

Moving in a Circle

I HAD to cross a very large flat field in Lincolnshire one evening; the ground covered with snow, and there being a dense fog. I knew my way perfectly; but on coming to the hedge found that I had deviated to the right. Next day I had occasion to re-visit my track and found that I had described about one quarter of a circle.

T. M. W.

JUSTUS LIEBIG

JUSTUS LIEBIG was born at Darmstadt, the native place of many eminent chemists, May 13, 1803; died at Munich, April 18, 1873.

As generations pass away, and the deeds and capacities of great men come to be truly estimated, it will be found that the name of Liebig claims a position very close to those of Lavoisier and Dalton, the greatest leaders in our science. It is not as the author of the 317 investigations the titles of which fill the pages of the Royal Society catalogue, nor even as the father of organic chemistry, nor as the great originator of a scientific physiology and agriculture, nor again as the writer of numerous handbooks, that Liebig has done most for science; his greatest influence has been a personal one, for it is to him that most chemists now living either directly or indirectly owe their scientific existence. The Giessen Laboratory was the first one in which our science was truly taught, and from this centre the flame of original research was carried throughout all lands by ardent disciples who more or less successfully continued, both as regards tuition and investigation, their master's work.

Liebig early showed his love for experimental inquiry, and his father apprenticed him—as was then usual in the case of boys who exhibit such tastes—to an apothecary. Ten months of the shop drudgery was sufficient to convince the boy that this sort of life was not what he required, and it is said that he ran away from his pill-making; at any rate, he returned to his home in Darmstadt, and soon entered the University of Bonn, and afterwards that of Erlangen, where he met with congenial spirits, and continued his scientific education. At that time (1822), however, the German universities were almost destitute of means of stimulating research, or even of imparting a knowledge of existing science in its higher and more modern forms; and for this reason the steps of all young German chemists were naturally turned towards Paris, where Gay Lussac, Thenard, Dulong, and other well-known masters were working and teaching. In 1822, being nineteen years of age, Liebig had already made himself known in his native town and to its paternal government by the investigation of the action of alkalis on fulminating silver, as well as by other publications on the composition of certain colouring materials; and the Grand Duke, anxious to promote the glory of his capital, gave his promising young townsman the means of studying in Paris. There Liebig, thanks to the friendly introduction of Alexander von Humboldt, was allowed to work in Gay Lussac's private laboratory, where he completed his investigation on fulminic acid, and became acquainted with Gay Lussac's methods of exact investigation. In Paris, too, he met Mitscherlich and Gustav Rose, and the intercourse with them and other men of science which he there enjoyed confirmed him in the choice of his profession, and in 1824 he returned home and was appointed, when twenty-one years of age, Extraordinary, and two years afterwards the Ordinary Professor of Chemistry at Giessen, the University of his country, and the scene of the great labours and triumphs of his life.

The influence which Liebig has exerted on the progress of discovery in our science is due to his possession of that peculiar gift essential to all great investigators of nature, which unites to indomitable perseverance in fol-

lowing out experimental details, the higher power of generalisation. His indefatigable energy in experimental investigation must be known to all who have even turned over the pages of his Annalen; there is scarcely a volume in the thirty years dating from the commencement of the journal in 1832 to 1862, which does not contain some important record of his labours, and in the height of his power the number of independent researches which he was able to carry out at once is certainly marvellous. A mere list of even the most important of his investigations in the one branch of organic chemistry would be far too long for a brief notice such as this; it may, however, be well to call to mind his productivity during the first few years of the Giessen career. In the first rank amongst his earlier researches; and serving as a necessary basis for the whole, come those in which he placed the analysis of organic substances upon a firm and simple basis. His final description of the apparatus is worth remembering—"There is nothing new in this arrangement but its simplicity and perfect reliability." The attack on this subject, commenced in conjunction with Gay Lussac in 1823, was not completed by himself till 1830; but then he furnished chemists with the simple and effectual methods which, with slight modifications, we still employ. Thus armed, the secrets of the composition of the organic acids and alkaloids were soon revealed, and among the most important discoveries we have first amongst the acids, fulminic (1822), cyanic (1827), hippuric (1829), malic, quinic, rocellic and camphoric (1830), lactic (1832), aspartic (1833), uric (1834), then we find chloral and chloroform (1831), acetal (1832), aldehyde (1835).

In 1837 he published, in conjunction with Dumas, a paper, "Note sur la constitution de quelques acides," in which for the first time the theory of polybasic organic acids was put forward. Graham's researches on the phosphates proving the polybasic character of phosphoric acid having been published in 1833. In a research on the constitution of these bodies published in 1838 this was more fully worked out, and Davy's previously expressed views as to the part played by hydrogen confirmed and supported. His researches on the cyanogen derivatives (1834), on the chlorine substitution-products of alcohol (1832), and those carried on for so many years in conjunction with his life-long friend Wöhler, as on the composition of sulphovinic acid (1832), and especially that on the derivatives of benzoic acid (1832) sufficed to place the theory of organic radicals on a firm basis. Then too we must not forget their conjoint researches, chiefly carried on by correspondence between Giessen and Göttingen on the oxo-acids of cyanogen (1830), a most difficult subject worked out in a masterly way, or that on the formation of benzoyl hydride from amygdalin in the bitter almond (1837), or again the memorable investigations on the nature of uric acid and the products of oxidation of this substance by nitric acid (1838), in which not only a large number of new bodies are described and allantoin artificially prepared, but system and order introduced among the whole.

One of his favourite subjects was that of Fermentation, and his explanation of the phenomena as being due to the action of a substance whose molecules are in a state of motion upon the fermentable body is yet well known, though now in the minds of most supplanted by the germ theory of Pasteur.

As a critic Liebig was sharp, satirical, and sometimes even unsparing and bitter, especially when his own views were assailed; his anonymous critiques are brimfull of good-humoured satire, whilst in others to which he gives his name, he lashes his victim most unmercifully. Who can read his "Das enträthselte Geheimniss der geistigen Gahrung" "Vorläufig briefliche Mittheilung," 1839, without amusement? His description of the minute organisms having the form of a Beindorfschen Destillirblase (ohne den Kühlapparat) feeding on sugar and excreting alcohol