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THURSDAY, AUGUST 4, 1870

THE SCIENCE AND ART DEPARTMENT

THE Report of the Science and Art Department just issued is a document of such vast importance to all interested in Science or Education, that we take the first opportunity of saying something upon it. The work which has been done in Science by this Department is so little known, however, that it is necessary to preface our account of this year's report by a brief history of what has been attempted, and accomplished, in former years.

In 1853 the Board of Trade proposed to extend a system of encouragement, similar to that already commenced in the Department of Practical Art, to local institutions of Practical Science, and the Treasury at once wrote one of their classical minutes, in which they expressed the concurrence of "My Lords" generally, in the plans proposed by the President of the Board of Trade, "as the most effectual means of giving effect to the recommendation of Her Majesty at the opening of the Session, with a view to the advancement of Practical Science."

Experiments were tried in the way of Science—or Trade and Navigation—Schools at Aberdeen, Birmingham, Bristol, Leeds, Newcastle-on-Tyne, Poplar, Green's Sailor's Home, Stoke, Truro, Wigan, Wandsworth, and other places. Most of these experiments failed after a short time.

In June 1859 the minute which is the foundation of the present system of aid passed, but this minute has been greatly modified from time to time and greatly enlarged.

The plan pursued before 1859 followed, more or less, the analogy of the elementary school system. That is to say, a trained teacher was sent where a committee was formed, a certain salary guaranteed for a year or two, and so on. This kind of encouragement, however, failed. The requirement of the country was not only teachers to teach but people who wished to learn. After a short time teachers exhausted the guarantee and the schools were broken up.

The state of the country as respects science instruction for artisans at this time (eleven years ago) is well described by Dr. Hudson in a letter then written to the Education Department. In Lancashire and Cheshire, he says, there was no instruction in chemistry, except in "small classes chiefly for mutual improvement in elementary chemistry, and conducted without the aid of efficient teachers, which are in operation at Ballington, Hyde, Staleybridge, Stockport, and Burnley. In Yorkshire, the only night schools affording instruction in chemistry are at Bradford, Halifax, Huddersfield, Leeds, and Selby."

"No instruction whatever is afforded at any Mechanics' Institute in Yorkshire, Lancashire, or Cheshire; and mineralogy, as applied to mining, has only been recently added to the programme of class instruction in one single society—the Wigan Mechanics' Institution."

"In the whole district of Lancashire and Yorkshire, extending from sea to sea, there is no adult school or mechanics' institute in which theoretical mechanics is taught, ... or experimental physics." "The three Ridings of Yorkshire, with their 150 mechanics' and kindred institutions, only possess two societies, and these mere village institutes, in which instruction—Manston in Physical Science, and Shipley in Natural Philosophy—is afforded, and this to an infinitesimal amount. With two exceptions, there are no mechanics' institutions or mutual improvement societies in Lancashire in which any elementary instruction in Physics (Natural Philosophy or Mechanics) is given, and the county of Cheshire does not present one instance in which these matters receive attention in similar societies."

The essential point of the system which the department has organised to reach this terrible state of things, is that it pays simply for results with a preliminary test examination of teachers,—the Honours examination enabling teachers to show high qualifications if they possess them. And the aim has been to enlist all kinds of persons resident in different localities—sometimes the teachers of the ordinary day schools, at other times workmen who had an aptitude for teaching—to commence science instruction, and it looks very much as if this plan has met the difficulty. It has permitted small beginnings by persons conversant with a locality when outsiders could have had neither chance of doing anything, nor sufficient work to support them. It has, in fact, been a missionary effort, and as such has succeeded, and has been paid for.

So much for a general historical sketch of the *modus operandi* of the Department; let us now come to the description, and give evidence of a power at work, which, with proper encouragement, will in time do wonders. The "no schools" of 1859 were represented by 120 schools with 5,479 pupils in 1865, and by 779 schools and 34,283 pupils in the present year. Here are the general results in tabular form :—

	1863.	1869.		1870.
Number of Schools under Teachers examined	300	523		799
Number of Classes in the same	856	1,489		2,200
Number of individuals under instruction in Classes under Certificated Teachers . . .	15,010	24,865		34,283
Number of the above who came up for examination	6,875	12,988	(about)	17,000
Number examined in addition to the above who were not in Schools under Certificated Teachers.	217	246	(about)	700
Number of Papers worked in :— Subject.				
1. Practical, Plane, and Solid Geometry	1,337	2,638		3,359
2. Machine Construction and Drawing	1,671	2,987		3,656
3. Building Construction . .	1,185	1,998		2,631
3 (alternative). Naval Architecture	21	12		39
4. Elementary Mathematics	1,390	2,329	Stage I. II. & III.	3,837
5. Higher Mathematics . .	33	84	" IV. & V.	108
			" VI. & VII.	50
6. Theoretical Mechanics .	353	629		830
7. Applied Mechanics . .	167	294		551
8. Acoustics, Light and Heat	769	1,352		2,021
9. Magnetism and Electricity	1,038	2,509		2,613
10. Inorganic Chemistry . .	964	2,173		2,694
11. Organic Chemistry . . .	123	210		235
12. Geology	309	619		1,069
13. Mineralogy	38	67		63
14. Animal Physiology . . .	1,182	2,227		3,705
15. Zoology.	298	303		114
16. Vegetable Anatomy and Physiology.	112	144		400
17. Systematic and Economic Botany	73	90		140
18. Principles of Mining . .	41	48		64
19. Metallurgy	81	126		160
20. Navigation	219	303		260
21. Nautical Astronomy . .	86	107		68
22. Steam	106	149		311
23. Physical Geography . .	1,516	2,687		5,435
Total number of Papers worked	13,112	24,085		89,395

From the above table we gather that there were in May, 1869, 523 schools and 24,865 pupils; in May, 1870, 799 schools with 34,283 pupils, the number of teachers at present giving instruction in connection with the Department being nearly 1,000. Now, how is this work being done? In the first place let us say that it is going on among classes of the community which all our other educational means do not touch, and, as may be imagined, much of the work is night work; in some cases the working men taught have commenced their education by building their schoolrooms; and those who know the delights of a laboratory would think that the chemistry was acquired by apparatus and appliances which made even the simplest experiment an impossibility.

Secondly, let us say that all the year's work is brought to a focus by examinations held on the same night throughout the length and breadth of the land, the papers being sent from South Kensington to the local committees with infinite precautions, and the answers being returned sealed the same night to London. They then are handed over, with no indication as to name of candidate or place of examination, to the Government examiners, and when we state that these examiners include the names of Huxley, Frankland, Ramsay, Tyndall, and others of like calibre, we need say no more as to the rigour and fairness of the examination. Here is a table showing how this ordeal is passed:—

Year.	No. examined.	No. of Papers worked.	No. of Papers passed.
1867	4,520	8,213	6,013
1868	7,092	13,112	8,649
1869	13,234	24,085	14,550

It is impossible within the limits of an article to dwell upon the various points of inquiry and interest which lie around the working of the system: we shall be content if we have shown what it is doing, and how the teaching is being conducted. When these points are known there can be no doubt as to the importance of the work done, and, although many improvements may be required, it is clear that *in essentials* the Department is now on the right track and is doing great good. What is most required is systematising and formulating the instruction. Hitherto the teaching has been rather desultory. It is very desirable that regular systematic courses of instruction, adapted to the local requirements, should be imposed as soon as this can be done without checking the spread of instruction. Some examiners complain of "cram," but this is not limited to the South Kensington system; and the teachers complain of poor pay. This should certainly be corrected; the results they are accomplishing are too important to be ignored; and it would seem that the time had almost come for a complete inquiry into the whole system in order that this important national engine should work with the least possible friction and waste of power.

WHAT IS ENERGY?

IV.—THE DISSIPATION OF ENERGY

At this point we can imagine some champion of perpetual motion coming forward and proposing conditions of truce. "I acknowledge," he will say, "that perpetual motion, as you have defined it, is quite impossible, for no machine can *create* energy, but yet I do not see from your own stand-point that a machine might not be constructed that would produce work for ever. You tell me, and I believe you, that heat is a species of molecular motion, and hence that the walls of the room in which we now sit are full of a kind of invisible energy, all the particles being in rapid motion." Now, may we not suppose a machine to exist which converts this molecular motion into ordinary work, drawing first of all the heat from the walls, then from the adjacent air; cooling down, in fact, the surrounding universe, and transforming the energy of heat so abstracted into good substantial work? There is no doubt work can be converted into heat—as, for instance, by the blow of a hammer on an anvil—why, therefore, cannot this heat be converted back again into work?

We reply by quoting the laws discovered by Carnot, Clausius, Thomson, and Rankine, who have all from different points of view been led to the same conclusion, which, alas! is fatal to all hopes of perpetual motion. We may, they tell us, with the greatest ease convert mechanical work into heat, but we cannot by any means convert all the energy of heat back again into mechanical work. In the steam-engine we do what can be done in this way; but it is a very small proportion of the whole energy of the heat that is there converted into work, for a large portion is dissipated, and will continue to be dissipated, however perfect our engine may become. Let the greatest care be taken in the construction and working of a steam-engine, yet shall we not succeed in converting one-fourth of the whole energy of the heat of the coals into mechanical effect.

In fact, the process by which work can be converted into heat is not a completely reversible process, and Sir W. Thomson has worked out the consequences of this fact in his beautiful theory of the dissipation of energy.

As far as human convenience is concerned, the different kinds of energy do not stand on the same footing, for we can make great use of a head of water, or of the wind, or of mechanical motion of any kind, but we can make no use whatever of the energy represented by equally diffused heat. If one body is hotter than another, as the boiler of a steam-engine is hotter than its condenser, then we can make use of this difference of temperature to convert some of the heat into work, but if two substances are equally hot, even although their particles contain an enormous amount of molecular energy, they will not yield us a single foot-pound of work.

Energy is thus of different *qualities*, mechanical energy being the best, and universal heat the worst; in fact, this latter description of energy may be likened to the dreary waste heap of the universe, in which the effete forms of energy are suffered to accumulate, and, alas! this desolate waste heap is always continuing to increase. But before attempting to discuss the probable effect of this process of deterioration upon the present system of things, let us look around us and endeavour to estimate the various sources of energy that have been placed at our disposal.

To begin with our own frames, we all of us possess a certain amount of energy in our systems, a certain capacity for doing work. By an effort of his muscles the blacksmith imparts a formidable velocity to the massive hammer which he wields: now what is consumed in order to produce this? We reply, the tissues of his body are consumed. If he continues working for a long time he will wear out these tissues and nature will call for food and rest; for the former in order to procure the materials out of which new and energetic tissues may be constructed; for the latter, in order to furnish time and leisure for repairing the waste. Ultimately, therefore, the energy of the man is derived from the food which he eats, and if he works much, that is to say, spends a great deal of energy, he will require to eat more than if he hardly works at all. Hence it is well understood that the diet of a man sentenced to imprisonment with hard labour must be more generous than that of one who is merely imprisoned, and that the allowance of food to a soldier in time of war must be greater than in time of peace.

In fact, food is to the animal what fuel is to the engine, only an animal is a much more economical producer of work than an engine. Rumford justly observed that we shall get more work out of a ton of hay if we give it as food to a horse than if we burn it as fuel in an engine. It is in truth the combustion of our food that furnishes our frames with energy, and there is no food capable of nourishing our bodies which, if well dried, is not also capable of being burned in the fire. Having thus traced the energy of our frames to the food which we eat, we next ask whence does this food derive its energy. If we are vegetarians we need not trouble ourselves to go further back, but if we have eaten animal food and have transferred part of the energy of an ox or of a sheep into our own systems, we ask whence has the ox or the sheep derived its energy, and answer, undoubtedly, from the food which it consumes, this food being a vegetable. Ultimately, then, we are led to look to the vegetable kingdom as the source of that great energy which our frames possess in common with those of the inferior animals, and we have now only to go back one more step and ask whence vegetables derive the energy which they possess.

In answering this question, let us endeavour to ascertain what really takes place in the leaves of vegetables. A leaf is, in fact, a laboratory in which the active agent is the sun's rays. A certain species of the solar ray enters this laboratory, and immediately commences to decompose carbonic acid into its constituents oxygen and carbon, allowing the oxygen to escape into the air while the carbon is, in some shape, worked up and assimilated. First of all, then, in this wondrous laboratory of Nature, we have a quantity of carbonic acid drawn in from the air: this is the raw material. Next, we have the source of energy, the active agent: this is light. Thirdly, we have the useful product: that is, the assimilated carbon. Fourthly, we have the product dismissed into the air, and that is oxygen.

We thus perceive that the action which takes place in a leaf is the very reverse of that which takes place in an ordinary fire. In a fire, we burn carbon, and make it unite with oxygen in order to form carbonic acid, and in so doing we change the energy of position derived from the separation of two substances having so great an attraction for each other as oxygen and carbon, into the energy of heat. In a leaf, on the other hand, these two strongly attractive substances are forced asunder, the powerful agent which accomplishes this being the sun's rays, so that it is the energy of these rays which is transformed into the potential energy or energy of position represented by the chemical separation of this oxygen and carbon. The carbon, or rather the woody fibre into which the carbon enters, is thus a source of potential energy, and when made to combine again with oxygen, either by direct combustion or otherwise, it will in the process give out a deal of energy. When we burn wood in our fires we convert this energy into heat, and when we eat vegetables we assimilate this energy into our systems, where it ultimately produces both heat and work. We are thus enabled to trace the energy of the sun's rays through every step of this most wonderful process: first of all building up vegetable food, in the next place feeding the ox or sheep, and lastly through the shape of the very prosaic but essential joint of beef or mutton entering into and sustaining these frames of ours.

We are not, however, quite done yet with vegetable fibre, for that part of it which does not enter into our frames may, notwithstanding, serve as fuel for our engines, and by this means be converted into useful work. And has not Nature, as if anticipating the wants of our age, provided an almost limitless store of such fuel in the vast deposits of coal, by means of which so large a portion of the useful work of the world is done? In geological ages this coal was the fibre of a species of plant, and it has been stored up as if for the benefit of generations like the present.

But there are other products of the sun's rays besides food and fuel. The miller who makes use of water-power or of wind power to grind his corn, the navigator who spreads his sail to catch the breeze, are indebted to our luminary equally with the man who eats meat or who drives an engine. For it is owing to the sun's rays that water is carried up into the atmosphere to be again precipitated so as to form what is called a head of water, and it is also owing to the sun's heat that winds agitate the air. With the trivial exception of tidal energy all the work done in the world is due to the sun, so that we must look to our luminary as the great source of all our energy.

Intimately linked as we are to the sun, it is natural to ask the question, Will the sun last for ever, or will he also die out? There is no apparent reason why the sun should form an exception to the fate of all fires, the only difference being one of size and time. It is larger and hotter, and will last longer than the lamp of an hour, but it is nevertheless a lamp. The principle of degradation would appear to hold throughout, and if we regard not mere matter but useful energy, we are driven to contemplate the death of the universe. Who would live for ever even if he had the elixir of life? or who would purchase, if he might, the dreary privilege to preside at the end of all things—to be "twins in death" with the sun, and to fill up in his own experience the melancholy dream of the poet,—

The sun's eye had a sickly glare
The stars with age were wan,
The skeletons of nations were
Around that lonely man,
Some died in war, the iron brands
Lay rusting in their bony hands,
In peace and famine some.
Earth's cities had no sound nor tread,
And ships lay drifting with their dead
To shores where all were dumb.

B. STEWART

POPULAR PHYSIOLOGY

What shall we Teach? or, Physiology in Schools. By Edwin Lankester, M.D., F.R.S., &c., &c.

A School Manual of Health. By Edwin Lankester, M.D., F.R.S., &c., &c. (London: Groombridge and Son.)

THERE is an old saying, "that every man when he gets to be forty is his own doctor unless he happens to be a fool;" by which is meant that the pains and discomforts of ill health will, in the long run, convince most men that some knowledge of the facts of physiology and of the laws which govern the human body, is, after all, a desirable thing for the comfortable conduct of life. The main object of Dr. Lankester's pamphlet is to urge the question, "Why leave these lessons to chance and the fourth decade? Why not steal a march on bitter experience, and by making physiology a branch of general education, forewarn and forearm everyone against bodily indiscretions and against transgressions of sanitary laws?" Leaving on one side altogether the value of physiology in its scientific aspect as a means of training the mind, and taking his stand on the ground simply of the importance of it as mere information, the author works out his plea with unflagging zeal and energy. Indeed, all the pages bear tokens of almost the enthusiasm of a crusade. Into town and country, into girls' schools, boys' schools, infants' schools and universities, into corporations, vestries, and town councils, into the functions of clergymen, householders, lawyers, and domestic servants, the flag of physiology is most gallantly carried; and we can hardly imagine an impressionable general reader finishing the little work without at once rushing off to order "Huxley's Elementary Lessons" and the "School Manual of Health."

For ourselves we are free to confess, that while thoroughly sympathising with Dr. Lankester in his laments over the contemptible ignorance, and worse than ignorance, of mankind in all that relates to their bodies, we are not so sanguine as he seems to be touching the results of even general and extensive physiological teaching. We quite feel with him that it is perfectly outrageous that men and women should be so profoundly ignorant, as they are, of the nature of that prison-house from which they can never escape so long as life lasts, that our youth should, under the pretence of training, be taught things which they can never see or touch in after-life, should be made wise in phantoms and myths, and encouraged to put aside all curiosity about the things which they carry about with them always everywhere. Is it not monstrous that many a lad of eighteen should have so vivid a picture in his mind's eye, of, say, Syracuse during the Peleponnesian war, as to make people think he must have lived long years in Sicily, while the inside of his own body is to him a dim mystery, of which he can call up no clear image, but fancies it is some how or other more or less like a pig's? Some day or other men will have difficulty in believing that such a state of things could possibly have existed, and certainly the longest chapter in that great book, *De Hominum Erroribus*, will be the one which deals with the teaching of the young. At the same time, we fear that the millennium will not be very much nearer when every schoolboy knows the properties of gastric juice and even vestrymen believe in respiration. We have seen too many professors of physiology lecture on "pepsin" in the morning and rush violently into heavy dinners and indigestion in the evening, and besides, have had already too much general experience in the "*meliora probo deteriora sequor*," to feel much confidence in the reforming virtues of even the widest and most exact information, especially in everything relating to eating, drinking, and building houses. Nursemaids will continue to choke children, schoolboys to eat green gooseberries, and artizans to block up ventilators, in spite of each and all of them bearing certificates of proficiency in the knowledge of the laws of life.

Dr. Lankester's strongest point is perhaps the negative and destructive, rather than the positive and constructive, value of sound biological knowledge. Mankind suffer not so much from ignorance as from error, not so much from lack of knowledge as from the prevalence of false notions. The thing which the doctor and the sanitary reformer has to struggle against above all other things is the pertinacity with which the general public stick to false and pernicious theories, and the avidity with which they swallow everything which is absurd and ridiculous. Sometimes the attitude of the public mind towards questions of biological science is one of wholesale scepticism, sometimes of blind superstition; in all cases they appear as if they would rather be guided by any spirit than by that of patient inquiry, and of trust in conscientious and careful observation and experiment. Their minds are always readily tickled by any theory if it be extravagant enough; they run rapidly after any sign that is striking enough; but they have no taste for the sober results of sound biology. It is not enough to offer them lessons in physiology. The teacher may, perhaps, by diligence and patience at last get them to accept a part of what he teaches, but not until he uses his science as an instrument of training as well as a source of information.

And this brings us to the point in which apparently we feel obliged to break away altogether from Dr. Lankester. We quite agree with him, as we have said, in the immense value of physiology as viewed as mere information and compared with other kinds of information. But we hold very strongly to the opinion that it is training that is wanted far more than information. It is a change in the eye rather than in the picture towards which we look with hope. Beat into the general run of men some little scientific spirit, teach them how to look at the world around them in a scientific manner, how to arrive at scientific conclusions, how to approach scientific questions; put them in a proper mood, and they will then perhaps begin to become earnest physiologists and sanitary reformers. It is a right state of mind, and not a schoolboy's lesson in oxygen, that will tear down the paper pasted over the ventilator and otherwise help to lessen the labours of the coroner for Middlesex.

MÜLLER'S PHYSICS AND METEOROLOGY

Grundriss der Physik und Meteorologie. Von Dr. John Müller. Zehnte Vermehrte und Verbesserte Auflage. Mit einem Anhange, Physikalische Aufgaben enthaltend. (Erste Abtheilung. Braunschweig, 1869.)

IT is impossible to disguise or repress the feeling of covetousness with which this book of "Elements of

Physics and Meteorology" fills an English reader. In a volume which, when completed, is to contain something less than 600 pages, we have an account of the fundamental phenomena of natural philosophy, which is at once readable and scientific. It is published at 6s., is illustrated with 600 admirable engravings, and is to be accompanied by a collection of examples which, with the chapter on heat, will make up the remainder of the book. It is just such another treatise—as copious and accurate, and at the same time as clear and concise—that is wanted in teaching the elements of natural philosophy in England. There are a hundred schools which are compelled to put up with books twice as big as boys care to read or carry, which would introduce such a book as this at once.

The great difficulty which has to be faced and overcome in an elementary treatise of the kind is well stated by Professor Müller in the preface. "The facts of physical science ought never to be presented to the pupil in a mere dogmatic fashion, as acquired results. It is essential that he should comprehend the mode in which they have been deduced, and grasp the connection between the facts themselves and their systematic presentation in a logical system, which exhibits their mutual relations. Even in an elementary treatise like the present the reader ought to find an introduction to the processes of thinking and reasoning which are employed in physics, and should see everywhere examples and applications of the inductive method."

It is of course impossible for the author within his limits to give more than the briefest account of the main facts of the physical sciences. We turn, for instance, to the subject of thermo-electricity, the article on which, we are told in the preface, has been entirely re-written for this tenth edition. It contains just two pages. Nevertheless there is a good account of the fundamental law, and illustrations which enable the reader to comprehend in a very satisfactory way the use of the thermo-pile. There follow two pages more on animal electricity, the bulk of which is devoted to an account of the familiar electric actions exercised by certain fish, with illustrations showing the nature of the organs to which that action is due. The article closes with a few lines indicating the results obtained by Nobili and Du Bois Raymond in confirmation of the ideas of Galvani. These brief summaries of subjects could scarcely fail to be obscure were it not for the abundant diagrams which serve as texts for them.

The book before us is the condensed quintessence of Dr. Müller's well-known larger book on the same subject, which travels over the same ground, giving about four times as much space, and nearly four times as many illustrations. It is obvious, of course, what an enormous advantage it must be, in a task which is, of necessity, one of great difficulty and discretion—that of saying the very least which is requisite for clearness—to have previously arranged the subjects treated in a manner which allows a distinct perception of their relative importance. Without the larger book, this little text-book could scarcely have been what it is. We hope to see some day—the sooner the better—a comprehensive English treatise on Natural Philosophy which will take the place of Müller's large book in Germany, appealing to mathematics as little as it is possible to do without wearisome circumlocution, sufficiently simple to be accessible to any student who has a serious purpose, and at the same time scientifically accurate. From such a treatise it would be easy to condense one which should be for English schools what Prof. Müller's book is for schools in Germany. It would be extremely difficult, in any other way, to put into forty-five pages an account of the theory of sound, and its applications, so full and so simple as that which we find here. Everything is preserved in its proper proportions, and the reader rises from its perusal, not of course imagining that he knows the subject fully, but with a clear apprehension of the fundamental ideas involved, of the main questions of difficulty in the inquiry, and of the more recent discoveries which have enlarged the borders of the science. He is left, at the end of the book, with his curiosity stimulated, and not destroyed. If his after occupations give him sufficient leisure, the boy who has mastered this text-book at school will be certain to ask for more.

WILLIAM JACK

OUR BOOK SHELF

Microscopical Manipulation. By W. T. Suffolk, F.R.M.S. (Gillman, 1870.)

THIS little book is the substance of a course of instruction given by Mr. Suffolk in the spring to members of the Quekett Club. It will be useful to those persons who amuse themselves with microscopes, and do not care to purchase the scientific treatises of Dr. Carpenter or Dr. Beale. There is a chapter for the very youngest beginner on the various parts of an English compound microscope and their uses; then we have hints about the cutting of glass and the old directions as to making cells; mounting objects in balsam and in fluid is next dealt with—the old, old routine methods being detailed once again, with an allusion to Dr. Bastian's process with benzine. It is a pity that Mr. Suffolk has not made himself acquainted with some of the many methods of mounting and preparing objects in use on the Continent, which he might have picked up from Stricker's handbook, Frey's work, or other similar treatises. The best chapter in the book is that on polarised light, because it deals with a subject rather slighted in other works of this kind, in a clear and intelligent manner. We were not, however, prepared for the following in a work on microscopical manipulation:—"The undulatory motion of light would seem to be expressed with considerable clearness in the 1st chapter of Genesis, when read in the original Hebrew, which, in common with the other languages of the same family, is remarkable for the numerous inflexions of its verb, which gives it a delicacy and precision of expression unattainable in Western languages." Mr. Suffolk is quite right in considering that more attention should be paid to the use of polarised light as demonstrating structure, than has been done hitherto. A necessary step towards this is that microscopists should properly understand what are the conditions of production of colour with the polariscope, and not be content with the mere sight of a pretty display. This little book of Mr. Suffolk's will not do much, we fear, to convert what we may call microscopical play into microscopical science. Its receipts and directions are such as will be useful to the man who cares merely to make a series of pretty slides for exhibition to his friends, but do not help the student wishing to add to the storehouse of science. Nothing is said of the manner of studying living objects, living cells, living cilia, living protoplasm; nor do we find an allusion to the use of chromic acid, section instruments, methods of embedding, of gold and silver staining, or other processes important to a working microscopist. The gold and silver-staining methods might have been given if only for the benefit of those who like to make gorgeous preparations.

A small book on "Microscopical Manipulation," well up to the time, would be useful to students. We are sure Mr. Suffolk does not wish to claim this position for his digest of the older handbooks. His excuse for its publication must be that in this country there are many people who indulge in the expensive peepshows sold by our English opticians, to whom it will really be acceptable.

It must not be imagined that we for one moment object to such amusements; on the contrary, they are altogether to be commended where more serious work cannot be undertaken—and only then. E. R. L.

Notes of a Season at St. Moritz in the Upper Engadine, and of a Visit to the Baths of Tarasp. By J. Burney Yeo, M.B. (London: Longmans, 1870.)

WE commend this sensibly-written and interesting little book to the notice of our readers, many of whom, notwithstanding the outbreak of hostilities between our friends across the Channel, may yet seek health and enjoyment in these remote valleys, where it is in the highest degree improbable the tide of war will ever roll. Dr. Yeo's little brochure contains all that it is necessary the intending tourist need know, and much that the invalid ought to know before starting for the Upper Engadine. To the latter class of travellers in particular it is of no slight importance to know the nature of the lodging and food they can obtain, and the advantages to be gained from a residence in a new and untried region; and upon these points Dr. Yeo's experience enables him to speak with much confidence. St. Moritz, it must be remembered, is 6,000 or 7,000 feet above the level of the sea, and the air, though bright and clear, is by no means warm. The waters contain a small proportion of iron, and are strongly charged with carbonic acid, which may perhaps act as a stimulant both to the skin and the stomach in tolerably healthy patients; but Dr. Yeo makes some judicious remarks on their effects on those who are debilitated and exhausted, and the advantages resulting from leaving off the prescribed cold bath, and glass or glasses of cold water. The last chapter contains a capital account of the Fauna and Flora of St. Moritz and Tarasp, the latter embracing between 300 and 400 plants, arranged according to their natural orders.

Reactions-Schema für die qualitative Analyse, zum Gebrauche im chemischen Laboratorium zu Berlin. (Berlin, 1870. Verlag von August Hirschwald. London: Williams and Norgate.)

THIS is a kind of pictorial analytical table in which the characters of the precipitates obtained are indicated by coloured oblong spaces, which will, doubtless, be found very useful for impressing the appearances of the different precipitates on the mind of the student. The borax bead obtained with a compound of cobalt is represented by a blue oval, and the effect of ammonia on red litmus paper is shown by an oblong half red and half blue. The changes of colour produced by the action of sulphuretted hydrogen on a salt of mercury are indicated by an oblong of four different colours, white, yellow, orange, and black.

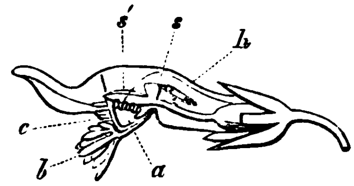
It is unfortunate that this table is not more complete; thus no means of obtaining the solution to be treated is mentioned; the destruction of organic matter before precipitation by ammonia and ammonia sulphide is omitted; the possibility of the precipitate in the third group containing phosphates, and the mode of examining it under such circumstances, is passed over entirely. The spectra of potassium, sodium, and lithium, are indicated by black lines with fine transverse white ones, representing the coloured bands, but unfortunately no means are given to show which is the more refrangible end of the spectrum. Besides these omissions there are some misprints which will no doubt be corrected in a subsequent edition.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his Correspondents. No notice is taken of anonymous communications.]

Fertilisation of Polygala

HAS the method of fertilisation of the milkwort, *Polygala vulgaris*, yet been described? It presents one of the most beautiful contrivances with which I have hitherto met for securing a cross through the agency of insects. The corolla consists of five petals united into one piece and folded into the form of a two-lipped tube, the upper lip of which is formed by the over-lapping edges of the corolla; while the lower lip is a somewhat cup-shaped appendage (*c*), furnished with a "beard" of gland-like bodies (*b*), and opening in front by a narrow, vertical slit. The filaments of the stamens are united throughout the greater part of their length with the corolla, but expand within the cup of the lower lip into a two-lobed membrane, crowned by the anthers (*a*). The pistil has two stigmas, one of which (*s*) is placed at right angles to the upper side of the style and is perfect, while the other (*s'*) is transformed into a spoon-shaped, petaloid prolongation of the pistil, reaching to the opening of the lower lip of the corolla, and dividing the interior of the flower into two chambers, in the lower of which are the stamens, thus completely separated from the true stigma. The entrance to the flower, below the style and in front of the stamens, is closed by hairs pointing outwards from the flower and meeting in front, on the mouse-trap principle; but a narrow passage is left open above the petaloid stigma, and is perhaps capable of a slight distension from the flexibility of the overlapping petals. On each side of the interior of the tube of the corolla, above the style and just behind the true stigma, is a group of strong, white hairs (*h*), pointing down the tube of the corolla, and meeting above the style. If we now suppose a small insect to light upon the "beard" of the flower, it is prevented from immediate entrance by the projecting hairs, but soon finds the narrow passage leading over the stigma into the upper chamber. It is prevented by the hairs in the tube of the corolla from returning by the same path, and is obliged to crawl out through the lower chamber and over the stamens; pollen from which it will, by a repetition of the same process, convey to the stigma of the flower next visited.



In the bud the anthers are in contact with the stigma, and some caution is necessary in dissecting that they may not be crushed, giving the appearance of the pollen having been deposited *en masse* on the spoon-shaped stigma. Naturally, I believe, the pollen is never shed till after the complete expansion of the flower.

I have never actually observed any insect either in the flower or sucking nectar from it, but I have almost invariably found a few small black flies upon the bunches that I have brought in for examination.

The broad and conspicuous "wings" of the calyx having fulfilled their office of "tempting insects to their food," gradually assume the green colour of the ordinary leaves, and closing over the ripening capsule, serve probably to conceal and protect it from the attacks of some enemy.

Kilderry, Co. Donegal W. E. HART

P.S.—I have to record a similar phenomenon with respect to the holly berries of this neighbourhood to that mentioned by Mr. Henry Reeks (NATURE, June 9). I did not remark that any varieties in particular had been rejected; but few that bore fruit (of which there was a much greater quantity than usual) appeared to have lost any of it, so late as the end of May. And yet we had not fewer of the migratory thrushes than in former years, when the holly bushes were generally stripped of their berries before the end of January; and, on the other hand, we had several days of frost, extraordinarily hard for this neighbourhood. On what arguments does Mr. Reeks ground his presumption, so different from Mr. Darwin's own conclusions on the subject, that "berries obnoxious to birds will stand a better chance of propagating and increasing that variety?" If C. W. W. (NATURE, July 7) will turn to Letter 55 of White's "Selborne" he will find the following observation on the House Martin:—"The young of this species do not quit their abodes all together, but the more forward birds get abroad some days before the rest. These approaching the eaves of buildings and playing out before them make people think that several old ones attend one nest."

Our Middle-Class Schools

I WISH to bring before your readers the necessity of immediate action with regard to a branch of education at present not liable to legislative interference. Government is becoming more and more alive to the fact that Education and Science at the present are England's greatest needs; hence the steps taken to extend and enforce primary education. But whilst increased facilities are being afforded to raise the standard of primary education, secondary education is at a stand-still, and upon the whole falls far short of the point it should reach. Thousands of our middle-class schools when compared with what is required, may be placed in the same category as the old dame's school when compared with the modern national school. It requires but the slightest knowledge of the subject to know that our middle-class educational system is as a whole a mere farce, and yet so averse are we to change, that matters are allowed to go on year after year in the same old matter-of-course style without the slightest indication of reform. In order to encroach upon your space as little as possible, I will in a succinct and concise form lay before your readers a scheme which has been lately mooted, which has received the sanction of the highest authorities in these matters, and which is destined ultimately to bring about quite a new system. In speaking thus indiscriminately of our middle-class schools, I do not include many excellent institutions, in which a thorough course of training forms the routine, and which are conducted by gentlemen capable and willing to do the work required. Alas that there should be so few!

Then 1st. It is well known that individual influence is of little service. This fact supports the theory that an association must be formed, consisting of the principals and assistants of middle-class schools, and others interested in the question.

2nd. This society should have certain objects, and its members combined should use their utmost endeavours to assist in carrying out these objects. A few of the aims would be as follows:—

α. The institution of normal colleges for the training of gentlemen who wish to enter the scholastic profession.

β. To recognise some examination, diploma, &c., as sufficient guarantee of the capabilities of gentlemen entering the profession, and insist that such gentlemen shall have this diploma. The evils arising from the incapability of so many of our masters cannot be over-estimated.

γ. The necessity of Government or other central supervision and examination of *every* school. At the present moment the standard of a school is calculated by *nothing*. An advertisement perhaps appears, stating that *all* boys sent to special examinations have passed; and instances are known where *one* boy has been sent up to such examination. It is impossible to decide upon the general tone of a school by the examination of a *few* of the best boys.

δ. The institution of a club-house in London where appointments could be made, business transacted, &c., and attached to it some means by which the incubus of agents could be avoided.

ε. Periodical meetings, &c., &c.

I am afraid this letter is running to an inordinate length, but I just wish to add that invitations have been issued by the editor of the *Quarterly Journal of Education* to a few representative gentlemen for a private preliminary meeting to be held in September next, when the above scheme is to be discussed. Any gentleman wishing to take part in that meeting should address the editor upon the subject. I might have referred to the failure of the College of Preceptors to do the least good. What we must have is an obligatory examination of the whole school, and every school; not leaving it to the whim of the principals. Neither are assistant masters treated as they should be by the College of Preceptors.

X

The Source of Solar Energy

MR. GREG ascribes to me views I do not hold, and then employs my own reasoning to overthrow them. He must have formed his conceptions of my theories from Prof. Pritchard's critique of my "Other Worlds"—a most unreliable source.

To begin with,—I do *not* believe that the solar heat supply is solely derived from the downfall of meteors. I have impressed this very clearly at p. 54 of my "Other Worlds."

I do not believe that *any part whatever* of the solar heat supply is derived from meteoric *percussion*, nor that any meteor ever comes within tens of thousands of miles of the sun's surface in the solid state.

Mr. Greg is very careful to show me that the meteor-systems encountered by the earth cannot fall into the sun. I dwell on this very fact at p. 203 of "Other Worlds"—I say, *totidem verbis*, that no known meteoric system can form a hail of meteors upon the sun. "It is forgotten," says Mr. Greg, "that the meteors themselves revolve round the sun," &c. If *he* has at any time forgotten this, I certainly have not.

"Has it ever been proved," he asks me, "that the entire mass of meteors constituting the zodiacal light, is either composed of matter in a solid state, or, if it were, that its mass would be equal to that of our own earth?" I answer, as Mr. Greg would—"No, it has not been proved, nor is it by any means probable."

There is nothing new to me in Mr. Greg's letter, and little which I have not described myself long ago in the *Intellectual Observer and Student* of 1867, 1868, and 1869. To suppose that I should venture to treat at all of meteoric astronomy, in ignorance of such elementary facts—the very A B C of the science—is not complimentary. Mr. Greg might, at least, have examined what I have written before assigning to me the absurdities he attacks so successfully.

The fact is, this matter of the solar energy only comes in *par parenthèse* in my "Other Worlds." I express no confident opinion whatever about it. I point to some deductions from known facts, and respecting *them* express a certain feeling of confidence. It is not my fault (nor, indeed, can I blame Mr. Greg) if Prof. Pritchard has tacked my words "I am certain" (used with reference to reliable inferences) to a theory respecting which I have distinctly written, that "I should not care positively to assert" its truth. Even that theory is not the absurd one attacked (very properly) by Mr. Greg.

For the rest, most of Mr. Greg's letter is sufficiently accurate, but there are two mistakes in it.

1. We have abundant evidence that the density of the aggregation of cometic perihelia increases rapidly near the sun. For example, whereas between limits of distance 40,000,000 and 60,000,000 miles from the sun this density is represented by the number 1·06, it is represented by the number 1·67 for limits 20,000,000 and 40,000,000 miles, and by the number 8·65 within the distance 20,000,000 miles. The evidence derived from this observed increase of aggregation is not affected by what we know of those cometic or meteoric systems whose orbits nearly intersect the earth's (for they must form but the minutest fraction of the total number) nor by the observed minimum perihelion distance of cometic orbits (for observed comets are but the minutest fraction of the total number).

2. It makes no difference whatever as regards the force-supply of the solar system, whether the substance of a meteor reaches the sun in the solid, fluid, or vaporous state. Given that the substance of a meteor, moving at one time with a certain velocity at a certain distance from the sun, is at another time (after whatever processes) brought to rest upon or within the sun's substance, then either the "force-equivalent" of its motion has been already distributed or the substance of the meteor is in a condition to distribute that "force-equivalent" mediately or directly. In other words, either heat and light have been already distributed, or the central energy has been recruited to the full extent corresponding to the mass, motion, and original distance of the meteor.

I may express here my agreement with the opinion of the Editor of NATURE that the observations made on the zodiacal light by Lieut. Jones and M. Liais ought to be taken into account in any theory of that mysterious object. Taken in conjunction with the other known phenomena of the zodiacal light, they admit of but one interpretation as to the position, dimensions, and general characteristics of the object. Taken alone, we might infer from them that the zodiacal light is a ring of bodies or vapours travelling around the earth (at a considerable distance);

other phenomena suggest that the zodiacal light is a disc of bodies or vapours travelling around the sun; yet others suggest that the zodiacal light is a phenomenon of our own atmosphere. But the only theory which accounts at once for *all* observed phenomena, is that which regards the zodiacal light as simply due to the continual presence in the sun's neighbourhood of bodies or vapours (meteoric or cometic, or both) which come there from very far beyond the earth's orbit, and pass away again on their eccentric orbits. A disc thus formed of continually varying constituents would shift in position, and would wax and wane in extent as well as splendour, precisely as the zodiacal light is observed to do.

RICHARD A. PROCTOR

Spontaneous Generation

THE physical capacity of fungus-spores to throw out mycelium, and from that to be able to reproduce a parent (or, according to Dr. Bastian, to produce a fungus *de novo*), shows a complicated organisation greatly above that of the monad. From a careful examination of Dr. Bastian's experiments and figures, I am led to believe that the majority of the ovoid bodies referred by him to fungus-spores are nothing of the kind, and that if they really belong to the vegetable kingdom at all, they are perfect unicellular plants in themselves reproducing their kind by subdivision; the presumed *mycelium* I should refer to the bursting of the cell-walls, and consequent discharge of the contents, a by no means uncommon occurrence with unicellular organisms. It is, however, impossible to follow the author in his speculations regarding these bodies, as his measurements are so imperfect, and in several instances, where most wanted, omitted altogether. A few of the bodies certainly bear an external appearance to fungus-spores (for instance C, Fig. 11, which might be referred to *Russula* or *Scleroderma*), but as no size is given it is impossible to form an opinion. Perhaps Dr. Bastian will say on what data he refers such objects as are shown on Fig. 3, to fungus-spores, and by what characters he knows the mycelial filaments to be such: the "half-grown" spore (?) described on page 197 has most extraordinary characters for such an object; for, says the author, "the nuclear particle within was seen moving from end to end of the cell."

Had not Dr. Bastian distinctly affirmed that the spores were generated at once from heterogenous materials, I should have assumed his belief in the presence of the perfect plants in the infusions, though the detached spores were all he met with in his experiments; for if any organism originates independently of a parent similar to itself, surely it is reasonable to expect the production to be at once perfect, and not in the egg state. Could an oviparous animal be produced from heterogenous materials, surely one would not expect eggs first to appear. In referring these unicellular bodies to spores, Dr. Bastian appears to me to have defeated the very object he had in view.

That some of the bodies figured are *bona fide* spores of fungi seems very probable, and that they were produced by ordinary parents, seems equally so, for the slight neck-like elongation or spot, which is analogous with the placental scar in animals and flowering plants, is clearly present in the lower right-hand object (Fig. 11) and the lower left-hand object (Fig. 13). If these things were evolved without parents, surely nature would not have given them an umbilicus; it is far more reasonable to suppose that true spores got into the infusions (and perhaps germinated) by some accident similar to the three recorded instances where foreign bodies were undoubtedly found. (Note, p. 197.)

It seems to me rational enough to suppose that unicellular bodies and objects of the lowest possible organisation may be heterogenously produced from the inorganic world, for here the line between one and the other is so fine as scarcely, if at all, to be perceived; indeed, the Brownian motion of monads, some spermatozoids, and the particles forming many inorganic infusions, are scarcely, if at all, to be distinguished from each other. From monads and unicellular organisms, however, spore-producing fungi are greatly removed, and the economy, functions, and structure of most of the latter are now so well known, that it would be simply impossible to convince any botanist that a spore like C (Fig. 11) could be produced from any other quarter than the hymenium of a well-defined parent.

I cannot see that the production of motile zoospores in Achlya (p. 174) has any bearing on the subject, as here we have an already *living* parent; and motile zoospores are by no means uncommon in the vegetable kingdom; their movements, however, so far as I have been able to observe them, do not differ from the Brownian movements seen in the inorganic world.

It is clear that no definite conclusions can be arrived at regarding these bodies and their production till a series of accurate figures is published to an *uniform scale* (with an indication of the colour of the cells, &c.), enlarged at least 2,000 diameters, for even then a monad would be no larger than a pin's-head. It will then be possible to compare the bodies with actual fungus-spores and other bodies well known to botanists and zoologists.

Prof. Wanklyn appears to be unable to estimate the number of germs of fungi known to exist in the atmosphere. That "there must be very many of them" is apparent from the calculation that, if each spore of one species only of one of the higher fungi germinated and reproduced its parent, the children would, in the first generation and in the course of a very few days, form a carpet all over the earth. Now, as fungi abound everywhere in myriads, and the family is almost illimitable, the number of diffused germs is evidently beyond all calculation; their size, too, is often so small that twenty could be conveniently accommodated on the diameter of a single human blood corpuscle. That they are alive is proved by the readiness with which, under favourable conditions, they may be made to germinate. It must also be admitted, in Prof. Wanklyn's favour, that "they must weigh something," though I am not aware of any attempt in that direction at present. Some of their "remarkably small" component parts are, however, made manifest by chemical reaction.

WORTHINGTON G. SMITH

Mildmay Park, London

Super-Saturation

THE following experiments may be found interesting from their bearing on the latest theories advanced on the subjects of super-saturation and the so-called inactive state of bodies. Professor Tomlinson's theory is that a super-saturated solution adheres as a whole to a chemically clean surface, but that a differential adhesion takes place in presence of a chemically unclean surface, because the salt or gas adheres to such a surface while the liquid does not; the former is consequently liberated. The presence or absence of grease is then stated to constitute chemical uncleanness or cleanness. If a greasy surface can be rendered inactive, it is clear that both these propositions cannot be true; either grease is not of itself a cause of uncleanness, or unclean surfaces are not necessarily active ones. The following experiments prove that the fats may be rendered inactive by the same processes which are applied to rods of glass or metal.

1. A bit of composite candle was melted with a very little alcohol; a glass rod was dipped in, allowed to cool, passed through flame of a Bunsen's burner, and a drop of melted fat deposited on surface of supersaturated solution of zincic sulphate. The fat solidified without affecting the solution even on prolonged agitation. A crystal of the salt caused instant solidification.

2. Some solution boiled remained supersaturated for a fortnight with a crust of fat on the top.

3. Ordinary tallow treated as No. 1. Inactive in solution of sodic sulphate solution; touched with finger, crystallised at once.

4. Lard cleaned simply by melting on rod passed through flame, allowed to cool, stirred in solution of sodic sulphate. Inactive. Other end of rod active at once.

5. Same solution boiled; cooled, stirred with rod, treated as the last, and left exposed to the air for 15 minutes. Did not crystallise. This experiment is interesting, as showing that greasy substances are not specially liable to be made active by exposure to ordinary air.

6. Some tallow was melted in a test-tube without precautions of any kind, and while melted was poured to the depth of half an inch on to solutions of ferrous, cupric, and sodic sulphates. In each case it was inactive. This is conclusive on the point in question.

Theoretical objections have been urged against the definition of chemical uncleanness, and I think this might now be surrendered.

Professor Tomlinson may very likely be right in looking to adhesion for an explanation of these phenomena; at all events, far greater probability seems to attach to this view than to that put forth by M. Gernez, adopted by Jamin, and even, I believe, favourably noticed by the Academy itself; which is that only a crystal of the same salt can induce crystallisation. This latter view is open to the theoretical objection that it necessitates our believing that all salts capable of supersaturation are everywhere and at all times present in the atmosphere. Mr. Tomlinson has shown experimentally that a crystal of the salt properly treated can be inactive in a solution of sodic sulphate.*

The following experiments show that an atmosphere presumably saturated with the salt may be inactive without any precautions whatever:—

7. Three solutions of sodic sulphate were prepared; a glass rod was dipped in melted tallow and left to cool for five minutes in a bottle of the salt, without touching the salt or the sides of the bottle. Then the three solutions were successively touched with the rod; inactive in all. Rod replaced in the bottle for ten more minutes; then all three again touched. The third crystallised after a minute or two. Rod replaced for fifteen minutes; active only in the second; replaced for fifteen minutes, active in the last. Thus this greasy rod was inactive in one of the solutions after an exposure of thirty minutes, and after being six times dipped in solutions of the salt.

8. An open test tube, containing a strong solution of sodic sulphate, remained supersaturated for a week suspended in the same large bottle of the salt. The bottle was frequently moved without producing any effect. On removing the cork, the solution crystallised instantly.

On the whole I am afraid we must for the present fall back upon that refuge for the destitute, "Catalytic action."

Birmingham J. G. GRENFELL

Derivation of the Term "Horse-Chestnut"

THE explanation of the above name by Mr. E. A. Connell in your last issue, though ingenious, is not, I think, the true one. In a work entitled "Etymons of English Words," by John Thomson, Edinburgh, 1826, the term is explained thus:—"Horse-Chestnut. The *harsh*-chestnut; but the F. and the Swedes have translated it as *horse*." Following this he gives in support of *horse*, being the corruption of harsh, horse-faced, *harsh*-faced, *hard*-featured, horse-radish, *harsh*-radish;" and *harsh*, *rough*, *sour*, austere, grating, S. *hærsk*, T. *harsch*, D. *harsk*. So that, accepting this explanation, harsh-chestnut is the more scientific term. J. JEREMIAH

Trehelig, Llangadock, Carmarthenshire, July 16

Ozone and Thunderstorms

IN reference to the production of ozone it may interest your readers to know that the quantity developed here has been unusually great during the last few days. On Sunday evening, during the electrical agitation that occurred and ended in a slight discharge, accompanied by heavy rain, we had the highest reading. Mr. Burrows' test paper registered 9, and was almost black. This observation was taken at 10 A.M. During the period of this development the air was very moist. Last evening and this morning have caused the ozonometer to register 7, and this is above the average. To-day, Tuesday, the hygrometer indicated the point of saturation. I may add that old Gilbert White's remark as to activity of swifts during thundery weather has been greatly confirmed. They have kept up an almost incessant screaming during the last few days.

Great Malvern, August 2 SAMUEL BARBER

The Sun's Corona

A LETTER of mine, addressed to you a fortnight since, has, I fear, miscarried. It had special claim to admission as complaining of an editorial remark.

I now renew my objection to the editorial note upon my letter referring to Professor Pritchard's critique on my "Other Worlds." As an uncourteous comment upon a passage in which I had paid a high but not undeserved compliment to Mr. Lockyer, I had just reason to be surprised at its appearance.

First, because my account of Mr. Lockyer's views respecting the corona agrees in all essential points with that given in the note, whereas the contrary is implied.

Secondly, because I have not mis-stated Dr. Gould's evidence, though forced to interpret it otherwise than he does.

Thirdly, because my whole reasoning on the corona has been founded on evidence, and is therefore unjustly described in the note as "evolved from the depths of my moral consciousness" (an old witticism, which, however, would have borne repeating had it been to the point.) *

To the personalities in the note, as to the reference to my age, and so on, I make no objection whatever, caring only to notice what seems worthy of notice.

Let me add, however, my protest against a mode of speaking which implies that observers only are to be considered as astronomical *workers*. Not on my own account, but on behalf of a long list of honoured names, I oppose the assumption that the careful study of observations (whether those observations have been made by others or not) is not to be regarded as work. If observers claim with pride such names as Herelius, Galileo, Tycho Brahe, Bradley, and many more, the advocates of thoughtful theorising may point no less confidently to Copernicus, to Kepler, and to Newton, and in our own times to Adams and Leverrier. Those who, like the Herschels, have been able to work successfully in both ways, are few indeed in number.

Observations will never be so little useful as when the attempt to utilise them is discouraged.

RICHARD A. PROCTOR

P.S.—Mr. Lockyer seems not to be aware that what he claims to have proved respecting the corona is accepted by me as proved, and forms an essential part of my theory. I am as well satisfied as he can be (and on the same grounds) that the corona is not a solar atmosphere.

VON GRAEFE

SPEAKING of the loss of Von Graefe, whose death, at the age of forty-one, we reported last week, the *Revue des Cours Scientifiques* remarks that Germany has sustained a loss equal at least to the loss of a battle. Von Graefe's death was the sequel of a long consumption, during which he neither diminished his work nor took ordinary precautions. His grand discovery of the cure for Glaucoma was made when he was only twenty-six years old. The *British Medical Journal* thus sums up his professional worth:—

> In him the world loses its foremost opthalmologist, one whose brilliant originality was equalled only by his steady industry. Not only was Graefe great in the practice of his profession, but as a teacher his influence was almost unbounded. Although comparatively young himself, he had taught almost all the present school of ophthalmic surgeons. His introduction of iridectomy was, without doubt, the greatest step in the operative surgery of the eye since the introduction of operations for the cure of cataract. Probably, there are now living some thousands in the possession of sight, who but for him would have been in darkness. It is one of those gains which is complete in itself, permanent, and beyond the reach of scepticism. It is priceless. Graefe was an untiring observer, and never allowed his pressing engagements to interfere with the record of his vast experience for the good of others. Although he had done a vast amount of other work, still, however, his discovery of iridectomy shines with such pre-eminent lustre that the inscription,
>
> "HE CURED GLAUCOMA,"
>
> would be by no means inappropriate. As a man, Graefe was everything that is admirable, and secured the love of all who knew him. He was open, generous, unostentatious, eager both to give and receive knowledge. His personal appearance was as remarkable as the qualities of his mind. The *Wiener Medizen Wochenschrift*, in announcing Graefe's death, says: "German science loses in him one of her greatest celebrities, and suffering humanity one of its greatest benefactors. With Graefe, a combination of geniality, erudition, self-devotion, energy, and amiability, such as is rarely found in one man, has descended into the grave. His name will ever remain most prominently connected with the history of ophthalmic surgery."

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* It would seem from the experiments of Dr. L. C. de Coppet (which do not appear to be as well known as they deserve) that the treatment adopted by Mr. Tomlinson for rendering the sodic sulphate inactive really changes the salt. Dr. de Coppet finds that a supersaturated solution of sodic sulphate may be prepared by dissolving the anhydrous salt in cold water; and he writes—"I have arrived at the conclusion that the anhydrous sodic sulphate obtained by the efflorescence of the crystals with ten molecules of water, undergo a change of constitution when heated to temperatures superior to 33° or 34°; for the contact of a particle of the effloresced sulphate always causes the crystallisation of a supersaturated solution of this salt, whereas anhydrous sodic sulphate heated above 33° does not necessarily determine the crystallisation."—Bull. Soc. Vaud. Sc. Nat. X., p. 151.

[These experiments render it probable that the so-called supersaturated solutions really contain the anhydrous salt in a state of unstable equilibrium, only requiring a disturbance to cause it to assimilate water, and thus produce a less soluble compound.—ED.]

* Still holding to our comments we gladly state that they were not written in the spirit in which Mr. Proctor has read them. He is known to all as an astronomical worker, and our objection to his mathematical result was that it was based upon data among which the principal point at issue was accepted as proved.—ED.

*THE CONTINUITY OF THE GASEOUS AND LIQUID STATES OF MATTER**

IT may be truly affirmed of Physical Science, that its history, for some generations at least, has been one of rapid progress and unceasing change, and that its most earnest promoters have not claimed infallibility for their opinions, nor finality for their results. Its advancing progress has been marked by eras when some long-accepted theory or hypothesis, which had appeared so closely in accordance with all known experiments and observations as to have been received as an obvious truth, has, by further experiments extending into regions previously unexplored, been found to be a faulty or incomplete representation of the phenomena.

Such an era has occurred in the discovery recently announced by Dr. Andrews of the Continuity of the Gaseous and Liquid States of Matter.

We have all been accustomed to consider matter as existing in one or other of three states,—the solid, liquid, and gaseous.

Fig 1.

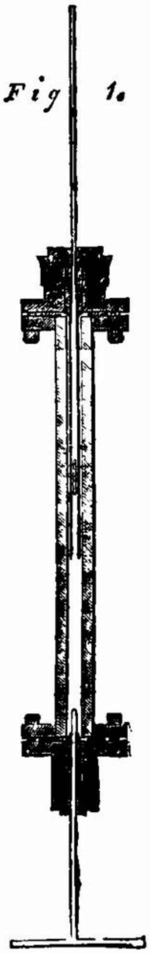
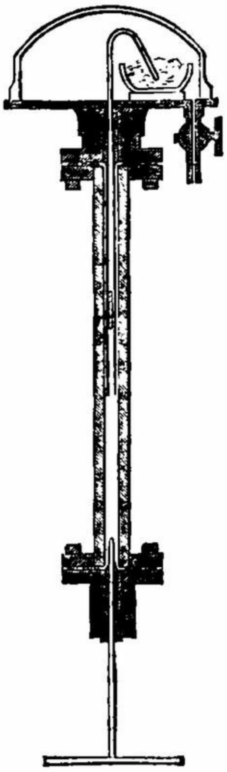


Fig. 2.



The transition, from any one of these states to another, has hitherto been regarded as necessarily abrupt ; at least, if we except the imperfectly understood conditions of softening or plasticity, assumed by such bodies as glass or iron, when gradually passing from the solid to the molten condition. The true state of the case is now found to be very different.

The memoir of Dr. Andrews, of which we propose to give an account in this article, opens with the following historical *résumé* of previous researches bearing more or less in the direction of his investigations :—"In 1822 M. Cagniard de la Tour observed that certain liquids, such as ether, alcohol, and water, when heated in hermetically sealed glass tubes, became apparently reduced to vapour in a space from twice to four times the original volume of the liquid. He also made a few numerical determinations of the pressures exerted in these experiments. In the following year Faraday succeeded in liquefying, by the aid of pressure alone, chlorine and several other bodies known before only in the gaseous form. A few years later Thilorier obtained solid carbonic acid, and observed that the coefficient of expansion of the liquid for heat is greater than that of any aëriform body. A second memoir by Faraday, published in 1845, greatly extended our knowledge of the effects of cold and pressure on gases. Regnault has examined with care the absolute change of volume in a few gases when exposed to a pressure of twenty atmospheres, and Pouillet has made some observations on the same subject. The experiments of Natterer have carried this inquiry to the enormous pressure of 2,790 atmospheres ; and although his method is not altogether free from objection, the results he obtained are valuable, and deserve more attention than they have hitherto received."

Fig. 3.

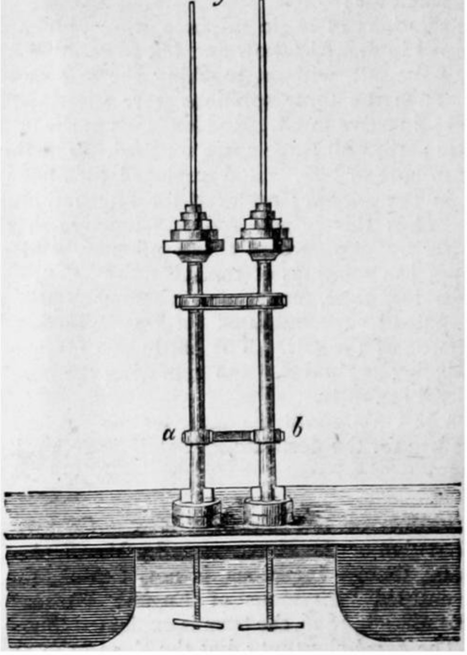
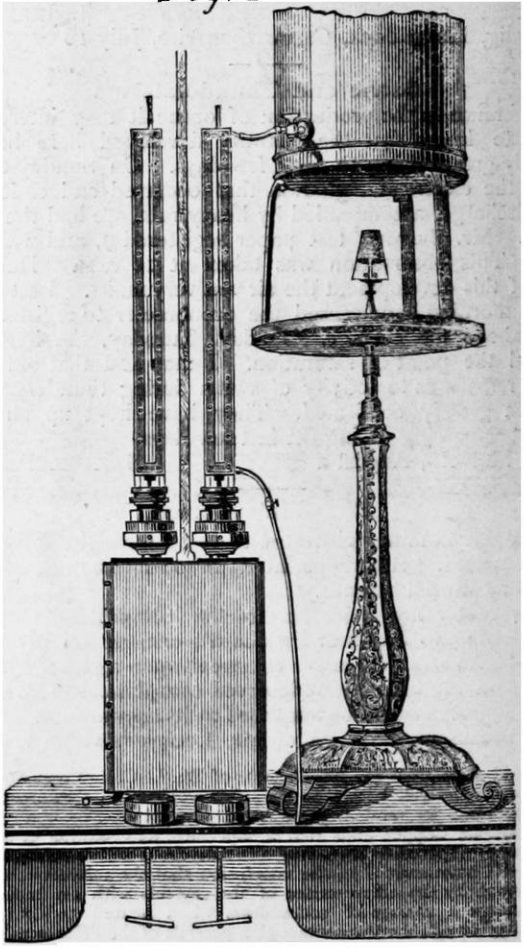


Fig. 4



In 1861 a brief notice appeared of some early experiments by Dr. Andrews in this direction. Oxygen, hydrogen, nitrogen,

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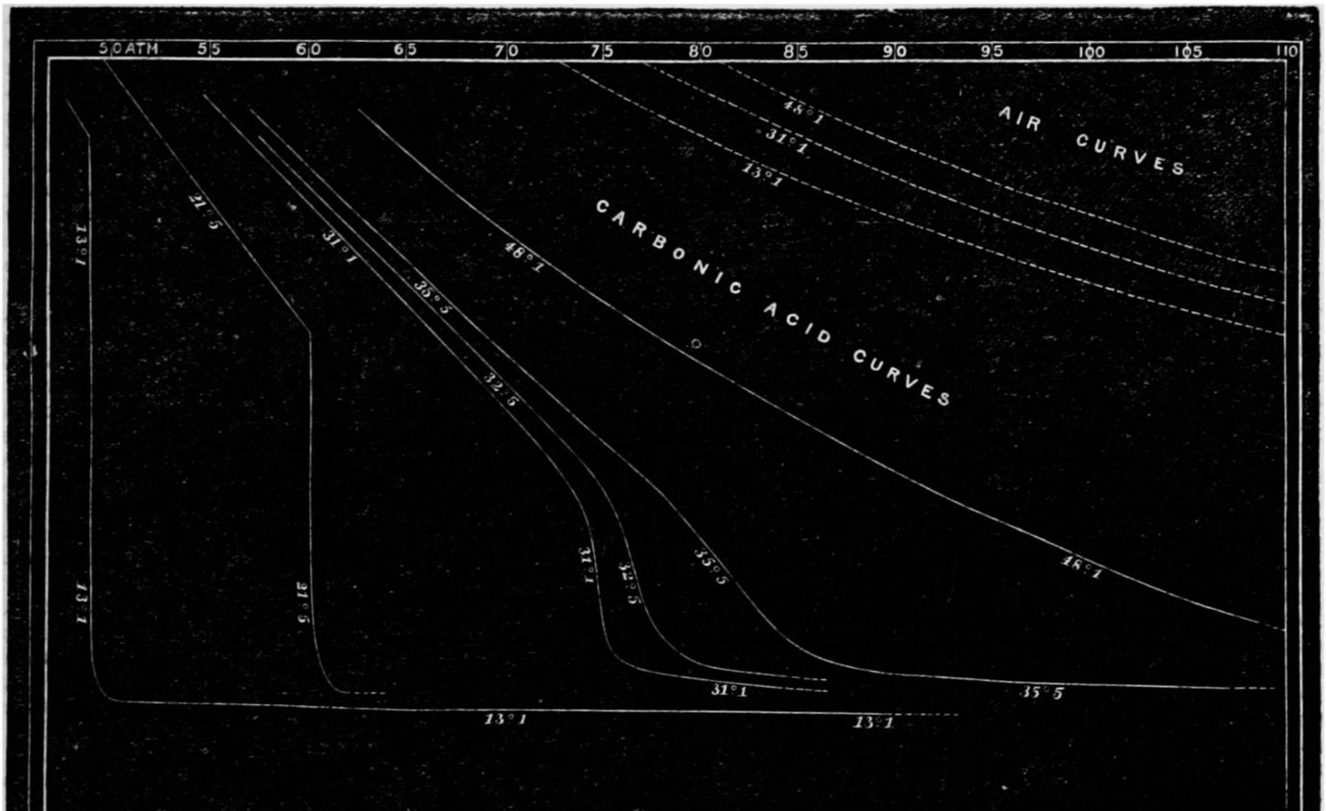
*"The Bakerian Lecture for 1869." By Thomas Andrews, M.D., F.R.S. (Abridged from an Original Essay of Professor James Thomson, LL.D.)

carbonic oxide, and nitric oxide were submitted to greater pressures than had previously been attained in glass tubes, and while under these pressures they were exposed to the cold of the carbonic acid and ether bath. None of these gases exhibited any appearance of liquefaction, although reduced to less than $\frac{1}{500}$ of their ordinary volume by the combined action of cold and pressure. Subsequently, in the third edition of Miller's "Chemical Physics," published in 1863, a short account, communicated by Dr. Andrews, appeared of some further results he had obtained, under certain fixed conditions of pressure and temperature, with carbonic acid. These results constitute the foundation of the researches which form the general subject of the present article, and the following extract from the original communication of Dr. Andrews to Dr. Miller may here be quoted:—"On partially liquefying carbonic acid by pressure alone, and gradually raising at the same time the temperature to 88° Fahr., the surface of demarcation between the liquid and the gas became fainter, lost its curvature, and at last disappeared. The space was then occupied by a homogeneous fluid, which exhibited, when the pressure was suddenly diminished or the temperature slightly lowered, a peculiar appearance of moving or flickering striæ throughout its entire mass. At temperatures above 88°, no apparent liquefaction of carbonic acid or separation into two distinct forms of matter could be effected, even when a pressure of 300 or 400 atmospheres was applied. Nitrous oxide gave analogous results."



For his recent researches Dr. Andrews again selected carbonic acid as the substance for investigation. He devised for his experiments an apparatus, novel in construction, and well suited to exhibit the properties acquired by fluids under very varied conditions of pressure and temperature. The carbonic acid was contained in a glass tube, capillary in the upper and larger part of its length, and for the remainder, of the widest bore in which a column of mercury would remain without displacement when the tube was placed in a vertical position. A movable column or bar of mercury confined the gas to be operated on. This glass tube was secured by careful packing in massive end-piece of brass, which carried a flange, by means of which a water-tight junction could be made with a corresponding flange, attached to a cold-drawn copper tube of great strength. To the other end of the copper tube a similar end-piece was firmly bolted. The latter carried a fine steel screw, 7 inches long, which was packed with such care that the packing was capable of resisting a pressure of 400 atmospheres or more. A section, exhibiting all the details, is given in Fig. 1. Before commencing an experiment the body of the apparatus was filled with water; the upper end-piece, carrying the glass tube, in which was the gas to be operated on, was firmly secured in its place, and the pressure was obtained by screwing the steel screw into the water chamber. In Fig. 2 the same apparatus is shown with the modifications required when the gas or liquid is exposed to very low temperatures under high pressure. The end of the capillary tube dips into a bath of ether and solid carbonic acid, under a bell jar, from which the air may be exhausted.

In order to estimate the pressure exerted in these experiments, a duplex or compound form of the apparatus was employed, as shown in Fig. 3. The two sides of the apparatus freely communicate through *a b*, so that on turning either of the steel screws the pressure is immediately transmitted through the entire apparatus. In the second tube known volume of air is confined, and the pressure is approximately estimated by its contraction.

Figure 4 exhibits the complete apparatus with the arrangements for maintaining the capillary tubes and the body of the apparatus itself at fixed temperatures. A rectangular brass case, closed before and behind with plate glass, surrounds each capillary tube, and allows it to be maintained at any required temperature by the flow of a stream of water. In the figure, the arrangement for obtaining a current of heated water in the case of the carbonic-acid tube is shown. The body of the apparatus itself, as is shown in the figure, is enclosed in an external vessel of copper, which is filled with water at the temperature of the apartment. This latter arrangement is essential when accurate observations are made.

The temperature of the water surrounding the air-tube was made to coincide, as closely as possible, with that of the apartment, while the temperature of the water surrounding the carbonic-acid tube varied in different experiments from 13° C. to 48° C. In the experiments as they were performed, the mercury did not come into view in the capillary part of the air-tube till the pressure amounted to about forty atmospheres. The volumes of the air and of the carbonic acid were carefully read by a cathetometer, and the results could be relied on with certainty to less than 1-20 of a millimetre or 1-500 of an inch. We must refer the reader to the original memoir for an account of the details of the experiments, and of the numerous precautions adopted to secure accuracy. The object of the present article is to place as clearly as possible before his mind the main results arrived at, and the general features of the apparatus employed.

In the above diagram, we have a graphical representation of the results of a large number of comparative experiments on air and carbonic acid, under pressures ranging from 48 to 107 atmospheres, and at temperatures for the carbonic acid varying from 13°·1 C. to 48°·1 C. The dotted lines (*Air Curves*) represent a portion of the curves of a perfect gas (assumed to have the same volume originally at 0° C., and under one atmosphere as the carbonic acid), for the temperatures of 13°·1 C., 31°·1 C., and 48°·1 C. The lines designated *Carbonic Acid Curves* show the volumes to which the carbonic acid is reduced at the temperatures marked on each curve, and under the approximate pressures indicated by the numbers at the top and bottom of the figure. Ordinates drawn from the inner horizontal line at the lower part of the figure to meet the curves, will represent the volume of the carbonic acid. These ordinates do not always refer to homogeneous matter, but sometimes to a mixture of gas and liquid.

It will be observed that in the curves for 13°·1 C. there occurs an abrupt, or almost quite abrupt, fall, when a pressure of about 49 atmospheres has been attained. The curve for 21°·5 C. exhibits a corresponding fall, but not till a higher pressure (about 60 atmospheres) has been reached. On close inspection of the figure, a slight deviation from perfect abruptness will be observed in the portion of the curves representing these falls, which Dr. Andrews showed to be due to a trace of air (about $\frac{1}{500}$ part) in the carbonic acid with which the experiments were made. Had the carbonic acid been absolutely pure, there can be no doubt that the fall would have been quite abrupt.

In the curve for 31°·1 C. there is no abrupt fall; but a rapid descent, indicating a corresponding diminution of volume, occurs between the pressures of 73 and 75 atmospheres. As the temperature rises this descent becomes gradually less marked, and when a temperature of 48°·1 C. has been attained, it has almost, if not altogether, disappeared.

At any temperature between – 57°C., and 30°·92 C., carbonic acid, under the ordinary pressure of the atmosphere, is unquestionably in the state of a gas or vapour. If within these limits we take a given volume of carbonic acid, and gradually augment the pressure, the volume will steadily diminish, not however uniformly, but according to a more rapid rate than the law for a perfect gas, till we reach the point at which liquefaction begins. A sudden fall or diminution of volume will now take place, and with a little care it will be found easy so to arrange the experiment that part of the carbonic acid shall be in the liquid, and part of it in the gaseous state; the carbonic acid thus coexisting in two distinct physical conditions in the same tube, and under the same external pressure. But if the experiment be made at 30°·92 C., or any higher temperature, the result will be very different. At 30°·92 C., and under a pressure of about 74 atmospheres, the densities of liquid and gaseous carbonic acid, as well as all their other physical properties, become absolutely identical, and the most careful observation fails to discover any heterogeneity at this or higher temperatures in carbonic acid, when its volume is so reduced as to occupy a space in which, at lower temperatures, a mixture of gas and liquid would have been formed. In other words, all distinctions of state have disappeared, and the carbonic acid has become one homogeneous fluid, which cannot by change of pressure be separated into two distinct physical conditions. This temperature of 30°·92 is called by Dr. Andrews the *critical point* of carbonic acid. Other fluids which can be obtained in both the liquid and gaseous states have shown similar phenomena, and have each presented a critical point of temperature. The rapid changes of density which slight changes of temperature or pressure produce, when the gas is reduced at temperatures a little above the critical point, to the volume at which it might be expected to liquefy, account for the flickering movements referred to in the beginning of this article.

The general conclusions arrived at we give in the words of the original memoir. "I have frequently exposed carbonic acid," observes Dr. Andrews, "without making precise measurements, to much higher pressures than any marked in the tables, and have made it pass, without break or interruption, from what is regarded by every one as the gaseous state, to what is, in like manner, universally regarded as the liquid state. Take, for example, a given volume of carbonic acid gas at 50° C., or at a higher temperature, and expose it to increasing pressure till 150 atmospheres have been reached. In this process its volume will steadily diminish as the pressure augments, and no sudden diminution of volume, without the application of external pressure, will occur at any stage of it. When the full pressure has been applied, let the temperature be allowed to fall, till the carbonic acid has reached the ordinary temperature of the atmosphere. During the whole of this operation, no breach of continuity has occurred. It begins with a gas, and by series of gradual changes, presenting nowhere any abrupt alteration of volume or sudden evolution of heat, it ends with a liquid. The closest observation fails to discover anywhere indications of a change of condition in the carbonic acid, or evidence, at any period of the process, of part of it being in one physical state and part in another. That the gas has actually changed into a liquid would, indeed, never have been suspected, had it not shown itself to be so changed by entering into ebullition on the removal of the pressure. For convenience this process has been divided into two stages, the compression of the carbonic acid, and its subsequent cooling; but these operations might have been performed simultaneously, if care were taken so to arrange the application of the pressure and the rate of cooling that the pressure should not be less than 76 atmospheres when the carbonic acid had cooled to 31°.

"We are now prepared for the consideration of the following important question. What is the condition of carbonic acid when it passes, at temperatures above 31°, from the gaseous state down to the volume of the liquid, without giving evidence at any part of the process of liquefaction having occurred? Does it continue in the gaseous state, or does it liquefy, or have we to deal with a new condition of matter? If the experiment were made at 100°, or at a higher temperature, when all indications of a fall had disappeared, the probable answer which would be given to this question is that the gas preserves its gaseous condition during the compression; and few would hesitate to declare this statement to be true, if the pressure, as in Natterer's experiments, were applied to such gases as hydrogen or nitrogen. On the other hand, when the experiment is made with carbonic acid at temperatures a little above 31° the great fall which occurs at one period of the process would lead to the conjecture that liquefaction had actually taken place, although optical tests carefully applied failed at any time to discover the presence of a liquid in contact with a gas. But against this view it may be urged, with great force, that the fact of additional pressure being always required for a further diminution of volume, is opposed to the known laws which hold in the change of bodies from the gaseous to the liquid state. Besides, the higher the temperature at which the gas is compressed, the less the fall becomes, and at last it disappears.

"The answer to the foregoing question, according to what appears to me to be the true interpretation of the experiments already described, is to be found in the close and intimate relations which subsist between the gaseous and liquid states of matter. The ordinary gaseous and ordinary liquid states are, in short, only widely separated forms of the same condition of matter, and may be made to pass into one another by a series of gradations so gentle that the passage shall nowhere present any interruption or breach of continuity. From carbonic acid as a perfect gas to carbonic acid as a perfect liquid, the transition we have seen, may be accomplished by a continuous process, and the gas and liquid are only distant stages of a long series of continuous physical changes. Under certain conditions of temperature and pressure, carbonic acid finds itself, it is true, in what may be described as a state of instability, and suddenly passes, with the evolution of heat, and without the application of additional pressure or change of temperature, to the volume which by the continuous process can only be reached through a long and circuitous route. In the abrupt change which here occurs, a marked difference is exhibited, while the process is going on, in the optical and other physical properties of the carbonic acid which has collapsed into the smaller volume, and of the carbonic acid not yet altered. There is no difficulty here, therefore, in distinguishing between the liquid and the gas. But in other cases the distinction cannot be made; and under many of the conditions I have described it would be vain to attempt to assign carbonic acid to the liquid rather than the gaseous state. Carbonic acid, at the temperature of 35°·5, and under a pressure of 108 atmospheres, is reduced to $\frac{1}{430}$ of the volume it occupied under a pressure of one atmosphere; but if any one ask whether it is now in the gaseous or liquid state, the question does not, I believe, admit of a positive reply. Carbonic acid at 35°·5, and under 108 atmospheres of pressure, stands nearly midway between the gas and the liquid; and we have no valid grounds for assigning it to the one form of matter any more than to the other. The same observation would apply with even greater force to the state in which carbonic acid exists at higher temperatures and under greater pressures than those just mentioned. In the original experiment of Cagniard de la Tour, that distinguished physicist inferred that the liquid had disappeared, and had changed into a gas. A slight modification of the conditions of his experiment would have led him to the opposite conclusion, that what had been before a gas was changed into a liquid. These conditions are, in short, the intermediate states which matter assumes in passing, without sudden change of volume, or abrupt evolution of heat, from the ordinary liquid to the ordinary gaseous state.

"In the foregoing observations I have avoided all reference to the molecular forces brought into play in these experiments. The resistance of liquids and gases to external pressure tending to produce a diminution of volume proves the existence of an internal force of an expansive or resisting character. On the other hand, the sudden diminution of volume, without the application of additional pressure externally, which occurs when a gas is compressed, at any temperature below the critical point, to the volume at which liquefaction begins, can scarcely be explained without assuming that a molecular force of great attractive power comes here into operation, and overcomes the resistance to diminution of volume, which commonly requires the application of external force. When the passage from the gaseous to the liquid state is effected by the continuous process described in the foregoing pages, these molecular forces are so modified as to be unable at any stage of the process to overcome alone the resistance of the fluid to change of volume.

"The properties described in this communication, as exhibited by carbonic acid, are not peculiar to it, but are generally true of all bodies which can be obtained as gases and liquids. Nitrous oxide, hydrochloric acid, ammonia, sulphuric ether, and sulphuret of carbon, all exhibited, at fixed pressures and temperatures, critical points, and rapid changes of volume with flickering movements, when the temperature or pressure was changed in the neighbourhood of those points. The critical points of some of these bodies were above 100°; and in order to make the observations, it was necessary to bend the capillary tube before the commencement of the experiment, and to heat it in a bath of paraffin or oil of vitriol.

"The distinction between a gas and vapour has hitherto been founded on principles which are altogether arbitrary. Ether in the state of gas is called a vapour, while sulphurous acid in the same state is called a gas, yet they are both vapours, the one derived from a liquid boiling at 35°, the other from a liquid boiling at – 10°. The distinction is thus determined by the trivial condition of the boiling-point of the liquid, under the ordinary pressure of the atmosphere, being higher or lower than the ordinary temperature of the atmosphere. Such a distinction may have some advantages for practical reference, but it has no scientific value. The critical point of temperature affords a criterion for distinguishing a vapour from a gas, if it be considered important to maintain the distinction at all. Many of the properties of vapours depend on the gas and liquid being present in contact with one another; and this, we have seen, can only occur at temperatures below the critical point. We may accordingly define a vapour to be a gas at any temperature under its critical point. According to this definition, a vapour may, by pressure alone, be changed into a liquid, and may therefore exist in presence of its own liquid; while a gas cannot be liquefied by pressure, that is, so changed by pressure as to become a visible liquid distinguished by a surface of demarcation from the gas. If this definition be accepted, carbonic acid will be a vapour below 31°, a gas above that temperature; ether, a vapour below 200°, a gas above that temperature.

"We have seen that the gaseous and liquid states are only distant stages of the same condition of matter, and are capable of passing into one another by a process of continuous change. A problem of far greater difficulty yet remains to be solved, the possible continuity of the liquid and solid states of matter. But this must be a subject for future investigation; and for the present I will not venture to go beyond the conclusion I have already drawn from direct experiment, that the gaseous and liquid forms of matter may be transformed into one another by a series of continuous and unbroken changes."

JAMES THOMSON

NOTES

AT last a sum of money has been voted for a new Natural History Museum. In introducing the vote the Chancellor of the Exchequer said the British Museum had long been suffering from repletion, and there were no means of exhibiting the valuable articles which, from time to time, were bought for the national collection. Five years ago the trustees resolved in favour of separating the collections, and it had been determined to separate the natural history department from the books and antiquities. For the natural history collection the typical mode of exhibition had been decided on, and the building required must cover at least four acres. Even the present collection would pretty well fill a building of these dimensions, and provision must be made for further extension. The question was, where should this building be situated? and after referring to possible sites he referred to the locality which we were enabled to state some time ago had been chosen—a plot of ground 16½ acres in extent, which the trustees of the Exhibition of 1851 sold to the Government at 7,000*l.* an acre. It therefore cost 120,000*l.*, but is now worth 100,000*l.* more. The sale was coupled with the condition that any building erected upon the land must be for purposes of science and art. For seven years the land had remained waste, a sort of Potter's field, and a scandal to that part of the metropolis. The Government now proposed to place on that piece of land the museum required for the natural history collection. It would occupy four acres; there would be room for wings, and the outside estimate for the building was 350,000*l.*, not an unreasonable price, considering its extent. For the present, however, the Government merely asked for a small vote to enable them to clear the ground, and in order to take the opinion of the House. Railway communication had now made South Kensington easily accessible, and unless a more eligible, a more accessible, and a cheaper site could be suggested, he hoped the Committee would agree to the proposal. He might add that, if it were hereafter thought desirable to do so, there would be room enough on the same site for the Patent Museum, the necessity of which had been much insisted on. We trust that after the discussion which followed the introduction of the vote the scientific men will speak for themselves, and again let their wishes and opinions be heard.

THE American Association for the Advancement of Science met yesterday (Wednesday) at Troy. Professor W. Chauvenet is president for the year.

IT is gratifying to learn that some of the recommendations of the Royal Commission on Military Education, which were most inimical to the scientific instruction of the army, will not be carried out.

BY Imperial decree the *Association Scientifique de France* has been acknowledged to be an *établissement d'utilité publique.*

THE French observers are making preparations for a combined attack on the 10th of August meteors.

THE list of pensions granted during the year ended the 20th of June, 1870, and charged upon the civil list (presented pursuant to Act 1 Victoria, cap. 2, sec. 6) has been published this week. Among them we note the following:—Mr. Augustus De Morgan, 100*l.*, in consideration of his distinguished merits as a mathematician; Mrs. Charlotte J. Thompson, 40*l.*, in consideration of the labours of her late husband, Mr. Thurston Thompson, as Official Photographer to the Science and Art Department, and of his personal services to the late Prince Consort; Dame Henrietta Grace Baden Powell, 150*l.*, in consideration of the valuable services to science rendered by her husband during the 33 years he held the Savilian Professorship of Geometry and Astronomy at Oxford; Miss Margaret Catherine Ffennell, Miss Elizabeth Mark Ffennell, and Mrs.

Charlotte Carlisle, formerly Ffennell, wife of Captain Thomas Carlisle, jointly, and to the survivors or survivor of them, 30*l.*; Miss Margaret Catherine Ffennell, 10*l.*; Miss Elizabeth Mark Ffennell, 10*l.*; Mrs. Charlotte Carlisle, 10*l.*, in recognition of the labours of their father in connection with the salmon fisheries of the United Kingdom; Mrs. Jane Dargan, 100*l.*, in recognition of the services of her late husband, Mr. William Dargan, in connection with the Dublin Exhibition of 1853, and other works of public importance in Ireland; Mrs. Charlotte Christiana Sturt, 80*l.*, in consideration of the services rendered by her late husband, Captain Charles Sturt, by his geographical researches in Australia; William Henry Emmanuel Bleek, Doctor of Philosophy, 150*l.*, in recognition of his literary services, and in aid of his labours in the department of philology, especially in the study of the South African languages.

THE Radcliffe Observer, the Rev. R. Main, has recently presented his annual report to the Board of Trustees. It concludes as follows:—"An unusually large number of meridional observations have been made, and their reductions kept up to their usual stage; a Second Radcliffe Catalogue of Stars (a work of very considerable labour in its compilation) has been printed and published, in addition to a new ordinary annual volume of the Radcliffe Observations; and, notwithstanding the amount of work of an unusual character which has been performed, none of the ordinary details, either of scientific or of clerk-like work, have in any sensible degree fallen behind or been neglected. I confess that I am well satisfied with what has been accomplished (all of it, in my judgment, being of great utility), and altogether it affords a good specimen of what can be accomplished by a small staff of astronomers well skilled in the making and reducing of observations, and devoting themselves steadily and without intermission to the carrying out of a certain number of definite aims on a plan well prepared and studied beforehand."

MR. JOHN HILTON, F.R.S., late President of the Royal College of Surgeons, who for twenty years has filled the office of surgeon to the above institution, has just been unanimously elected by the governors Consulting Surgeon—an honour which, adds the *Medical Times*, has not been bestowed on any member of the surgical staff since Sir Astley Cooper.

A COMMITTEE has begun operations at the Society of Arts for inquiring into the relations of inventors with the Government departments, and the treatment by these latter of scientific inventions. Considerable zeal is shown on the subject, and the whole question of scientific tribunals will be made matter of discussion. Printed forms for collecting the opinions of those interested will be extensively circulated.

THE Statistical Society has entered on a new epoch of activity. Formerly its presidents were statesmen, but it determined lately, like other learned Societies, to select its president from among its own working members, by choosing Mr. Newmarch, F.R.S. This has been attended with more vigorous action of the Council, and corresponding interest among the Fellows. For the first time the Society, the resources of which have always been limited, gives a premium, having received a donation of fifty guineas from Mr. Wm. Taylor, a Fellow. The Taylor premium is to be devoted to an essay on the subject of Taxation in England, and it appears likely that it will be the means of bringing out many new points on an old and trite subject.

IN order to encourage science our authorities have accorded to graduates of the Lahore University the envied privilege of being seated in Durbar and on other state occasions.

THE first of the Quarterly Weather Reports of the Meteorological Office, with pressure and temperature tables for the year 1869, and notes on Easterly Storms, issued by the Meteorological Committee, embodies the results of observations made at the observatories of Kew, Stonyhurst, Glasgow, Aberdeen, Armagh, Falmouth, and Valencia, during the first three months of last year. The succeeding quarterly numbers for the year will follow as quickly as possible, and the journal will in future appear regularly at intervals of three months. The first number contains complete tables for pressure and temperature, &c., for the year 1869, and the plates exhibiting the continuous registration of these observations for the quarter are arranged to show at one view the instrumental curves at each of the stations for five days, one plate comprising pressure and temperature, while another shows the direction and velocity of the wind, scales of measurement being given at the sides both on the British and French systems. We shall return to this report.

THE *Engineer* states that the new dye known as soluble garnet seems to be coming more largely into use on the Continent, and as the colours produced with it are exceedingly brilliant, similar to those obtained with archil, but much more stable when exposed to light and air, the garnet dye is likely to become a great favourite. The dye was first prepared by Casthelaz of Paris, and is the ammonia salt of isopurpuric acid, which is formed by the action of a metallic cyanide upon picric acid. It is not prepared from the pure crystallised, but from an inferior kind of picric acid, and is probably destined to replace the archil in many cases, in imparting to wool all shades from garnet to chestnut brown. It may be readily combined with other pigments, so that a number of different colours may be obtained. According to Casthelaz, the dyeing of wool and of silk is effected by the addition of an organic acid to the bath, for instance, acetic or tartaric acid, mineral acids being excluded. The dye bath for silk should be cold or tepid in the beginning. Different shades in red and brown are thus obtained that are dependent upon the concentration of the bath, the nature of the mordant, and the time of the operation.

IN the attempts now being made further to utilise the hill regions of India for English residence, the Observatory at Nynee Tal, itself a hill town, is to be removed to Raneekhet, which is said to be chosen by some of its patrons as the future hill capital of India.

A HORTICULTURAL establishment has been opened at Guatemala for the export of the seeds, flowers, and young plants of the country.

THE Peruvian Government is endeavouring to develop the saltpetre district of Tarapaca.

A RICH silver mine has been discovered by Messrs. Lepiani and Steffani near Huamantanga, in Peru, and measures are taken for working it.

THE field of the new silver mines near Cobija, in Bolivia, the discovery of which was reported by us, is stated to be 3,000 to 5,000 marcs per cajou, or from 700*l.* to 1,200*l.* of silver per ton of ore.

ON the 16th June an earthquake was felt all over the state of Nicaragua. At Granada, alarming noises were heard from Momotombo, an extinct volcano in the neighbourhood.

ON the 26th May there was a tremendous earthquake at Lima, the first for a long time. It was also felt at Callao.

AMONG the sums voted last week by the House of Commons in Committee of Supply were the following:—64,721*l.* for Public Education in Great Britain; 164,836*l.* to complete the vote for the Department of Science and Art (being an increase of 11,883*l.* on the vote of last year); 51,255*l.* to complete the vote for the Museum; 6,827*l.* for the University of London; 8,220*l.* for the salaries and expenses of the Endowed Schools Commission; 12,894*l.* for the Scottish Universities; 2,140*l.* for the Queen's University, Ireland; and 2,915*l.* for the Queen's Colleges, Ireland. The total educational estimate for the year was stated by Mr. Forster to be 914,721*l.*, being a net increase of 74,010*l.* over that of last year. The day scholars in average attendance have increased from 1,082,000 to 1,200,000. There are 223 more male and 104 more female teachers than last year. Since 1868 the number of Science schools has increased from 300 to 810, and the number of scholars is now nearly 30,000; the number of scholars in Art has increased since last year from 123,562 to 157,198. The increase in the number of scholars in the regular schools is stated to be in excess of the increase of population. These statistics are interesting, as showing that the increased desire for education in the country at least keeps pace with the advance of opinion among the governing classes in favour of a truly national system of education. The query whether prevention is better than cure is forcibly suggested by three other votes which were passed on the same night:—315,627*l.* for convict establishments in England and the colonies, 203,880*l.* for the maintenance of juvenile prisoners in reformatories, and 643,070*l.* for the constabulary force in Ireland. When shall we arrive at the pitch of civilisation of one of the Swiss Cantons, where the expenditure for educational purposes exceeds that for all other purposes put together?

WE learn from the last report of the Geological Survey of Italy (R. Comitato Geologico) that that body will publish a geological map of Italy on the scale of 1 to 600,000 during the course of next year. The map is that which was compiled by Professor I. Cocchi in 1867 and sent to the Universal Exhibition in Paris. It was a hand-coloured map, the Ordnance map of Upper and Central Italy in six sheets being used as a basis. In compiling this map Professor Cocchi made use of all the published and unpublished materials that he could find. The most southern provinces of the Peninsula and Sicily were not however represented, for although notes and papers on their geology were not wanting, that part of the kingdom had not been mapped geologically. The new map will be divided into four sheets, and new plates will be engraved copying the topography of the Ordnance map, and introducing such modifications and improvements as may be deemed necessary for the new object to which the map is to be applied. The colouring will be done by chromolithography. Accompanying the map there will be a short descriptive memoir and two geological sections, one along the length and the other across the breadth of the country.

M. DIAMILLA-MULLER calls upon all directors of magnetical observatories to observe the declination and inclination every ten minutes from midnight 29th of August (Paris time), to the next midnight, and send the results to him at the bureaux of the Association Scientifique de France. He adds, "On croyait généralement que le soleil agissait indirectement par suite des changements de température qu'il produit à la surface de la terre. J'avais déjà présenté l'hypothèse, basée sur les observations d'Arago, tendant à établir que l'action directe du soleil sur le magnétisme est absolument semblable à l'action d'un aimant sur le fer. Cette théorie est confirmée par les observations faites dans les Colonies anglaises, où l'on remarque l'opposition de signe que le changement de déclinaison du soleil imprime aux courbes qui représentent la variation magnétique dans les pays tropicaux. Il est nécessaire de constater, par une observation directe, que cette loi d'opposition, en rapport avec la déclinaison solaire, s'exerce dans toutes les régions du globe."

PROF. LIONEL BEALE's inaugural lecture to the course of Pathological Anatomy, delivered at King's College, May 5th, 1870, is issued as a separate publication, with the title "On Medical Progress; in memoriam R. B. Todd."

THE third part is published of Dr. Manzoni's "Bryozoi fossili Italiani," accompanied by four plates.

ANOTHER contribution to astronomical literature lies on our table, in the shape of the second volume of "Astronomical Observations taken during the years 1865-69, at the private Observatory of Mr. J. G. Barclay, of Leyton."

MR. KEITH JOHNSTON, jun., publishes, in his usual admirably clear style, a map of the Lake Region of Eastern Africa, showing the sources of the Nile, recently discovered by Dr. Livingstone; with notes on the exploration of this region, its physical features, climate, and population.

*ON VOLCANOES**

VOLCANOES are but so many existing proofs of the activity of internal forces at the present moment, and, as a geologist, I may be almost pardoned if I regret that we do not in our happy isles possess even a single example of an active volcano.

As regards the geographical distribution of recent volcanoes, a glance at the geological map of the world will suffice to show that they are in reality scattered all over its surface, yet, it may be added, more rarely occurring at any great distance from the sea, although exceptional instances are met with inland, in all the four quarters of the globe.

In the North we find the volcanoes of Iceland, Jan Meyen, Kamskatca, Alaska, and others; whilst the Antarctic voyages of Ross proved that the mountains of the land nearest accessible to the South Pole were also active volcanoes.

At the equator, all but innumerable volcanoes are seen in the islands of the Indian and Polynesian Archipelagos, as well as in the Pacific and Atlantic Oceans, and on the main land of South America. Midway between the Equator and the Poles are situated the volcanoes of New Zealand, the Canaries, Cape Verde, Azores, and Sandwich Islands, as also those of Arabia, Eastern Africa, Mexico, Central America, and the volcanoes of the whole range of the Andes down to Terra del Fuego. Nearer home, Vesuvius, Etna, Stromboli, Santorin, and numerous others in the Mediterranean, if not so grand in their dimensions as some of those previously referred to, still present on the large scale all the various aspects of volcanic phenomena, both submarine as well as terrestrial.

If now, however, we take a broader view of volcanic phenomena, and, in addition to the before-mentioned still existing proofs of the general distribution of volcanic centres, as they have been termed, we also take into consideration the occurrence of eruptive rocks of similar origin which are everywhere found disturbing and breaking through the strata of even the oldest rock formations, it will be seen, as least as far as the geology of the earth's surface is at present known to us, that there is scarcely a single area of any magnitude, of either the land or sea, which, at some period or other, has not been broken through or disturbed by what may be termed volcanic forces acting from within the mass of the earth itself; and it is impossible to come to other than the conclusion that these agencies must have played a most important part in determining the main features of the earth's external configuration as well in our times as throughout all periods of its history.

If now the question be asked, what is a volcano? the simplest reply would be "a hole in the ground deep enough to reach such portions of the interior of the earth as are in a molten condition."

In ordinary language, however, the appellation of volcano is usually restricted to those cone-shaped mountains, from the hollow summit of which flames, smoke, and vapours are at times seen to ascend, and which occasionally break out into more imposing activity by vomiting forth showers of ashes and fragments of incandescent rock, or by pouring out torrents of molten stone, to deluge and devastate the unfortunate country in the vicinity.

It having always been admitted that volcanoes owed their origin to forces operating from below, it was suggested by Von Buch, and supported by Humboldt and others, that volcanic cones must be formed by some portion of the surface of the earth, weaker than the rest, being forced out, or, as it were, thrown up like a soap-bubble by the pressure of the vapour and gases confined below, the strata being thereby elevated, fractured, and tilted up on all sides, so as to produce a conical elevation, the central fissure in which became a crater or vent for the escape and passage of the gaseous and liquid emanations from below.

[*] Outline of a Lecture delivered at St. George's Hall, Langham Place, 9th June, 1870, by David Forbes, F.R.S.

This hypothesis, which accounted for the formation of volcanic cones and craters by a process of upheaval, or, as it was termed, the "crater of elevation," is here alluded to, only because it for a long time was accepted by many eminent men of science, until the subsequent researches, especially of Mr. Scrope and Sir Charles Lyell, demonstrated conclusively that it is not confirmed when their actual structure is studied in the field, and explained their true formation, by what is now termed the "crater of eruption" theory.

If we imagine a volcanic cone cut through its centre, so as to present us with a section of its entire mass, it will be seen that the mineral matter of which it is composed possesses in itself a sort of arrangement in layers, which at first sight somewhat resembles beds of ordinary sedimentary origin broken through and tilted up towards the centre; a closer examination, however, shows that these layers were never at any time horizontal, but that, on the contrary, they had from the very first been deposited in the same inclined position in which they are now seen, and that they must have been formed subsequently, not previous to the opening of the crater itself, since they are entirely composed of matter thrown up from its orifice.

The commencement of an eruption is known in most cases by certain preliminary symptoms indicative of great internal disturbance, such as rumbling noises, and sounds as if of explosions below, which have been likened to subterranean thunder. The surface waters, springs and wells in the vicinity generally acquire an unusually high temperature, diminish in volume or disappear altogether, and repeated earthquake shocks more or less severe are felt, which eventually culminate in a grand convulsion, by which the surface is rent asunder with fearful violence, allowing immense volumes of previously pent up vapour and gases to rush forth from the fissure with such impetuosity as to hurl high into the air huge fragments of the shattered rocks, along with vast quantities of molten lava, in so liquid a condition that during its ascent it is seen to be splashed about in the air like water, and to become separated into particles of all sizes. Vast quantities of these particles, to which the name of volcanic ash or dust has been applied, are instantaneously reduced to so fine a state of division, literally "blown to atoms," as to become converted into an almost impalpable powder, capable of being carried away by the winds prevailing during an eruption to distances of even hundreds of miles from the orifice from which they had been ejected, and ultimately settle down on the land or in the sea to form deposits, whose nature would often be a puzzle to geologists, did not the microscope at once reveal their true mineral character and volcanic origin. Other particles less finely divided become granulated and fall down from the air in the shape of small black grains, known as volcanic sand; whilst still larger portions, owing to the bubbles of vapour or gas entangled in their substance, descend as black porous or spongy stones, from the size of a pea to that of one's head, or larger; and have received the names of Lapilli, scoriæ, or volcanic cinders, from their presenting much the appearance of an ordinary cinder from a coal fire. Although the scoriæ thrown up by volcanoes are in major part of a dark colour, there are also others (called trachytic) much lighter both in colour and weight, which are usually more common at the commencement of an eruption, the ordinary pumice stone which is imported in large quantities from the volcanoes in the Lipari Islands, for the use of the painters, &c., is an example of this variety familiar to you all. A peculiar form of lava is produced by the currents of wind blowing over the surface of the molten matter in the crater, catching up portions of it and drawing them out into long slender filaments like hair or spun glass of all shades of black, brown, or yellow. In the Sandwich Islands, where this variety is very abundant, it is called Pele's hair, from the name of one of their ancient goddesses. In the intervals of an eruption, or after the greatest force of the rush has spent itself, the vapours often rise through the molten lava in the crater, in smart puffs which carry up with them portions of the fluid lava high into the air, whence they descend consolidated as spheres or somewhat elongated bodies consisting of an external shell of solid lava, hollow or only filled with vapour or gas in the centre. From their resemblance to military projectiles, these bodies, which vary from the size of an orange to that of a pumpkin, have received the name of volcanic bombs.

The mineral matter thrown up into the air from a volcanic vent necessarily descends again by virtue of its own weight, a portion drops back into the crater, but the major part falling beyond it, accumulates around its brink to form a mound, which, since the larger and heavier pieces are not projected to so great a distance as the others, keeps, as it increases in size, raising itself more rapidly in height nearest around the vent, then farther off, and thus builds up a hollow cone, the throat or chimney of which is kept open, at least during the continuance of an eruption, by the upward rush of the gases and vapours forced through it by the pressure below. The action of the heat being of course much more intense in the chimney or throat of the crater, now causes, the at first comparatively loose materials which formed its walls, to soften and cement themselves together on the inside into a sort of compact stony tube of communication with the lower regions, much more solid and resistant than the rest of the mass of which as before described the entire cone had been built up. Once this is the case, the molten lava, forced up by the gaseous pressure below, frequently ascends into the crater itself, and overflowing its brim, pours down the outside of the cone, just like water when placed over too rapid a fire is seen to boil over the edge of the pot in which it is heated. These occasional overflows of lava explain how in the section of a volcanic cone layers of more compact lava are so frequently seen alternating with those of the porous scoria and volcanic sand before described. In more rare instances, as for example in the eruption of Mauna Loa, in the Sandwich Islands, in February 1859, the lava is ejected in so wonderfully liquid a condition, and in such enormous volumes, as to present the appearance of a red-hot fountain; the jet of molten lava thrown up from the crater on that occasion is described as about 250 feet in diameter, and as rising some 500 feet above the level of the brim of the crater itself. Occasionally, during an eruption, the rim of the crater, unable to support the weight of the molten lava which fills it, gives way at its weakest point, the lava bursting out and carrying away one side of the cone itself; at other times the lava, after having risen some height up the crater, finds out a point of weakness and breaks through, discharging itself by a fissure some way up the side of the cone, as was the case with the volcano of Sajama, in Bolivia, in 1859, and with Etna in 1865. In many eruptions the lava does not ascend at all into the crater, but breaks out at the very base of the cone, or even at some considerable distance from it, through a subterranean passage. This took place in the eruption of Kilauea, in the Sandwich Islands, in June 1840, when the lava first showed itself at the surface at Arare, some six miles eastward of the crater which supplied it. In fact, most volcanoes will, upon examination, be found at one or other period in their history to have presented examples of more than one, if not of all, these different modes of discharging their molten products.

The eruption of Etna in 1865, which I witnessed, did not proceed from the summit or main crater, but broke out on the side of the mountain, about 5,000 feet above the level of the sea. Along the fissure or rent formed by this convulsion, no less than seven distinct cones rose up at intervals, building themselves up very rapidly from the enormous quantities of scoriæ which were thrown up from their rents; as they became larger the bases of several of these cones extended until they united, and so formed a range of hills, the summits of which in but a few weeks reached the height of several hundred feet, and entirely changed the character of the scenery of this part of the island. The four lowest cones were the most active, but from none of their craters was there any overflow of lava, which, however, poured out from the very base of the cones, forming a fiery river apparently about three miles across, which destroyed all before it, cutting through a large pine forest, and at one place leaping like a cascade of liquid fire over a precipice some 150 feet in height.

The formation of a new or re-opening of an old volcanic vent is usually accompanied by a terrific explosion, often to be heard at immense distances; thus, in 1812, the outburst of the volcano of San Vincent was heard in the north of South America some 700 miles distant. The enormous force developed by the rush of gases and vapours from the fissure may be imagined when it is known that in the eruption of Mount Ararat, in 1840, huge masses of rock weighing as much as 25 tons were thrown out of the crater; Cotopaxi is said to have even hurled a 200-ton rock to a distance of nine miles; whilst the volcano of Antuco, in Chili, in 1828, sent stones flying to a distance of 36 miles.

The issue of gaseous matter from the crater of a volcano is often described as a column of flame; this is incorrect, for although possibly a little burning hydrogen or sulphuretted hydrogen might be present, especially on the outer edge of the column, the appearance of a column or fountain of flame is in reality due to the gaseous matter of which it consists being illuminated by the fragments of red-hot rock and molten lava thrown up along with it (like sparks in fireworks), assisted by the reflection from the red-hot sides of the crater itself, and from the surface of the molten lava below.

The chemical composition of the gasiform emanations from volcanoes proves that they are in greater part incombustible, and therefore does not support the idea that the body of such a column of vapour and gases could be in flames, *i.e.*, actually burning. On the outside of the column, however, innumerable brilliant scintillations of a bluish colour are frequently seen, due to particles of sulphur taking fire as they come in contact with the outer air, and patches of melted sulphur are splashed about, burning brightly as they fall through the air on to the slopes of the cone. The emission or belching forth, as it has been called, of the gaseous matter with its accompanying red-hot ashes and scoriæ, is more an intermittent than a continuous operation. When an eruption is at its height the spasmodic puffs or blasts are jerked out at intervals of but a few seconds, attended by a terrific roaring or bellowing noise difficult to describe in words.

The buried cities of Stabia, Herculaneum, and Pompeii, covered up in parts to the depth of 100 feet by the ashes of Vesuvius, are ocular proofs of the vast quantity which can be sent out of a volcanic vent during an eruption. The volcano of Sangay, in Ecuador, in constant activity since 1728, has buried the country around it to a depth of 400 feet under its ashes, and a French geologist has estimated that in the course of only two days the volcano of Bourbon has thrown out no less than 300,000 tons of volcanic ashes. The immense distances to which these may be transported by the winds is no less surprising; the ashes of Vesuvius, in the eruption which buried Pompeii, darkened the sun at Rome, and were carried as far as Syria and Egypt; those from San Vincent, in 1812, are reported to have made the sky as dark as night in the Barbadoes; and in Iceland, in 1766, the air became so charged with ashes for a distance of 150 miles around Hecla, that even the brightest light could not be distinguished at a few yards.

Amongst the still active volcanoes we meet with some whose craters are several miles in diameter, encircled by precipitous sides rising to even a thousand feet above the bottom of the crater when at rest, which, as in the Sandwich Islands, may contain reservoirs, or rather lakes of liquid lava, two to four miles across, and at times send forth rivers of molten stone several miles in breadth, extending their fiery inundation to a distance of even forty miles from the crater whence they issued. In the eruption of Hualalai, in 1801, a lava current, after reaching the coast, poured out such volumes of melted matter as to fill up a bay some twenty miles deep, and in its place extend a headland some three or four miles farther into the sea. The rate at which these rivers of molten stone flow is a very varying one; in 1805 the lava current from Vesuvius is said to have run down the first three miles in four minutes, yet only completed its total distance of six miles in three hours; and in 1840 that from Mauna Loa advanced no less than eighteen miles in two hours; whilst on the other hand it is recorded that during the eruption of Etna, which commenced in 1614, and continued many years, the lava stream only completed a distance of six miles in ten years, notwithstanding that all this time it was seen to be in slow but almost imperceptible motion; during the eruption of this volcano in 1865, I found, however, that at the edge of the current the rate of motion varied from 15 to 120 feet per hour according to local circumstances; in the centre of the stream the lava was evidently still more rapid in its movements.

The entire mass of a lava stream often advances, even when to the eye it would appear to have become quite solid; upon my throwing a heavy stone on to the top of a lava current so far consolidated that the stone merely fixed itself into the surface without sinking deeper, it was seen that the stone moved along with the lava which otherwise looked as if stationary. The surface of this lava consolidated and cooled with almost incredible rapidity, so much so that, notwithstanding the protestations of my guides, I walked over lava currents when, at the same time, the fiery stream still flowing below could be distinctly seen through the cracks in the crust over which I passed.

On this occasion also the stems of the pine-trees in the forest which was destroyed by this eruption were converted into charcoal as high as the lava reached, but the upper portions of the trees then toppled over, and remained in an almost unaltered and uncharred condition on the top of the lava current which had so quickly cooled. The crust which forms on the top of lava when cooling, being an excellent non-conductor, acts so efficiently in preventing further escape of heat, that we find streams of lava requiring many years and even ages to become quite cold. Dolomier relates that the lower part of the Ischia lava of 1301 was still hot in the year 1785.

When, owing to the descriptions of the ground around volcanoes, the water from springs, rivers, lakes, or the sea itself, is brought into contact with the heated mineral matter below, we have the production of the so-called mud volcanoes or of fissures sending forth torrents of heated mud and water, and often, to the great surprise of the inhabitants, throwing out numbers of fishes which had lived previously in these sources. The Geysers of Iceland are somewhat similar phenomena, but on the present occasion time will not permit these subjects being treated in detail.

Whilst some volcanoes like Stromboli, the lighthouse of the Mediterranean, as it was called by the ancients, have continued in incessant activity from the oldest historical periods down to the present day, the eruptions of others are only known to have taken place at long intervals. Vesuvius, although imagined by Strabo to have had a volcanic origin, was not known even by tradition to have ever been in eruption until the year 79, when Pompeii was overwhelmed by it. Since that time, however, up to the present date, it has given ample proof of its volcanic activity, yet its history shows several intervals of a century, and one of more than two centuries, in which no eruption took place. No outbreak of the volcano Sangay in Ecuador is recorded before 1728, since which year it has been in continued activity, and Krabla in Iceland also remained at rest for several hundred years before 1724. In fact, it may be safely affirmed that it is quite impossible for us to know whether any volcano at all is entitled to be regarded as really extinct. Even for ages after the last outburst of lava, it is found that smoke and acid vapours continue to be given off from most volcanic rents, and the extraction of the sulphur found in the craters and sublimed into the fissures around dormant volcanoes, forms in many countries an important branch of industry.

Although, as yet, I have confined my remarks altogether to terrestrial volcanoes, it must not be supposed that the depths of the sea are exempt from such visitations, and in the last few years we have had several prominent examples to the contrary in different parts of the world. Submarine volcanoes were well known to the ancients; Pliny and older writers refer to those in the Mediterranean which threw up the islands of Delos, Rhodes, Anappe, Nea, &c. In the Cyclades very curious examples have occurred, both in very ancient and in the most recent times. Of these islands, Therasia is recorded to have been formed in the third century B.C., as also somewhat later in the same century the island of Thera, now called Santorin; subsequently Hiera, 91 B.C., and then Thea, A.D. 19, appeared, which last two were, in 726, united by an eruption, and together formed the present island of Kaimeni. In 1575 a smaller island called Little Kaimeni showed itself, around which, in 1650, numerous other islets were thrown up, which subsequently became united to Little Kaimeni during the eruptions, which continued from 1707 to 1812, when the island, thus increased in size, became known as New Kaimeni. Finally, the last eruption (still going on), which commenced 28th January, 1866, presented us, on the 2nd February, with a new island, now called King George's Island, from the present King of Greece, which, according to the latest accounts, still continues to increase in size. Numerous other examples might be cited, but I shall only mention the island of Johanna Bogoslawa, in Alaska, which, although it only first showed itself above the water in May 1796, had, in 1806, increased so as to be an immense volcanic island, the summit of which was then elevated to no less than 3,000 feet above the level of the sea.

The volcanic products thus forced out under the sea present, as might be expected, a very different aspect from that of the ashes, scoria, and lava from terrestrial volcanoes; the molten lava coming in contact with the water is at once broken up into fragments, coarser or finer, in proportion to the greater or less cooling power of the water in immediate contact with them, and often in great part instantly converted into fine mud, of a greyish colour when formed from prachytic lava, but more commonly of a chocolate or other dark tint, and much denser when produced from the more prevalent pyroxenic lava. Beds of this character, spread out by the action of the sea, often enclosing shells, fish, and other organic remains, become in time consolidated and upheaved, and as they often present an appearance much resembling ordinary volcanic rocks, they have frequently puzzled geologists, who at first found a difficulty in explaining the presence of such fossils in rocks apparently of igneous origin.

Many writers on this subject hold to the belief that volcanoes are mere local phenomena, each one springing from its own comparatively small reservoir of molten matter, supposed to have originated from the softening or fusion of rocks pre-existing on the spot at some depth below the surface. To me, however, this hypothesis appears altogether untenable when it is remembered, amongst other objections which I have elsewhere considered, that volcanic rocks are encountered in all parts of our globe, often continuous or nearly so, over immense areas, and that all these rocks, without reference to the part of the world in which they occur, are invariably alike in character to one another.

Volcanic rocks may be classified under two heads, viz., the dark-coloured, more dense; and the less heavy, light-coloured lavas, termed, respectively, the basic or pyroxenic, and the acid or trachytic lavas. Both these varieties may proceed from the same volcanic vent in succession—for instance, in Vesuvius, where the mineral matter which buried Pompeii is trachytic, but the later lavas are generally pyroxenic in character. This also was the case in the recent eruption of Santorin, as reported upon by the Austrian Scientific Commission.

The examination of volcanic products, no matter how distant the volcanoes may be from one another from which they are taken, prove them to be altogether identical in general, mineral, and chemical constitution.

Taking all these and other data into due consideration, I cannot arrive at any other conclusion than that all volcanoes are connected with one another in depth, and having one common source, not necessarily situated at any enormous depth below the surface, but in which the molten matter—whilst always containing certain general characters—has undergone considerable modifications in composition, mineralogical and chemical, from time to time in the world's history; for under the term volcanic rocks, I would here include all eruptive rocks without exception, whether called granites, syenites, porphyrites, basalts, or lavas, all of which I regard as but so many members of one series, or simply as the products of the volcanic action of different geological epochs.

So much for the molten products of volcanoes. Now a few words on their gasiform emanations, which consist in greater part of the vapour of water, *i.e.* steam, along with volatile chlorides, hydrochloric and sulphurous acids, nitrogen and sulphuretted hydrogen gases. The sulphur, seen to be sublimed in so large quantities, is probably derived from the mutual reactions of the sulphurous acid and sulphurated hydrogen gases, as they come into contact with one another.

Now if it be true that we have a vast accumulation of molten matter at a certain depth below the surface, which observation further informs us must, in major part, consist of the silicates and sulphides of the metallic elements, then, in my opinion, at least, it only requires the assumption that water from the sea should, by some means or other, find its way down into such a reservoir, to account for all the phenomena of volcanoes, both mechanical as well as chemical. The greater part of the water so introduced would be at once converted into steam, which, in its turn, would become still further expanded by a heat so great as that of molten lava, and would develope an enormous power. Calculations have been made which show that water, even when treated to a much less temperature, would exert an "ejection force," as it has been termed, even exceeding that developed in eruptions of the highest volcanoes known. Another portion of the water with the air carried down along with it, acting upon the highly heated sulphides, would become decomposed, and furnish the sulphuretted hydrogen, sulphurous acid, and nitrogen gases given off, whilst the common salt in the sea water, by its action on the hot silicates in presence of steam, would eliminate hydrochloric acid, and account for the appearances of it, as well as of the volatile chlorides found in volcanic fumes. If we accept this explanation. the chemical reactions would be but the effects and not the cause of volcanic phenomena.

The destructive effects attendant on volcanic convulsions are of two different characters, viz., those arising from the earthquakes which accompany and, as a rule, precede outbreaks; and those caused by the products ejected from the volcano itself. The connection of earthquakes with volcanoes has been noted from the oldest times; the earthquakes which commenced A.D. 63, were but the efforts made by Vesuvius to relieve itself, which culminated in the great eruption of 79; the same was the case in Mexico with Jorillo in 1759, and with the great earthquake of 1834 in Chili, which ended in the outbreaks of Osorno and three other volcanoes of the Andes; and lastly, in 1868, the terrible earthquake which visited the coast of Peru and totally destroyed the cities of Arica and Iquique, was followed by the eruption of Isluga, which, according to the latest news, still continues. There seems little reason to doubt that all earthquakes are of purely volcanic origin, and that volcanoes themselves may be regarded as so many safety-valves for blowing off the surplus steam, gases, and molten products from our great internal boiler; for, as a rule, it has been observed that earthquakes either cease altogether or diminish greatly in violence as soon as a neighbouring volcano has cleared its throat.

Although I have resided several years in what are called earthquake countries, and have experienced numerous and severe shocks, amongst others those which resulted in the total destruction of the cities of Copiapo and Mendoza, on which latter occasion some 20,000 inhabitants perished in the ruins, it seems to me quite impossible to convey in words anything like a true picture of such a dreadful catastrophe; the feeble shocks occasionally felt in England cannot give you even the remotest idea of what a severe earthquake is in reality, for not only are cities destroyed and whole villages swallowed up in an instant, as in the case of Arqure during the eruption of Mount Ararat in 1840, but when situated on the coast, even when they have withstood the shock itself, they may be entirely swept away by the great sea wave which follows close upon it, as happened with the cities of Arica and Iquique, in Peru, little more than a year ago. Equally terrible is the destruction caused by the showers of ashes and torrents of molten rock, as in the well-known instances of Pompeii, Herculaneum, and others, too numerous to mention.

The study of volcanic phenomena presents a wide and interesting field for exploration, for as yet our knowledge of the subject is lamentably defective. To follow it up, however, the student should work out a path for himself, taking advantage of every new means of research placed in his hands by the advance made by the collateral sciences, and steering clear of all schools or preconceived notions. Schools in science are what parties are in politics; the "follow my leader" style will not do in this age, for it does not permit of that perfect independence of thought absolutely requisite to ensure success in the pursuit of science. The study of science is the search after truth, but in its study the persevering and conscientious worker, although sure to attain good results in the end, must always bear in mind that his results, even when proved to be *truths*, are still only fragments of *the whole truth*, and that he therefore should guard himself against overrating their value, *i.e.* the extent of their application, since this can only be correctly estimated when these fragments have been found to fit accurately into their true place in the grand plan of nature.

D. FORBES

SCIENTIFIC SERIALS

THE *Journal of Botany* for July commences with a short account by Dr. D. Moore on a form of *Salix arbuscula* in Ireland, which inclines rather towards *S. myrsinites*. Dr. Seemann proceeds with his "Revision of the Natural Order *Bignoniaceæ*," and Mr. Worthington Smith with his valuable "Clavis Agaricinorum," these three articles completing the portion of the paper devoted to original articles, which we regret to see reduced to so small a space. Then follow the second part of Dr. Braithwaite's "Recent Additions to our Moss Flora," and appreciative reviews of Dr. Hooker's "Students' Flora," and Prof. Babington's "Flora of Iceland."

THE *Student and Intellectual Observer* for July contains several good articles, though none of any striking originality. The longest is by Dr. W. B. Carpenter, on the Deep Sea, its Physical Conditions, apparently a report of a lecture delivered during the winter in St. George's Hall. Dr. Henry White's article on Demonism and Convulsionism gives some interesting details of the epidemic which prevailed in Europe during the 17th century. Dr. Wickham Legg, on Zymotics, discusses the theory of the fungus-germ theory of diseases of this class, which he admits explains a good many of the facts, but demands too great a concession in the outset, in the presence in the blood of nearly twenty distinct and separate substances, which exist only to serve as a nidus for the specific ferment, and to be a source of injury to the individual. Mr. Llewellynn Jewitt contributes an article on Celts and other Implements of Bronze, profusely illustrated; Mr. Barff, a third article on Poisons; and Mr. Henry J. Slack, two short papers on the Juniper Fungus (*Podisoma*), and on the Structure of *Pinnulariæ*. The two publications of the quarter selected for separate reviews are Proctor's "Other Worlds than Ours" and Wallace's "Contributions to the Theory of Natural Selection;" and minor papers and reports fill up the number.

SOCIETIES AND ACADEMIES

LONDON

Royal Society of Literature, June 22.—N. E. S. A. Hamilton, librarian, in the chair. Mr. W. R. Cooper exhibited a Greek Tablet from the Hay Collection, found by the late Mr. Robert Hay in the Aasaseef, Thebes, about 1823. Mr. Cooper stated that the relic was one of peculiar interest, as it was a palimpsest tablet, upon which had been written, in the bold uncials peculiar to the fourth century, a list of familiar Grecian names, and among them that of Athanasius. This circumstance, and the fact that it was found near to the ruins of a Christian church, where a long inscription in honour of Athanasius once existed, seemed to warrant a belief that the tablet had some connection with that famous bishop, the more so as the name was not a common one in Grecian history, and the characters are unquestionably of the period in which he lived. Mr. Cooper was supported in his views by Mr. W. S. Vaux and Mr. Hamilton, who examined the antiquity with much interest, and supplemented his short paper by some very able remarks of their own.

Quekett Microscopical Club, July 22.—Annual general meeting, Mr. Peter le Neve Foster, president, in the chair. According to the annual report of the committee, which was read, the Club still maintains its popularity and success. It numbers over 500 members, and meets for the prosecution of miscroscopical inquiry twice a month throughout the year. Mr. Peter le Neve Foster, in vacating the presidential chair which he had so ably filled during the past year, delivered his valedictory address, in which he called attention to various open questions in microscopical science, and which were fields well worth the labour required for their investigation, and which he considered the members might undertake with pleasure to themselves and advantage to the world at large.—Prof. Lionel S. Beale, F.R.S., was elected president for the ensuing year, and Messrs. Henry Lee, F.L.S., Arthur E. Durham, F.R.C.S., Peter le Neve Foster, M.A., and Dr. Robt. Braithwaite, F.L.S., were elected vice-presidents, while Messrs. Allbon, T. W. Burr, F.R.A.S., Witham M. Bywater, and Charles F. White, were elected to fill four vacancies on the Committee.—The proceedings then terminated in a *conversazione.*

Syro-Egyptian Society, July 19.—Messrs. Bonomi and Simpson attended to exhibit and explain a large collection of water-colour and pencil drawings, mostly by the late Mr. Robert Hay, and now the property of his son, Mr. R. J. A. Hay, of Munraw. The sketches represented Egyptian views and antiquities, the most interesting of which were as follows:—A series of coloured views of *Philol* and *Koum Ombos*, taken about 1833, the more valuable as the latter temple having fallen down is now almost completely buried in the Nile alluvium. A series of very elaborately finished drawings of the palace temple of *Medinet Habou*, by the late C. Laver. The original measured plans, sections and details of the Pyramids of Gizeh, by C. Catherwood (to whom and Bonomi we owe the first accurate map of the *Haram es Shereef*). These were accompanied by notes and details of the now famous Sarcophagus in the king's chamber. A large panoramic view of *Thebes* and a folio of sketches near Karnak, in pencil, by F. Arundale. A view of the singular Purple Lake near Thebes, so called from an unexplained phenomenon, viz., that its waters at a certain period annually assume a purple tint. And, lastly, a collection of miscellaneous hieroglyphic inscriptions and mural paintings from the Tombs at Gourna. Many of these, apart from their artistic merit, are deserving notice as being excellent illustrations of the marvellous accuracy obtainable by the use of an almost forgotten instrument, the camera lucida, by means of which, ere the days of photography, the splendid works of Canaletti, Britton, Roberts, and Hay were produced. At the same meeting were also exhibited, by Mr. T. Christy of Fenchurch-street, seven volumes of beautiful photographs from the East, taken in 1869 by M. Felix Bonfils. They represented the present condition of most of the buildings comprised in the Hay drawings, and exemplified in many cases the wanton vandalism of the celebrated Mahomet Ali, who caused many of the then almost perfect temples to be destroyed for the sake of their materials, with which distilleries, cotton factories, and warehouses were erected about the years 1836 and 1840, in fact until the havoc was arrested by a vigorous "Appeal to the Antiquaries of Europe" (1841), by the late G. R. Gleddon, U.S. Consul at Cairo, to whose energy and the united action of the savans of France and England, the present conservation of the monuments of Ancient Egypt are due.

Zoological Society, June 23.—Prof. Flower, F.R.S., V.P., in the chair. An extract was read from a letter received from Dr. J. Anderson, of Calcutta, containing additional remarks on the dolphin of the Irrawaddi.—Two letters were read from Mr. W. H. Hudson, Corresponding Member, containing remarks on birds observed by him in the vicinity of Buenos Ayres.—Mr. Howard Saunders exhibited and made remarks upon some nestlings of the Booted Eagle (*Aquila pennata*) from Southern Spain.—Dr. J. Murie read a memoir on the anatomy of the walrus (*Trichechus rosmarus*), principally founded upon the example of this animal that had lived for some time in the Society's Gardens in November 1867.—Dr. J. Murie also read notes on a species of *Tænia* from the rhinoceros, which he regarded as probably undescribed; and on a case of variation in the horns of the Panolian Deer (*Cervus eldi*). A third communication from Dr. J. Murie contained remarks on *Phoca groenlandica*, its modes of progression and its anatomy.—Mr. R. Swinhoe communicated a catalogue of the mammals of South China and Formosa, with notes upon the various species that he had observed during his numerous travels in those countries. A second communication from Mr. R. Swinhoe contained a list of birds collected by Mr. C. Collingwood during a cruise in the seas of China and Japan, with notes by the collector. The collection was stated to embrace examples of 33 species, amongst which were several of rare occurrence.—A communication was read from Dr. O. Finsch, C.M.Z.S., containing an account of a collection of birds recently obtained in the Island of Trinidad. The collection included 115 species, amongst which were several new to the avi-fauna of the island.—Messrs. H. E. Dresser and R. B. Sharpe read a paper on the Great Grey Shrike (*Lanius excubitor*) and its allies. The differential characters of the various species were pointed out, and special attention was drawn to the Indian Grey Shrikes (*Lanius lahtora*) which was considered to be identical with the Algerian *Lanius pallens* or *dealbatus.*—A communication was read from Mr. J. Brazier, C.M.Z.S., containing notes on the habits of the Grakle of the Solomon Islands, recently described by Mr. Sclater as *Gracula kreffti.*—Mr. J. Brazier also communicated descriptions of ten new species of land shells, collected by Mr. W. F. Petterd in various parts of the Australian region.—Messrs. Sclater and Salvin read an account of several species of birds recently received by M. Boucard of Paris, in collections from Mexico, which were new to the avi-fauna of that country.—Dr. J. E. Gray communicated a paper on some tortoises in the British Museum, with description of some new species.

Ethnological Society, June 27.—Extra meeting, Prof. Busk, F.R.S., in the chair. Sir John Lubbock, Bart., described the opening of the Park Cwm Tumulus, in the peninsula of Gower, South Wales, and exhibited a plan of the structure.—The Rev. Canon Greenwell read a paper on his explorations in Grime's Graves, Norfolk. These so-called graves consist of a large number of pits and galleries in the chalk, excavated in prehistoric times for the working of flint. The explorations led to the discovery of many neolithic flint implements, picks made of the antlers of the red deer, and curiously-sculptured fragments of chalk. Colonel Lane Fox, Mr. Flower, Mr. Fisher, Sir J. Lubbock, and Mr. Dawkins took part in the discussion.—Mr. J. W. Flower exhibited a large collection of specimens from the neighbourhood of Mr. Greenwell's discoveries, including objects of widely different dates, such as palæolithic and neolithic flint implements, a large British urn, and a fine Roman glass bottle. Mr. Boyd Dawkins then gave a verbal abstract of his paper on the discovery of the remains of platycnemic, or flat-shinned people in Denbighshire. Explorations were made in a refuse-heap in a tumulus, and in two bone-caverns, and the human remains thus obtained were exhibited. These proved that platycnemism was manifest in the ancient dwellers in North Wales, as well as in those who buried their dead in the cave of Cro-Magnon in France, and in those whose remains are found in the caves of Gibraltar.—Prof. Busk exhibited and described the peculiarly-formed tibiæ, and distinguished two forms of platycnemism, but attached no value to this peculiarity as a race-character.—Several other papers were taken as read, this being the last meeting of the session.

PARIS

Academy of Sciences, July 25.—M. J. Darboux read a reply to some observations by M. Catalan on his note on the centres of curvature of an algebraic surface. M. Bertrand communicated a report on a memoir by M. Massieu on the characteristic functions of various liquids and on the theory of vapours.—A note was read on the mechanical equivalent of heat and on the electro-chemical properties of aluminium, by M. J. Violle.—Father Secchi communicated some further remarks on the spectra furnished by various types of stars.—M. Bertrand presented a note by M. Laussedat on the restoration of a conical sun-dial, from a fragment brought from Phœnicia by M. Renan.—Remarks on the variations of the magnetic needle, by M. Broun, were read; the author cited the decennial differences observed at Munich from 1841 to 1861, and drew from them the conclusion that the western declination increased up to 1855, remained variable in 1856, and then diminished to about 1860, since when there appears to have been a slight increase.—A note by M. H. Gal on the brominated derivatives of anhydrous acetic acid was communicated by M. Cahours. The compound described by the author was bibrominated anhydrous acetic acid, which was obtained by pouring bromide of monobrominated acetyle upon pulverised fused acetate of soda, and distilling the mixture. Its formula is $C^8H^4Br^2O^6$.—A note was read by M. Guyot on the volumetric determination of the soluble fluorides. The author employs a solution of perchloride of iron.—A note by M. Dobroslavine on the fatty matters of the chyle was presented by M. Wurtz; and M. H. Sainte-Claire Deville communicated a note from Professor Cossa, of Udine, giving an account of some experiments made with an amalgam of aluminium, and stating that aluminium acts upon iodide of æthyle in sealed tubes at ordinary temperatures, and that he has prepared aluminium-æthyle by the action of aluminium upon stannæthyle.—M. Faye presented remarks upon some peculiarities of the soil of the Landes of Gascony, in which he noticed especially the characters of the "alios" or impermeable stratum which exists at a depth of one metre from the surface of the soil, and which, in his opinion, was the main cause of the former insalubrity of the Landes. He considered that it was formed by the infiltration of water holding decomposing organic matter in solution during the winter season, and the evaporation of the water in the summer.—M. H. Sainte-Claire Deville presented a note on a schistose rock impregnated with carbonaceous matter, sent by MM. Ravizza and Colomba.—A note was read by M. Dieulafait on the *Terebratula-diphya* limestones of the French Alps, from Grenoble to the Mediterranean. From stratigraphical considerations, the author confirms the results arrived at by M. Hébert upon palæontological evidence.—An extract from a letter by M. Pissis to M. Elie de Beaumont on mountain-systems and on the formation of the desert of Atacama was read.—M. Daubrée presented a note by M. F. Garrigou on the chemical examination of a metamorphosed cement from the Bayen spring at Luchon. A ball of cement which had remained for eighteen years in the hot water (147° F.) of the spring was found to have gained a considerable quantity of silica, some organic matter, and a little fluorine. It contained some "microzymas."—M. de Quatrefages presented a note by MM. F. Garrigou and de Chasteigner on the contemporaneity of man with the cave-bear and the reindeer in the cave of Gargas (Hautes Pyrénées). The remains discovered consisted of a hearth, with flint implements, split bones, &c.—A note by M. Perez on the generation of the Gasteropoda was communicated by M. Milne-Edwards, consisting chiefly of remarks upon the phenomena of copulation in snails.—An extract from a letter of M. de Vallier stated that whilst the general results of the silkworm cultivation in the department of the Basses-Alpes have been deplorably bad, M. Rayband-Lange, following M. Pasteur's rules, has sold cocoons to the value of 64,000 francs.

BERLIN

German Chemical Society, June 27.—F. Sonnenschein has found the oxide of cerium $Ce_3\ O_4$ to give characteristic colours with alkaloids. The oxide, when added to strychnine and sulphuric acid, produces a violet colour more stable than that obtained with bichromate of potassium. The oxygen thus developed is in the form of ozone.—C. Graebe and C. Liebermann have discovered that anthrahydrochinone ($C_{14}\ H_8\ O.\ OH_2$) is formed when the chinone of anthracene is fused with potash. By treating bromide of anthracene, $C_{14}\ H_8\ Br_2$, with sulphuric acid, bisulpho-anthrachinonic acid is formed, which yields alizarin when fused with potash. They have also prepared alizarin-sulphuric acid and tried in vain to transform it by fusing potash into purpurine.—O. Hesse has investigated opium-wax, consisting chiefly of cerotate of ceryl, and of palmitate of ceryl.—W. v. Schneider, by oxidising diamylene, has obtained an acid, $C_7\ H_{14}\ O_2$, and an indifferent oil, $C_{10}\ H_{20}\ O$.—E. v. Priwoznik describes tetracetyl bromo-gallic acid and bromacetyl-gallic acid.—P. Wexlsky communicates an easy way of obtaining bichlorinated chinone by treating trichlorinated phenole with nitrous acid: $C_6\ Cl_3\ H_3\ O + O = C_6\ Cl_2\ H_2\ (O_2)'' + HCl$.—A. Ladenburg describes some chlorinated derivatives of stanno-triethyl.—R. Radziscewsky has obtained nitro- and dinitro-derivatives of phenylacetic acid.—Hugo Schiff has observed that phenylcarbamic ether—

$$CO\begin{matrix} O\ C_2\ H_5 \\ N\ H\ C_6\ H_5 \end{matrix}$$

yields, by heating, cyanurate of phenyl, diphenylated urea and triphenylated biuret.—A. W. Hofmann has obtained, in an easy way, cyanate of phenyl by treating phenyl-carbamic ether with phosphoric anhydride. The cyanate is slowly transformed into cyanurate. The transformation takes place suddenly when triethylphosphine is brought into contact with the cyanate. As phenyl-carbamic ether when distilled by itself also yields a certain proportion of cyanate of phenyl, the reaction just now mentioned by Schiff obtains a simple explanation. The cyanates of tolyl, of xylyl, and of naphthyl have been prepared in an analogous manner.—Prof. Hofmann then drew the attention of the society to some new lecture experiments, apologising that an experiment formerly described by him as new was not so. The demonstration of the development of heat through crystallisation, by pouring ether upon a super-saturated solution of acetate of sodium, belongs to Faraday. He then poured fuming nitric acid into hydriodic acid gas in a test-tube, which inflamed the hydrogen. $H_2\ S$ and H_2Se show a similar combustion. A second experiment consisted in heating a watch-glass containing a minute quantity of aniline green. According to experiments instituted by Dove the red copper lustre shown by this substance in reflected light is exactly complementary to the green colour shown in transmitted light. When heated a violet is obtained exactly complementary to the yellow metallic lustre which it shows in reflected light. A third experiment showed the colouring power of aniline red. In one hundred million parts of water added to one part of the colouring matter, the colour may be distinguished, supposing the layer of the liquid to have half a metre's thickness. A white silk thread left in this bath for twenty-four hours exhibits a very decided colour. A fourth experiment was arranged to show the formation of nitrous vapour and nitric acid, by burning hydrogen in air. A balloon of 10 litres capacity was provided with three openings, two of which, opposite each other, were provided with platinum tubes soldered to glass-tubes, and serving to introduce the two gases. The red vapours and the acid property of the water can easily be observed. The fifth experiment, an easy way of condensing cyanogen gas, depends upon a simple apparatus, for the description of which we must refer to the society's reports. Lastly, a pretty experiment to show alternate reduction and oxidation was exhibited. A copper crucible was placed on a triangle, so that it could be heated inside with a strong gas burner. A funnel was placed over it, the tube of which was connected with a hydrogen apparatus. By alternately removing and again approaching the funnel the copper became oxidised and reduced.—N. Limpricht described derivations of meconic acid.—R. Rieth has taken the vapour density of metallic chlorides, arriving at the formulæ of $Hg\ Cl$ and $Hg\ Cl_2$, $Sn\ Cl_2$, and $Sn\ Cl_4$, dissociation being out of the question, because tin is scarcely volatile.

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