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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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papers by Prof. Carey Foster on "Magnetic Apparatus" and "Electrical Instruments;" a paper by Mr. J. Norman Lockyer on "Astronomical Instruments;" by Prof. Goodeve on "Applied Mechanics," by Prof. McLeod on "Chemical Apparatus and Products," by Mr. R. H. Scott on "Meteorological Instruments." "Geographical Instruments and Maps" are illustrated historically and descriptively in four papers by Mr. C. R. Markham, and one by Capt. J. E. Davis. Prof. Geikie treats of "Geology," Mr. Warington Smyth of "Apparatus used in Mining," Prof. Story Maskelyne of "Crystallography and Mineralogy," Prof. Huxley of "Instruments employed in Biological Research," and Mr. H. C. Sorby of "Microscopes." Is not this strong enough evidence of the genuine interest which British men of science take in this Loan Collection of Scientific Apparatus?

There is only one drawback to our joy in seeing this collection at last completed and ready to be thrown open to the public: it is after all only a "loan" collection, and in a few months must be disorganised, and the apparatus returned to their owners. We have some reason to hope, however, that this will not be the end of all the labours of the eminent men who have exerted themselves to make the collection a success; we are persuaded that in time it will be succeeded by a permanent collection, which will form a Science Museum on an equal footing with the other Museums supported by Government. The Introduction to the Handbook says:—

"The Lord-President of the Council, the Duke of Richmond, and the Vice-President, Viscount Sandon, in explaining the objects of the collection, took occasion to refer to the recommendations of the Royal Commission on Scientific Instruction, with regard to the creation of a Science Museum. Their Lordships stated their conviction that the development of the Educational and certain other Departments of the South Kensington Museum, and their enlargement into a Museum somewhat of the nature of the Conservatoire des Arts et Métiers in Paris, and other similar institutions on the Continent, would tend to the advancement of science, and be of great service to the industrial progress of this country."

We cannot doubt that neither Government nor the public, after having substantial evidence of the value and important results of a Science Museum in this Loan Collection, will rest satisfied until this country is at least on an equal footing in this respect with our neighbour France. It seems to us that a permanent Science Museum will be the natural outcome of the unexpectedly magnificent collection which the Queen will open on Saturday; it cannot fail to make the public at large conscious of a serious want which for long has been painfully felt by men engaged in scientific research, both pure and applied.

DIFFUSION OF GASES THROUGH ABSORBING SUBSTANCES

Ueber die Diffusion der Gase durch absorbirende Substanzen. Habilitationsschrift der Mathematischen und Naturwissenschaftlichen Facultät der Universität Strassburg, vorgelegt von Dr. Sigmund v. Wroblewski, erstem Assistanten am physikalischen Institute. (Strassburg: G. Fischbach, 1876.)

THE importance of the exact study of the motions of gases, not only as a method of distinguishing one gas from another, but as likely to increase our knowledge of the dynamical theory of gases, was pointed out by Thomas Graham. Graham himself studied the most important phenomena, and distinguished from each other those in which the principal effect is due to different properties of gases.

The motion of large masses of the gas approximates to that of a perfect fluid having the same density and pressure as the gas. This is the case with the motion of a single gas when it flows through a large hole in a thin plate from one vessel into another in which the pressure is less. The result in this case is found to be in accordance with the principles of the dynamics of fluids. This was approximately established by Graham, and the more accurate formula, in which the thermodynamic properties of the gas are taken into account, has been verified by the experiments of Joule and Thomson. (Proc. R. S., May, 1856.)

When the orifice is exceedingly small, it appears from the molecular theory of gases that the total discharge may be calculated by supposing that there are two currents in opposite directions, the quantity flowing in each current being the same as if it had been discharged into a vacuum.

For different gases the volume discharged in a given time, reduced to standard pressure and temperature, is proportional to—

$$\frac{p}{\sqrt{s\theta}}$$

where p is the actual pressure, s is the specific gravity, and θ the temperature reckoned from $-274°$ C.

When the gases in the two vessels are different, each gas is discharged according to this law independently of the other.

These phenomena, however, can be observed only when the thickness of the plate and the diameter of the aperture are very small.

When this is the case, the distance is very small between a point in the first vessel where the mixed gas has a certain composition, and a point in the second vessel where the mixed gas has a quite different composition, so that the velocity of diffusion through the hole between these two points is large compared with the velocity of flow of the mixed gas arising from the difference of the total pressures in the two vessels.

When the hole is of sensible magnitude this distance is larger, because the region of mixed gases extends further from the hole, and the effects of diffusion become completely masked by the effect of the current of the gas in mass, arising from the difference of the total pressures in the two vessels. In this latter case the discharge depends only on the nature of the gas in the vessel of greater pressure, and on the resultant pressures in the two vessels. It consists entirely of the gas of the first vessel, and there is no appreciable counter current of the gas of the other vessel.

Hence the experiments on the double current must be made either through a single very small aperture, as in Graham's first experiment with a glass vessel accidentally cracked, or through a great number of apertures, as in Graham's later experiments with porous septa of plaster of Paris or of plumbago.

With such septa the following phenomena are observed:—

When the gases on the two sides of the septum are

different, but have the same pressure, the reduced volumes of the gases diffused in opposite directions through the septum are inversely as the square roots of their specific gravities.

If one or both of the vessels is of invariable volume, the interchange of gas will cause an inequality of pressure, the pressure becoming greater in the vessel which contains the heavier gas.

If a vessel contains a mixture of gases, the gas diffused from the vessel through a porous septum will contain a larger proportion of the lighter gas, and the proportion of the heavier gas remaining in the vessel will increase during the process.

The rate of flow of a gas through a long capillary tube depends upon the viscosity or internal friction of the gas, a property quite independent of its specific gravity.

The phenomena of diffusion studied by Dr. v. Wroblewski are quite distinct from any of these. The septum through which the gas is observed to pass is apparently quite free from pores, and is indeed quite impervious to certain gases, while it allows others to pass.

It was the opinion of Graham that the substance of the septum is capable of entering into a more or less intimate combination with the substance of the gas; that on the side where the gas has greatest pressure the process of combination is always going on; that at the other side, where the pressure of the gas is smaller, the substance of the gas is always becoming dissociated from that of the septum; while in the interior of the septum those parts which are richer in the substance of the gas are communicating it to those which are poorer.

The rate at which this diffusion takes place depends therefore on the power of the gas to combine with the substance of the septum. Thus if the septum be a film of water or a soap bubble, those gases will pass through it most rapidly, which are most readily absorbed by water, but if the septum be of caoutchouc the order of the gases will be different. The fact discovered by St. Claire-Deville and Troost that certain gases can pass through plates of red hot metals, was explained by Graham in the same manner.

Franz Exner[1] has studied the diffusion of gases through soap bubbles, and finds the rate of diffusion is directly as the absorption-coefficient of the gas, and inversely as the square root of the specific gravity.

Stefan[2] in his first paper on the diffusion of gases has shown that a law of this form is to be expected, but he says that he will not go further into the problem of the motion of gases in absorbing medium, as it ought to form the subject of a separate investigation.

Dr. v. Wroblewski has confined himself to the investigation of the relation between the rate of diffusion and the pressure of the diffusing gas on the two sides of the membrane. The membrane was of caoutchouc, 0·0034 cm. thick. It was almost completely impervious to air. The rate at which carbonic acid diffused through the membrane was proportional to the pressure of that gas, and was independent of the pressure of the air on the other side of the membrane, provided this air was free from carbonic acid. The connection between this result and Henry's law of absorption is pointed out.

[1] "Pogg. Ann.," Bd. 155.

[2] "Ueber das Gleichgewicht u. d. Diffusion von Gasgemengen." Sitzb. der k. Akad. (Wien), Jan. 5, 1871.

The time of diffusion of hydrogen through caoutchouc is 3·6 times that of an equal volume of carbonic acid. The diffusion of a mixture of hydrogen and carbonic acid takes place as if each gas diffused independently of the other at a rate proportional to the part of the pressure which is due to that gas.

We hope that Dr. v. Wroblewski will continue his researches, and make a complete investigation of the phenomena of diffusion through absorbing substances.

J. CLERK MAXWELL

MACALISTER'S "ANIMAL MORPHOLOGY"

An Introduction to Animal Morphology and Systematic Zoology. Part I.—Invertebrata. By Prof. Alexander Macalister, M.B. (Longmans, Green, and Co., 1876.)

HOW many of those who are not of an extra systematic turn of mind, when they review their reading in any special line of research, have continually to regret that they have not had the industry to abstract as well as to classify the various monographs and papers they have perused, and to preserve them in a united form for future reference. Those of us who are zoologists may lay aside some of our misgivings on this score; for one among us, an exhaustive reader and an acute appreciator of the relative importance of facts, has so widely distributed his literary investigations, at the same time that he has made it a principle to keep a memorandum of those points which have most impressed him, that he has felt justified—quite correctly, as all his readers we are convinced will agree—in placing his compilation at the disposal of the scientific public. The volume on the Invertebrata, now before us, fills between four and five hundred closely printed octavo pages.

It is evident that a work constructed on the principles above indicated must be of too exhaustive and too abstruse a nature for the commencing student. It would be impossible for any author so to combine primary definitions and first principles with elaborate detail as to produce a book which would appeal to the tyro as well as the advanced zoologist. Prof. Macalister's "Introduction to Animal Morphology" must be therefore looked upon as an introduction to the science proper, to be read by the second-year student, or to be interleaved for further annotation by the specialist. To teachers of Zoology it will be found invaluable on account of the great fund of information it contains in a highly condensed form, also because in nearly all cases the *name* of the authority for each important fact is associated (in brackets) with his observation. In such a work we think that no better method could have been employed. It would have greatly overloaded the pages if full references had been given; and now that the invaluable Catalogue of Scientific Papers, published by the Royal Society—in which the publications are arranged under the *names* of authors—is within reach of all, in the libraries of the learned societies, if not elsewhere, it is a matter of no great difficulty for anyone who is particularly interested in any special detail, to find which is, and refer to, the monograph or shorter communication in which the point in question is embodied.

There is a small detail in association with the printing of the work, a modification of which in the second volume