density continues to increase, the effect of the mutual attraction of the particles becomes sensible, and this causes the rise of pressure to be less than that given by Boyle's Law. If the temperature is low, the effect of attraction may become so large in proportion to the effect of motion that the pressure, instead of always rising as the density increases, may reach a maximum, and then begin to diminish.

At length, however, as the average distance of the particles is still further diminished, the effect of repulsion will prevail over that of attraction, and the pressure will increase so as not only to be greater than that given by Boyle's Law, but so that an exceedingly small increase of density will produce an enormous increase of pressure.



Hence the relation between pressure and volume may be represented by the curve *A B C D E F G*, where the horizontal ordinate represents the volume, and the vertical ordinate represents the pressure.

As the volume diminishes, the pressure increases up to the point *C*, then diminishes to the point *E*, and finally increases without limit as the volume diminishes.

We have hitherto supposed the experiment to be conducted in such a way that the density is the same in every part of the medium. This, however, is impossible in practice, as the only condition we can impose on the medium from without is that the whole of the medium shall be contained within a certain vessel. Hence, if it is possible for the medium to arrange itself so that part has one density and part another, we cannot prevent it from doing so.

Now the points *B* and *F* represent two states of the medium in which the pressure is the same but the density very different. The whole of the medium may pass from the state *B* to the state *F*, not through the intermediate states *C D E*, but by small successive portions passing directly from the state *B* to the state *F*. In this way the successive states of the medium as a whole will be represented by points on the straight line *B F*, the point *B* representing it when entirely in the rarefied state, and *F* representing it when entirely condensed. This is what takes place when a gas or vapour is liquefied.

Under ordinary circumstances, therefore, the relation between pressure and volume at constant temperature is represented by the broken line *A B F G*. If, however, the medium when liquefied is carefully kept from contact with vapour, it may be preserved in the liquid condition and brought into states represented by the portion of the curve between *F* and *E*. It is also possible that methods may be devised whereby the vapour may be prevented from condensing, and brought into states represented by points in *B C*.

The portion of the hypothetical curve from C to E represents states which are essentially unstable, and which cannot therefore be realised.

Now let us suppose the medium to pass from B to F along the hypothetical curve $B\ C\ D\ E\ F$ in a state always homogeneous, and to return along the straight line FB in the form of a mixture of liquid and vapour. Since the temperature has been constant throughout, no heat can have been transformed into work. Now the heat transformed into work is represented by the excess of the area FDE over BCD. Hence the condition which determines the maximum pressure of the vapour at given temperature is that the line BF cuts off equal areas from the curve above and below.

The higher the temperature, the greater the part of the pressure which depends on motion, as compared with that which depends on forces between the particles. Hence, as the temperature rises, the dip in the curve becomes less marked, and at a certain temperature the curve, instead of dipping, merely becomes horizontal at a certain point, and then slopes upward as before. This point is called the critical point. It has been determined for carbonic acid by the masterly researches of Andrews. It corresponds to a definite temperature, pressure and density.

At higher temperatures the curve slopes upwards throughout, and there is nothing corresponding to liquefaction in passing from the rarest to the densest state.

The molecular theory of the continuity of the liquid and gaseous states forms the subject of an exceedingly ingenious thesis by Mr. Johannes Diderik van der Waals,* a graduate of Leyden. There are certain points in which I think he has fallen into mathematical errors, and his final result is certainly not a complete expression for the interaction of real molecules, but his attack on this difficult question is so able and so brave, that it cannot fail to give a notable impulse to molecular science. It has certainly directed the attention of more than one inquirer to the study of the Low-Dutch language in which it is written.

The purely thermodynamical relations of the different states of matter do not belong to our subject, as they are independent of particular theories about molecules. I must not, however, omit to mention a most important American contribution to this part of thermodynamics by Prof. Willard Gibbs,† of Yale College, U.S., who has given us a remarkably simple and thoroughly satisfactory method of representing the relations of the different states of matter by means of a model. By means of this model, problems which had long resisted the efforts of myself and others may be solved at once. J. CLERK-MAXWELL

(*To be continued.*)

* Over de continuiteit van den gas en vloeistof toestand. Leiden: A. W. Sijthoff, 1873.

† "A method of geometrical representation of the thermodynamic properties of substances by means of surfaces." Transactions of the Connecticut Academy of Arts and Sciences, Vol. ii. Part 2.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, Feb. 19.—Annual General Meeting.—Mr. John Evans, V.P.R.S., president, in the chair.—The Secretary read the reports of the Council and of the Library and Museum Committee. The general position of the Society was described as satisfactory, although, owing to extraordinary expenses during the year, the excess of income over expenditure was but small in comparison with former years. The Society was said to be prosperous, and the number of Fellows to be rapidly increasing.

In presenting the Wollaston Gold Medal to Prof. de Koninck, of Liége, F.M.G.S., the President addressed him as follows:—"Monsieur le Docteur de Koninck, it is my pleasing duty to place in your hands the Wollaston Medal, which has been awarded to you by the Council of this Society in recognition of your extensive and valuable researches and numerous geological publications, especially in Carboniferous Palæontology. These researches are so well known, and have gained you so worldwide a reputation, that I need say no more than that your palæontological works must of necessity be almost daily consulted by all who are interested in the fauna of the Carboniferous period. Already in 1853 the numerous and able Palæontological works which you had published in the preceding twenty years had attracted the grateful notice of the Council of this Society, who in that year begged you to accept the balance of the proceeds of the Wollaston Fund, in aid of the publication of your work on Encrinites, then in progress. It was in the same year that the Society had the satisfaction of electing you a Foreign Member of their body; and now, after a second period of rather more than twenty years devoted to the study not only of geology and palæontology, but also of chemical analysis, I have the pleasure of conferring upon you the highest additional honour it lies in the power of this Society to bestow, by presenting you with the medal founded by the illustrious Wollaston, who was himself also a chemist as well as a geologist. If anything could add to the satisfaction we feel in thus bestowing the medal, it is your presence among us this day, which will enable you more fully to appreciate our unanimous sense of the high value of your labours in the cause which we all have at heart."

The President then presented the balance of the proceeds of the Wollaston Donation Fund to Mr. L. C. Miall, of Leeds, and addressed him in the following terms:—"Mr. Miall, I have much pleasure in presenting you with the balance of the proceeds of the Wollaston Fund, which has been awarded you by the Council of this Society to assist you in your researches on Fossil Reptilia. Those who had the good fortune to be present at the meeting of the British Association at Bradford in 1873, and to hear the masterly report of the Committee on the Labyrinthodonts of the Coal-measures, drawn up by yourself, and those also who have studied the papers which you have communicated to this Society on the Remains of Labyrinthodonta from the Keuper Sandstone of Warwick, must be well aware of the thorough and careful nature of your researches, carried on, I believe, in a somewhat isolated position, and remote from those aids which are so readily accessible in the metropolis and some of our larger towns. I trust that the proceeds of this fund which I have now placed in your hands will be regarded as a testimony of the interest which this Society takes in your labours, and may also prove of some assistance to you in still further prosecuting them."

Mr. Miall, in reply, said that he felt that his sincere thanks were due to the Geological Society for awarding him the balance of the proceeds of the Wollaston Donation Fund as a token of appreciation of the little work that he had been able to do, and also to the President for the terms in which he had been kind enough to speak of him. He should regard this donation, not only as an honour received by him, but also as a trust to be expended to the best of his power in accordance with the intentions with which it had been conferred upon him by the Society.

The President next handed the Murchison Medal to Mr. David Forbes for transmission to Mr. W. J. Henwood, F.R.S., and spoke as follows:—"Mr. David Forbes, in placing the Murchison Medal and the accompanying cheque in your hands, to be conveyed to our distinguished Fellow, Mr. William Jory Henwood, I must request you to express to him our great regret that he is unable to attend personally to receive it. His researches on the metalliferous deposits, not only of Cornwall and Devonshire, but of Ireland, Wales, North-western India, North America, Chili, and Brazil, extending as they do to questions of subterranean temperature, electric currents, and the quantities of water present in mines, are recorded in memoirs which form text-books for mining students. They have for the most part been contributed to the Royal Geological Society of Cornwall, which has taken a pride in publishing them; but I trust that it will be a source of satisfaction to Mr. Henwood, after fifty years of laborious research, and amidst the physical suffering caused by a protracted illness, to receive this token of appreciation at the hands of another Society which takes no less interest in the subjects of his investigations."

Mr. David Forbes said that in receiving the Murchison Medal, on behalf of Mr. W. J. Henwood, he was commissioned by that gentleman to express his great regret that the bad state of his health and his advanced age prevented his appearing in person to thank the Council for the high honour they had conferred upon him, and the extreme gratification he felt in finding that the results of his labours in the investigation of the phenomena of mineral veins, which had extended over more than fifty years, had thus been recognised by the Geological Society of London.

The President then presented to Prof. H. G. Seeley the balance of the Murchison Geological Fund, and said:—"Mr. Seeley, your researches in geology and on fossil osteology have already extended over a period of upwards of sixteen years, and the numerous and valuable essays which you have contributed to the Annals and Magazine of Natural History, as well as to the Quarterly Journal of this Society, are only a portion of their fruits. Your separate works on the fossil remains of Aves, Ornithosauria, and Reptilia, in the Woodwardian Museum at Cambridge, and on the bones of Pterodactyles, are well known to every student of fossil osteology, and have been thought worthy of the by no means empty compliment of being printed at the expense of the Syndics of the University Press of Cambridge. The esteem in which your researches are held by the Council of this Society, and their hope that you may still be enabled to prosecute them, are best evinced by their presenting you with the balance of the proceeds of the Murchison Fund, which I now have the pleasure of placing in your hands."

Prof. Seeley replied as follows :—"Mr. President, I have ever been taught that the Geological Society is the fountain of geological honour. It has always been a great honour to be associated with the Fellows of this Society, who are constructing the sciences we cultivate. Out of this association have grown bonds of comradeship, encouraging some of us to follow on in the labour of those whose work is ended; and when, sir, I receive at your hands this award of the balance of the Murchison Fund, I am grateful for such a distinguished mark of sympathy with my special studies, and shall be encouraged by it to prosecute researches which I hope may be better worthy of the Society's acceptance."

The President then proceeded to read his Anniversary Address, in which, after congratulating the Fellows upon their having at length got possession of their new premises, he called attention to the advantage which accrued both to the Fellows of the Society and to the officers of the School of Mines, Geological Survey, and Museum of Practical Geology, by the close proximity of the two establishments, and expressed a hope that there might be no severance of this union, whether by the removal of the School of Mines to South Kensington or otherwise. He also contrasted the position of the Society as regards funds, number of Fellows, &c., in 1829 and in 1875, the former being the first year in which the anniversary meeting of the Society was held in the Society's rooms at Somerset House. He then took up the main subject of his address, namely, the question of the antiquity of the human race, and the geological evidence bearing upon it. The address was prefaced by some obituary notices of Fellows and foreign members deceased during the past year, including Prof. Phillips, Dr. F. Stoliczka, the Rev. C. Kingsley, Mr. J. W. Pike, Dr. Arnott, Prof. W. Macdonald, M. Elie de Beaumont, and M. J. J. d'Omalius d'Halloy.

The ballot for the council and officers was taken, and the following were duly elected for the ensuing year :—President, John Evans, F.R.S. Vice-Presidents : Prof. P. Martin Duncan, F.R.S., Robert Etheridge, F.R.S, Sir Charles Lyell, Bart., F.R.S., Prof. A. C. Ramsay, F.R.S. Secretaries : David Forbes, F.R.S., Rev. T. Wiltshire, M.A. Foreign Secretary, Warrington W. Smyth, F.R.S. Treasurer, J. Gwyn Jeffreys, F.R.S. Council : H. Bauerman, Frederic Drew, Prof. P. Martin Duncan, F.R.S., Sir P. de M. G. Egerton, Bart., F.R.S., R. Etheridge, F.R.S., John Evans, F.R.S., David Forbes, F.R.S., R. A. C. Godwin-Austen, F.R.S., Henry Hicks, Prof. T. McKenny Hughes, M.A., J. W. Hulke, F.R.S., J. Gwyn Jeffreys, F.R.S., Sir Charles Lyell, Bart., F.R.S., C. J. A. Meyer, J. Carrick Moore, F.R.S., Prof. A. C. Ramsay, F.R.S., Samuel Sharp, F.S.A., Warrington W. Smyth, F.R.S., H. C. Sorby, F.R.S., Prof. J. Tennant, F.C.S., W. Whitaker, B.A., Rev. T. Wiltshire, F.L.S., Henry Woodward, F.R.S.

Victoria (Philosophical) Institute, March 1.—Mr. C. Brooke, F.R.S., in the chair.—A paper on the chronology of recent geology was read by Mr. S. R. Pattison, F.G.S. Mr. Pattison maintained that geology furnishes no proof, nor high probability, that the introduction of man into Europe took place longer ago than about six or seven thousand years.

PARIS

Academy of Sciences, Feb. 22.—M. M. Frémy in the chair.—The following papers were read :—A report, by M. Leverrier, on the meridian observations of the minor planets, made at the Greenwich and Paris Observatories during the last three months of 1874. The details are given for planets 69, 76, 91, 120, 11, 43, 83, 6, 78, 140, 10, 3, 2, 4, 5, 59, 81, 33, 46, and 49.—New observations of the nature of alcoholic fermentation, by M. L. Pasteur.—On ruthenium and its oxides, by MM. H. Sainte Claire Deville and H. Debray. These gentlemen had at their disposal a considerable quantity of ruthenium and its compounds, and have made them the subject of elaborate investigations. Their report contains valuable details concerning this rare metal and its compounds; among them perruthenic acid, RuO_4, is of particular interest, as up to the present it was hardly known; they obtained it in yellow crystals of such instability as to make it impossible to determine their form, their melting point was at 40° C. They also obtained several salts of this acid. At 108° it is decomposed under explosion.—On the simultaneous formation of several crystallised mineral species in the thermal source of Bourbonne-les-bains (Haute Marne), particularly of grey antimonial copper (tetrahedrite), copper pyrites (chalcopyrite), streaky copper (philippsite), and copper sulphide (chalcosine); by M. Daubrée.—On the action of borax in fermentation and putrefaction, by M. J. B. Schnetzler. This paper treats of three distinct actions of borax, viz., that upon protoplasma of vegetable cells, that upon mineral organisms, and that upon matter undergoing fermentation.—On the boiling of sulphuric acid, by M. A. Bobierre. The boiling of this acid is generally considered a difficult operation; the author shows that it is very easy and even more regular than that of water, if one introduces into the vessel holding the acid a sufficient quantity of platinum.—On the winter vegetation of Algæ at Mossel Bay (Spitzbergen), by M. F. Kjellman : observations made during the Swedish Polar Expedition of 1872–73. The author found that the Algæ at Mossel Bay during the winter are the same as those during the summer and autumn, and that the dark season in the winter, which lasts about three months and a half, makes little or no difference to this part of the vegetation. He gives a list of numerous species which he observed, belonging to the orders of *Corallinaceæ*, *Florideæ*, *Fucaceæ*, *Phæozoosporaceæ*, and *Chlorozoosporaceæ*.—On the chemical composition of the *petit lait* of Luchon, by M. T. Garrigou. The author gives the analysis of these waters, which hold about 7 per cent. of solid matter partly in solution.—On a case of epilepsy treated with sulphate of copper, and the presence of a considerable quantity of copper in the liver, by MM. Bourneville and Yvon.—The Secretary read the following telegram, dated Aden, Feb. 16, 1875, from M. Mouchez, the chief of the expedition sent to observe the Transit of Venus. The telegram runs as follows :—"Three months of bad weather; transit rather fine; interior contacts excellent, exterior contacts cloudy; numerous photographs. *Dives* (the vessel carrying the material for the expedition) started for Cherbourg; all well."—A note by M. J. L. Soret, on the diffraction phenomena produced by circular nets.—On the influence of pressure upon combustion, by M. Cailletet.—On the impurities in boracic acid, by M. A. Ditte.—A note by M. Béchamp on the *Microzymata* and *Bacteria*, with regard to a remark of M. Balard. This paper is a continuation of another one read before the Academy on Nov. 30 last, on the birth and evolution of *Bacteria* in organic tissues sheltered from the air, by M. Servel.—A note by M. Gayat on some comparative researches on man and animals with reference to the ophthalmoscopic signs of death.—M. J. Vinot then replied to a note of M. Chapelas, read at the last meeting, regarding a large bolide, which was supposed to have been an illuminated cloud, and proved that M. Chapelas' idea was erroneous.

CONTENTS