3. Obituary Notice of Justus Liebig. By Professor Crum Brown.

Justus Liebig was born on the 12th May 1803, at Darmstadt, where his father carried on business as a grocer and colour merchant. He early showed a strong inclination to the study of experimental chemistry, reading all the chemical books he could procure from the Darmstadt Library, and repeating every experiment he read of, as far as he could obtain from his father's warehouse necessary materials. His father acceded to his wish that he should be a chemist, and as the only way in which this could be carried out, sent him at the age of fifteen to an apothecary's shop to learn chemistry. There he remained only ten months, and he returned to Darmstadt satisfied that he must seek some other mode of obtaining his object. He remained at home for some months preparing for a University course, upon which he entered in 1819 at Bonn. He soon left Bonn for Erlangen, where he studied chemistry under Kastner. When at Erlangen he attended Schelling's lectures, and long after used to speak of the interest he had taken in them, and of the injurious effect they had exercised upon his success as a practical investigator. Both at Bonn and at Erlangen he founded a students' society of chemistry and physics, in which the members communicated and discussed novelties of science. Liebig left Erlangen in 1822, having already published a paper on the preparation of Schweinfurth green.

Assisted by the liberality of the Grand Duke Louis of Hesse, he proceeded to Paris, where he attended the lectures of Gay-Lussac, Thenard, and Dulong, and obtained from Gay-Lussac permission to work in his private laboratory. He there carried on his investigation into the composition and properties of the fulminates, the results of which he communicated to the Academy. He at once attracted the notice of Humboldt, who was then resident in Paris, and through his influence was appointed, in 1824, Extraordinary Professor of Chemistry in the University of Giessen. In 1826 he was raised to the ordinary professorship. In 1845 the Grand Duke of Hesse conferred upon him the title of Baron von Liebig. In 1852 he accepted an invitation by the Bavarian Government

to the ordinary Professorship of Chemistry, and the Directorship of the Chemical Laboratory in the University of Munich. He died 18th April 1873, at Munich.

The time had not yet come for a calm and judicial estimate of Liebig's influence on the progress of chemistry. It must be left for future generations of chemists, removed from the direct influence of his work, and unbiassed by personal recollection, to assign him his proper place among the great leaders of chemical thought and investigation. It is, however, possible for us to give a general sketch of his career, and to point out some of the more prominent effects of his work as seen in the present state of the science.

We may consider him as a teacher of chemistry, as an inventor of new means of investigation, as a discoverer of new facts and a creator of new ideas in pure chemistry, and as an expounder of the relations of chemistry to common life and to the arts. As a teacher, he introduced into Germany systematic practical training in laboratory work, and induced the Darmstadt Government to build at Giessen a students' laboratory, which has served as the type of those magnificent scientific laboratories which have recently been erected in connection with all the great German universities. His stinging attacks upon the great German Governments for their neglect of practical scientific education, his own success as a teacher, and the zeal for the good cause which he imparted to his pupils, have had for their effect the establishment throughout Germany of numerous well-equipped and usefully active schools of practical science. It is not too much to say that there is no school of chemistry in the world which does not owe a great part of its usefulness to the example of the Giessen laboratory.

It is unnecessary here to catalogue the improvements in chemical apparatus which we owe to Liebig, but there is one invention which must at once occur to every chemist as of vital importance in the history of the science. Organic analyses were made with great accuracy before 1831, but they could be made only by highly skilled chemists, and involved great labour and trouble. The publication by Liebig, in that year, of his method of organic analyses—the method which (with important but secondary improve-

ments) we still employ, made it easy for any advanced student to make an accurate analysis of an organic body. It may be truly said that the astonishingly rapid development of organic chemistry, which dates from that time, was only rendered possible by the simplification of the method of organic analysis entirely due to Liebig.

Of Liebig's discoveries and speculations it is possible to give, in such a notice as this, only an outline. The whole progress of chemistry for the last fifty years is so intimately connected with what he did, that a life of Liebig would necessarily include the history of chemistry for that period.

His investigations extend to nearly every branch of chemistry, but it was to organic chemistry that he specially devoted himself; and it is through his work, in this direction chiefly, that he has influenced other departments of chemistry and the science generally. His first research, that on fulminic acid, published in Paris in 1823, led to the recognition of the isomerism of fulminic acid and the cyanic acid discovered in 1822 by Wöhler, and was followed by a long series of investigations on the compounds related to cyanogen, in which he opened out and to a great extent explored this intricate and interesting path of inquiry. Another group of researches was directed to the determination of the composition and constitution of organic acids. In a comprehensive memoir published in 1838, he pointed out the analogies between many organic acids and phosphoric acid, and introduced the idea of polybasic acid into organic chemistry, enumerating the criteria for the determination of the basicity of an acid with extraordinary precision and accuracy.

He made numerous analyses of the vegetable alkaloids, and greatly increased our knowledge of their properties, of their equivalents, and of the relation of equivalent to composition.

His investigations into the derivatives of alcohol, particularly those formed by oxidation and by the action of chlorine, including the discovery of aldehyde and chloral, poured a flood of light upon the whole question of the constitution of organic compounds. Liebig was the first to regard ether as an oxide, of which alcohol is the hydrate, and the compound ethers salts. By doing so he challenged the defenders of the "etherine" theory, who looked upon

ether as a hydrate of olefiant gas. The result was one of those controversies which have proved of immense value in the progress of chemistry. In the course of this controversy the relations of alcohol and ether to other substances were investigated and discussed with great minuteness, and the result was the general adoption of Liebig's ethyl theory. The subject of decay, putrefaction, and fermentation early engaged Liebig's attention. Entirely opposed to the *vital* theory of fermentation, he attacked it with both argument and ridicule, and proposed a purely chemical theory, which he defended with great ingenuity.

A very important part of Liebig's work in pure organic chemistry was carried on along with Wöhler. As might be expected, the joint efforts of two men of such genius and industry produced results unexampled in number and importance. One of the first objects of their research (in 1830) was cyanic acid, a substance discovered by Wöhler, and in which Liebig had a special interest from its isomerism with his fulminic acid. But the investigations undertaken by them, which exercised the greatest influence on the science of chemistry were those on the benzoic compounds and on uric acid. These are models of what such work ought to be, not only enriching the science with new facts, but compacting it by the discovery of new relations. The theoretical views brought forward in the papers on benzoic acid and bitter almond oil were the commencement of the development of the new theory of compound radicals which soon took the place of that of Berzelius.

The most widely known part of Liebig's work consists in his applications of chemistry to physiology and agriculture. The facts he discovered in reference to the chemistry of animal and vegetable nutrition, and the explanations he gave of the chemical processes involved in the life of organisms, have had an incalculable effect upon physiological chemistry. In his application of the principles of chemistry to agriculture, he proceeded in a thoroughly scientific manner; and although he in some cases generalised too fast, and was thus led into practical error, his work forms the foundation of a true science of agriculture.

By far the greater part of Liebig's scientific work was done at Giessen. After his removal to Munich, the claims of society and the court life of a capital upon his time made the devotion to

laboratory work which distinguished the earlier part of his career impossible. His work in Munich consisted chiefly in elaborations of his previous ideas, and in researches, the results of which are of comparatively little general scientific interest, although in some cases of considerable practical value. Among these may be mentioned the discovery of the mode of preparing the extract of meat, and that of a method of depositing a uniform coherent layer of silver of any thickness upon smooth surfaces.

Liebig was a most voluminous author. His papers were published in many journals, but chiefly in Poggendorff's "Annalen," and in the "Annalen der Pharmacie" (now "Justus Liebig's Annalen der Chemie und Pharmacie"), of which he became one of the editors in 1831. Of separately published books, the most important are "Introduction to the Analysis of Organic Bodies," 1837; "Chemistry in its Application to Agriculture and Physiology," 1840; "Animal Chemistry," 1842; "Handbook of Organic Chemistry" (as second volume of a revised edition of Geiger's "Pharmacy"), 1843; "Chemical Letters," 1844; "On the Chemistry of Food," 1847; "On Some Causes of the Motions of the Juices in the Animal Body," 1848; "Principles of Agricultural Chemistry, with special Reference to the late Researches made in England," 1855. Of most of these works many editions were published in German and in almost every European language. From 1831 till his death he was one of the editors of the chemical journal now known as "Justus Liebig's Annalen der Chemie und Pharmacie." Along with Kopp he edited, from 1847 to 1856, the "Jahresbericht über die Fortschritte der Chemie;" and along with Poggendorff and Wöhler, the "Handwörterbuch der Chemie."

His personal character was simple and easily characterised. Open, amiable, and generous, vehement in carrying out his convictions, utterly intolerant of pretence and dishonesty, he was either a warm friend or a declared enemy. In controversy he was often violent, sometimes ferocious, but he never struck an unfair blow.

By his death many chemists have lost a friend, and all feel one more link attaching them to the last generation broken.