spontaneous motions of particles of matter, whether in the state of gas or in the liquid state.

It was known that 1 part by weight of hydrogen occupies the same volume as 16 parts by weight of oxygen when measured at like temperature, and under like pressure. Chemical investigations prove that these equal volumes of the two gases contain the same number of atoms. We also know that the atoms in such a gas are in rapid motion, and resist the pressure to which the gas is at any particular time exposed, by striking against the surface which presses them together with force equal to that which presses them together.

Thus a given volume of hydrogen is maintained against the atmospheric pressure by an energy of atomic motion, equal to that of the same volume of oxygen. Each atom of hydrogen accordingly exerts a mechanical energy equal to that of each atom of oxygen; but we have seen that the hydrogen atom is much lighter than the oxygen atom, and accordingly it must move with much greater velocity than the oxygen atom.

Now Graham allowed hydrogen to escape through a very small hole in a plate of platinum; and allowed oxygen to escape under similar circumstances. He found that each hydrogen atom moves out four times as fast as each oxygen atom. His experiments were so arranged as to enable him to measure the relative velocities of certain motions of the atoms—motions not imparted to them by any peculiar or unnatural conditions, but belonging to them of necessity in their natural state. He found, moreover, that heat increases the velocity of these atomic motions, whilst increasing the force with which a given weight of the gas resists the atmospheric pressure.

The study of the condensation of gases by solids, and the combination of soluble compounds with membranes led him to discoveries which are likely to be of great value to physiologists in explaining processes of absorption and secretion.

Thus he found that oxygen is absorbed to a greater extent than nitrogen by caoutchouc, and that when a bag made of a thin membrane of this substance is exhausted by means of a good air-pump, the oxygen and nitrogen diffuse through it (probably as condensed liquids), and evaporate inside the bag in different proportions from those in which they are present in air; the oxygen rising to over 40 per cent. of the diffused air. Again, a mixture of hydrogen and oxygen was separated almost completely by the action of palladium, which condensed the hydrogen in very large quantity, and the oxygen very slightly.

Perhaps the most remarkable substances discovered in the course of his experiments on diffusion, were the soluble modifications of tungstic and molybdic acids, ferric oxide, &c., and the process by which these bodies were obtained was, perhaps, the most instructive part of the result; proving, as it does, that in their salts, these bodies have properties different from those which they normally possess in the free state; and retain them when the other constituent is removed by a sufficiently gentle process.

Another remarkable fact which bears on a most important theory, is the separation effected by Graham of potassic hydrate and hydric sulphate, by diffusion of potassic sulphate in aqueous solution—a fact which requires us to admit that the solution of the salt in water contains those products mixed with one another; just as much as the experiment of diffusing air through a porous clay pipe, and getting its constituent in a different proportion from that of the original air, proved that air is a mixture and not a compound of the two gases.

In his later researches Graham was assisted by Mr. W. C. Roberts, and cordially acknowledged the zeal and efficiency displayed by that able young chemist. Graham's scientific influence extended beyond his researches; for, on the one hand, his lectures for 18 years at University College were remarkable for logical accuracy and clearness of exposition, and were highly valued by those who had the privilege of hearing them. On the other hand, his "Elements of Chemistry" is a masterly exposition of the best known facts of the science and of chemical physics. It was translated into German, and afforded at that time the most philosophical account of the working and theory of the galvanic battery.

In many of his ideas Graham was in advance of his contemporaries, and it might be difficult to find a chemist who has dealt more cautiously with general questions and delicate experimental operations,—or one whose results, in each direction in which he has worked, may more safely be expected to stand the test of future investigations.

A. W. WILLIAMSON

THE MEETING OF GERMAN NATURALISTS AND PHYSICIANS AT INNSBRUCK, TYROL

FROM the 18th to the 24th of September last the little town of Innsbruck wore an air of unwonted bustle and excitement. Its population, already augmented by the usual throng of summer tourists, was swelled by the advent of somewhere about 800 additional visitors—professors, doctors, directors, men of all sciences, often with their wives and daughters, who had come from all parts of Germany to attend the forty-third Meeting of the German Naturalists and Physicians. These meetings resemble those of our own British Association, though they differ in several very characteristic respects. One of the first contrasts to strike an Englishman is the entire absence of private hospitality. Everybody, so far as we can learn, is in private lodgings or in a hotel; and there are no such things as dinner-parties. Although our own customs in these respects are certainly very pleasant, there can be no doubt that the German fashion leaves the visitors more freedom, and allows them much more opportunity of seeing and talking with the friends they most wish to meet. With us it is no easy matter to get together a party of chemists, or geologists, or physiologists, to hold a social gathering after the labours of the sections are over. We are all either staying with friends, or invited to dinner, or engaged in some way. But at the German meetings such social reunions are one of the distinguishing features. One o'clock in the day brings with it the necessity for dining, and numerous dinner parties are improvised there and then; friends of like tastes, who have not met perhaps for a year before, adjourn to a *restauration* or *kaffee-haus*, and while eating the meal have a pleasant opportunity of comparing notes, and discussing questions which have in the interval arisen.

Another feature of contrast is in the length of time devoted to the sitting of the sections. At the British Association the sections open their sittings at eleven in the forenoon; and the work goes on steadily all day without intermission till four or five o'clock in the afternoon. But, in Germany, the sittings commence sometimes as early as 8 A.M., and are frequently over by ten or eleven o'clock, leaving the rest of the day for some short after-dinner excursion, or for general miscellaneous intercourse among the members. In fact, the German meetings are designed less for the purpose of bringing forward new scientific work, than with the view of affording to men of science opportunities of becoming personally acquainted with each other, and of discussing the value and bearing of recent contributions to knowledge. Hence, the papers which are brought before the sections, contain, to a large extent, outlines, summaries or notices of recent researches, and exhibitions of books, maps, memoirs, specimens, experiments, &c., which have recently attracted notice.

In our British Association gatherings, there is probably more hard work than in those of our German brethren, and I daresay there is as much opportunity for sociality as suits our national temperament. For our Association

is meant, not merely to promote a friendly intercourse among scientific men, but to be a kind of propagandist for the advancement of science through the general community. So we make a compromise between sober, serious, hard work for science on the one hand, and unrestrained festivities on the other. The German meetings keep less prominently before them the scientific culture of the world outside, and aim rather at the strengthening of the hands of the individual worker.

From the papers read at the different sections; from the discussion which they elicited; and still more perhaps from the public addresses on subjects of general interest given to the whole assembled meeting; one could gather some suggestive traits of the present current of thought in at least one great section of the cultivated society of Germany. What specially struck me was the universal sway which the writings of Darwin now exercise over the German mind. You see it on every side, in private conversation, in printed papers, in all the many sections into which such a meeting as that at Innsbruck divides. Darwin's name is often mentioned, and always with the profoundest veneration. But even where no allusion is specially made to him, nay, even more markedly, where such allusion is absent, we see how thoroughly his doctrines have permeated the scientific mind even in those departments of knowledge, which might seem at first sight to be furthest from natural history. "You are still discussing in England," said a German friend to me, "whether or not the theory of Darwin can be true. We have got a long way beyond that here. His theory is now our common starting point." And so, as far as my experience went, I found it.

But it is not merely in scientific circles that the influence of Darwin is felt and acknowledged. I do not think it is generally known in England, that three years ago, when, after the disastrous war with Prussia, the Austrian Parliament had assembled to deliberate on the reconsolidation of the empire, a distinguished member of the Upper Chamber, Professor Rokitansky, began a great speech, with this sentence:—"The question we have first to consider is, Is Charles Darwin right or no?" Such a query would no doubt raise a smile in our eminently unspeculative houses of legislature. But surely never was higher compliment paid to a naturalist. A great empire lay in its direst hour of distress, and the form and method of its reconstruction was proposed to be decided by the truth or error of the theory of Darwin. "The two men," said one able physician of Vienna to me (himself, by the way, a North-German), "who have most materially influenced German thought in this country are two Englishmen—George Combe and Charles Darwin."

There was another aspect of the tone of thought at Innsbruck, which could not but powerfully impress a Briton. Although we were assembled in the most ultra-Catholic province of Catholic Austria, there was the most unbridled freedom of expression on every subject.

In an address on recent scientific progress, Helmholtz thus expressed himself—"After centuries of stagnation physiology and medicine have entered upon a blooming development, and we may be proud that Germany has been especially the theatre of this progress—a distinction for which she is indebted to the fact that among us, more than elsewhere, there has prevailed a fearlessness as to the consequences of the wholly known Truth. There are also distinguished investigators in England and in France, who share in the full energy of the development of the sciences, but they must bow before the prejudices of society, and of the Church, and if they speak out openly, can do so only to the injury of their social influence. Germany has advanced more boldly. She has held the belief, which has never yet been belied, that the full Truth carried with it the cure for any injury or loss which may here and there result from partial knowledge. For this superiority she stands indebted to the stern and disinterested enthusiasm which, regardless alike of external advantages and of the opinions of society, has guided and animated her scientific men."

This liberty of expression, however, seemed sometimes apt to wear not a little the aspect of a mere wanton defiance of the popular creed. Yet it was always received with applause.

In an address on the recent progress of anthropology, Karl Vogt gave utterance to what in our country would be deemed profanity, such as no man, not even the most free-thinking, would venture publicly to express. Yet it was received, first with a burst of astonishment at its novelty and audacity, and then with cries of approval and much cheering. I listened for some voice of dissent, but could hear none. When the address, which was certainly very eloquent, came to an end, there arose such a prolonged thunder of applause as one never hears save after some favourite singer has just sung some well-known air. It was a true and hearty *encore*. Again and again the bravos were renewed, and not until some little time had elapsed could the next business of the meeting be taken up. Not far from where I was standing, sat a Franciscan monk, his tonsured head and pendent cowl being conspicuous among the black garments of the *savans*. He had come, I daresay, out of curiosity to hear what the naturalists had to say on a question that interested him. The language he heard could not but shock him, and the vociferation with which it was received must have furnished material for talk and reflection in the monastery.

ARCH. GEIKIE

TRIASSIC DINOSAURIA

IT will probably interest geologists and palæontologists to know that a recent examination of the numerous remains of *Thecodontosauria* in the Bristol Museum, enables me to demonstrate that these Triassic reptiles belong to the order *Dinosauria*, and are closely allied to *Megalosaurus*. The vertebræ, humerus, and ilium, found in the Warwickshire Trias, which have been ascribed to *Labyrinthodon*, also belong to *Dinosauria*. The two skeletons obtained in the German Trias near Stuttgart, and described by Prof. Plieninger, some years ago, are also unquestionable *Dinosauria;* and, as Von Meyer is of opinion, probably belong to the genus *Teratosaurus*, from the same beds. Von Meyer's *Platæosaurus*, from the German Trias, is, plainly, as he has indicated it to be, a Dinosaurian.

As Prof. Cope has suggested, it is very probable that *Bathygnathus*, from the Triassic beds of Prince Edward's Island, is a Dinosaurian; and I have no hesitation in expressing the belief, that the *Deuterosaurus*, from the Ural, which occurs in beds which are called Permian, but which appear to be Triassic, is also a Dinosaurian. It is also very probable that *Rhopalodon*, which occurs in these rocks, belongs to the same order. If so, the close resemblance of the South African *Galesaurus* to *Rhopalodon*, would lead me to expect the former to prove a Dinosaur.

I have found an indubitable fragment of a Dinosaurian among some fossils, not long ago sent to me, from the reptiliferous beds of Central India, by Dr. Oldham, the Director of the Indian Geological Survey. Further, the determination of the Thecodonts as *Dinosauria*, leaves hardly any doubt that the little *Ankistrodon* from these Indian rocks, long since described by me, belongs to the same group.

But another discovery in the same batch of fossils from India, leaves no question on my mind that the Fauna of the beds which yield Labyrinthodonts and Dicynodonts in that country, represents the terrestrial Fauna of the Trias of Europe. I find, in fact, numerous fragments of a crocodilian reptile, so closely allied to the *Belodon* of the German Trias, that the determination of the points of difference requires close attention, associated with a *Hyperodapedon*, larger than those discovered in the Elgin Sandstones, but otherwise very similar to it.