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978-0-521-56224-9 - Justus von Liebig: The Chemical Gatekeeper

William H. Brock

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One of the founding fathers of organic chemistry and also a great teacher, the German scientist Justus von Liebig transformed scientific education, medical practice, and agriculture in Great Britain. William H. Brock's fresh interpretation of Liebig's stormy career shows how he moved chemistry into the sociopolitical marketplace, demonstrating its significance for society in food production, nutrition, and public health. Through his controversial ideas on artificial fertilizers and recycling, his theory of disease, and his stimulating suggestions concerning food and nutrition, he warned the world of the dangers of failing to recycle sewage or to replace soil nutrients. Liebig also played the role of an elder statesman of European science by commenting, via popular lectures and expansions of his readable *Chemical Letters*, on such issues as scientific methodology and materialism.

This is the first English-language biography of Justus von Liebig (1803–73) since 1895.

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# Justus von Liebig

## The Chemical Gatekeeper

WILLIAM H. BROCK

*University of Leicester*



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## Preface

Liebig has always been revered in Germany as the father of organic chemistry, as an agricultural chemist, and for the Extract of Meat, which is still sold there in its original form. Elsewhere, Liebig's name is less familiar, though chemistry teachers continue to associate him with a condenser used in organic preparations (which he did not invent) and with the early history of organic chemistry. In fact, Liebig had an international reputation during his lifetime, when he enjoyed a particularly close relationship with Great Britain, whose pattern of scientific education, agriculture, and medical practice he helped to change.

Liebig visited Great Britain six times between 1837 and 1855, rubbing shoulders with English and Scottish landowners, politicians, industrialists, men of science, and members of the Royal Family. Through British friends in high places he was able to obtain a post in the British Army Medical Service in India for his eldest (and most favoured) son Georg. He arranged to have all his books published in English through the London publishing house of Taylor & Walton (in Gower Street), as well as translations or abstracts of all his chemical papers in such journals as *The Lancet*, the *Philosophical Magazine*, the *Chemical Gazette*, and from 1843 the *Quarterly Journal of the Chemical Society*. A number of his letters were even published in *The Times* during the 1860s. Liebig strongly influenced the development of chemistry teaching in Britain, he transformed English farming and the practice of agricultural chemistry, and stimulated medical and engineering ideas concerning public health, sanitation, and the nature of disease. He also dared to criticise Victorian reverence for the seventeenth-century philosopher and statesman Francis Bacon. In 1843, several of his English friends, including Wheatstone, tried to persuade him to apply for the vacant Chair of Chemistry at King's College, London, but the college's affiliation with the Church of England precluded any serious offer being made to him, and the position went instead to his erstwhile pupil William Allen Miller. Two years later, when the Royal College of Chemistry was about to be established, it was again hoped that Liebig might personally come to London to superintend it and to re-create his

Giessen research school in the laboratory in Oxford Street; in the event, the post of director was given on Liebig's personal recommendation to his greatest pupil, Wilhelm August Hofmann, who spent twenty years in London. Together with Liebig's fifty or so other British pupils who held industrial or academic posts throughout the British Isles, Hofmann ensured that Liebig's name and work were kept prominently before the public eye. And after 1865, when sadly (and according to contemporaries, disastrously for Britain), Hofmann left London for Berlin, Liebig's name was kept before the public through his commercial activities with Liebig's Extract of Meat and Liebig's Concentrated Milk Baby Food.

It would not be farfetched to claim, therefore, that Liebig, though born and bred in Darmstadt and fulfilling his academic destiny in Giessen and Munich, was very much an honorary Englishman. To be sure, most of his books and writings, notably the *Chemische Briefe*, appeared in French and Italian and other, more exotic European languages, he had numerous European pupils and he travelled much within Europe. Even so, his connections with Britain were undoubtedly special. Liebig's relationship with Britain and with the British was, as much recent research has suggested, a symbiosis. Liebig looked to Britain for a respectful and sympathetic audience for his ideas on and discoveries in chemical science. Here was an overseas audience that, though frequently provoked into controversy by his work, was often more sympathetic towards it than those in the German nations. Equally, young professionalising groups of British chemists, doctors, engineers, and educators, found "LIEBIG" an effective publicity slogan, agent, and figurehead in their campaigns to reverse the individualistic and utilitarian tendencies in British culture and society. Liebig himself captured the mood for this need in his famous critical observation, which he made to Michael Faraday in 1844: "What struck me most in England was the perception that only those works of a practical tendency awake attention and command respect; while the purely scientific, which possess far greater merit, are almost unknown."

Liebig could be irascible, pigheaded, quarrelsome, opinionated, and sometimes devious, but unlike his younger contemporary Hermann Kolbe, whom he much admired, he never became quirky, obstreperous, and an embarrassment. Quarrels were quickly patched up, and by deliberately sidelining himself from the theoretical problems of organic chemistry after 1840, he avoided the frequently painful controversies over atomic weights and the issue of chemical structure, leaving what Alan Rocke has called "the quiet revolution" to his pupils and younger colleagues such as Hofmann, Frankland, Williamson, Kekulé, and Kolbe. Instead, Liebig moved chemistry into the market place, into a sociopolitical context, by arguing and demonstrating its significance for the benefit

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of society in food production, nutrition, and public health. Like Linus Pauling in the twentieth century, his stance as a public scientist was often controversial, and controversy was exacerbated by his stubbornness in admitting that the models and systems of agricultural and animal chemistry that he had articulated were lacking in precision. But he is to be admired for the courage with which he ventured into such questions and honoured for the stimulus that he gave to the development of what the twentieth century recognises as biochemistry. Released from teaching by his position at Munich in 1852, he was able to relax from the punishing schedule of work he had kept up since joining Kastner as a student at Bonn and Erlangen. At Munich, through popular lectures and expansions of his readable *Chemische Briefe*, he was able to play the role of an elder statesman of science and to comment on broader issues such as scientific methodology, to oppose rank materialism, or, like a Hebrew prophet, warn the nations of the earth of the dangers of failing to recycle sewage or replace soil nutrients that were harvested as animal and human food. Above all, after signal failures in his prime to make money from chemistry, he was able to demonstrate, through the exploitation of the cadavers of South American cattle, how chemistry or, rather, chemical physiology could be exploited commercially. His success here was surely a model for the industrialisation of the food processing industry upon which twentieth-century society is rooted.

Although this biography, being written in English, emphasizes Liebig's British connections, I have tried nevertheless to adopt an international perspective by portraying Liebig as a gatekeeper and, as Edmund Muspratt admirably said, "Man of the century." In adopting the gatekeeper image, I have in mind the ways in which Liebig acted as an entrepreneur and propagandist for the extension of chemistry's boundaries. For Liebig, chemistry was a mature field of knowledge loosely separated or bounded by other disciplines. His essential message was that these adjacent fields of endeavour populated by workers trained in very different traditions of theory and practice would benefit from some chemical fertilizer. Once done, these boundary sciences would not only make more sense and prove more fruitful but would enable important new interdisciplines to emerge.

German historians of pharmacy, as well as a number of Liebig specialists, have drawn attention to the ways pharmacy and mining became catalysts for the creation of the modern chemistry teaching and research laboratory. At the same time, attention has been drawn to the fact that apothecaries were the founders of several chemical firms and industries. The movement to "modernise" the training of pharmacists and to improve their social status was well under way in the late-eighteenth-century German states, as was the cameralism that stimulated interest in mineral

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resources, their identification, analysis, and metallurgical exploitation; but the completion of these processes owed much to the efforts of Geiger and Liebig in the reconstructed *Annalen der Pharmacie* in the 1830s. In an important editorial of 1835, “On the study of pharmacy in its relation to medicine and in the training of pharmacists,” Geiger and Liebig agreed that, with the development of purer and active-ingredient-only drugs and a greater understanding of their *chemical* constitution, doctors and medical schools needed to take pharmacy much more seriously. And, of course, pharmacy was no longer *materia medica* and the memorisation of a few prescriptions but a discipline that had been transformed by organic chemistry. In another editorial of 1838, soon after returning from a trip to Britain where something similar was afoot through the activities of Jacob Bell, Liebig emphasised the close relationship between pharmacy and industry.

These statements of Liebig’s concerning the borders between pharmacy and medicine, pharmacy and industry, and pharmacy and chemistry can be seen as a broader effort on his part to establish chemistry as the most significant and fundamental science for the modern age. These efforts, which began as early as 1826 in his correspondence with Hessen government officials over a salt works near Giessen, reached their climax in the well-known and notorious 1840 review of the state of chemistry teaching in Prussia. This polemic was penned at the same moment that Liebig was completing the *Agricultural Chemistry*, which was also published in French, German, and English in 1840. As Regina Zott and others have demonstrated, Liebig saw his *Agricultural Chemistry* as an example of the power of chemistry to transform an empirical activity like farming or agriculture into a science. In practice, he saw the book as revolutionising plant physiology and as demonstrating to “botanists” that their discipline could become properly scientific only if its students were trained in experimental chemistry.

Two years later Liebig continued his argument with physiologists in *Animal Chemistry*, where in its “Preface” he argued that animal physiology and pathology were inextricably “mixed up together.” It was at these borderlands that chemists could make their greatest contributions to society. As gatekeeper to these borderlands, Liebig said of himself, as Macaulay had said of Francis Bacon, that he was the voice that was in a position to draw attention to the inexhaustible supplies of neglected wealth that the commercial and industrialised nations of the world could mine by following the chemical road.

Liebig’s central message was extremely successful, so that now it actually takes some effort to understand that despite the glamorous propaganda of twentieth-century cosmologists and physicists or molecular biol-

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ogists chemistry really is the most fundamentally central and useful of all the sciences. Liebig's aphorism that soap is a measure of civilization is really a metaphor of the fact that our modern complex societies cannot function without chemists and the understanding of chemistry. Liebig's other message as gatekeeper concerned the vital importance of good husbandry and of the significance of chemical cycles in nature. The very success of his first message, however, with its support for High Farming using mineral and ammoniated fertilizers, or the belief that disease could be eradicated only by an understanding of the chemistry of living processes, tended to suppress his other essentially "ecological" perspective during his own lifetime. It is only fairly recently that the relentless growth of world population, increasingly frequent famines caused by overintensive farming, and Malthusian warning of limits to growth have led to a reappraisal of Liebig's "law of the minimum," his recognition that the nutrient that is present in the least amount relative to the amount required determines the yield of a plant or the health of an organism. And only relatively recently has come recognition of the significance of his denunciations and warnings concerning *Raubbau*, our prevalent current exploitive system of civilisation that pillages Nature and breaks her own chemical laws of recycling. The fixation of nitrogen by the Haber–Bosch process solved the late-Victorian need to recycle, but soon we may be faced by a shortage of the phosphorus that is also an essential ingredient of living systems. These themes of ecological conscience have certainly led to a revival of interest in Liebig's ideas in Germany, and in Britain they have even led the poet Tony Harrison to introduce Liebig into his thought-provoking verse drama *Square Rounds*.

Liebig's career, therefore, deserves attention not only because he helped to transform the teaching of chemistry and created the modern research school, but because he transformed the ways doctors, pharmacists, and physiologists saw chemistry and how chemists themselves saw their roles intellectually and as possessing "civic worth" in a modern society. For Liebig, chemistry was the fundamental, or central, science. Other sciences were diminished and distorted if their exponents were ignorant of it. At the borderlands between different sciences, there were new disciplines such as chemical physics, pharmaceutical chemistry, agricultural chemistry, physiological chemistry (or biochemistry), and industrial chemistry calling out for research and for able recruits. It was at these borderlands that chemists could make their greatest contribution to society.

There has been no English-language biography of Liebig since the 1895 publication of a brief life by a public school chemistry teacher and researcher, William Shenstone. This drew heavily on the brilliant account of his former teacher given by A. W. Hofmann in a Faraday Lecture to the

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London Chemical Society in 1875, as well as on the Cantor Lectures of 1875–76 delivered at the Royal Society of Arts by another Anglo-German pupil, Ludwig Thudichum. German readers, appropriately for someone who was one of the giants of nineteenth-century chemistry, have been better served: an unofficial biography in 1904 by a leading historian Adolph Kohut, who did not, however, have access to most of the family papers; and the massive official biography by Liebig's pupil and family friend Jakob Volhard that was published in 1909. Although he was not a professional historian, Volhard was enormously conscientious and his biography is an impressive achievement. Time after time in writing the present biography, when convinced that I was exploiting a document for the first time, I found that Volhard had been there before and that he had referred to the same evidence. Apart from not being translated into English, the principal drawback of Volhard's biography is its lack of an index. My new life of Liebig should not be regarded as replacing Volhard but as complementing his pioneering achievement.

Although several German popular biographies, encyclopaedia entries, and commemorative essays, all based upon Volhard, appeared in the 1920s and 1930s, notably a nationalistic one by Richard Blunck in 1938 (reprinted 1946), it was not until 1973 that Irene Strube penned a 100-page portrait for readers in the then German Democratic Republic. Not surprisingly, she laid stress on the social implications of Liebig's work by concentrating on his agricultural chemistry, giving short shrift to his equally important research in animal chemistry or the popularisation of chemistry in the mid-Victorian period. By then, the 1970s, the professionalisation of history of science in Britain and America was in full flood. In the United States in 1964, Frederic L. Holmes produced a rich and scholarly essay to accompany an English-language reprint of Liebig's *Animal Chemistry*; he capped this a decade later with a stimulating, archive-based sketch of Liebig's career and work for that great cooperative enterprise of the 1970s, the multivolumed *Dictionary of Scientific Biography*. There, in contrast to Strube, Holmes stressed the role of Liebig's intellectual and practical activities as one of the new breed of organic chemists who emerged in the 1830s. In 1971, Holmes's Yale student Margaret Rossiter examined the impact that Liebig had had on American agriculture between 1840 and 1880. Her stimulating study of Liebig's influence on the Americans was subsequently published in 1975. In Britain, complementing Holmes and Rossiter, Jack Morrell's seminal *Ambix* essay of 1972 emphasized the significance of the chemical school that Liebig had established and made world-famous at Giessen, and he portrayed Liebig as a breeder of chemists and of chemical research. In so doing, he raised influ-

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ential questions concerning the role of patronage in science and the social conditions that had allowed this thriving academy to emerge.

My own interest in Liebig began in the 1960s when I contemplated research on Edward Frankland – now happily and better executed by my friend Colin Russell. Frankland led me in 1973 via a Deutsche Akademie Austauschdienst scholarship to Germany, where I was able to explore the rich and scarcely tapped Liebig archives at the Liebig Museum in Giessen and at the Bavarian State Library in Munich. Such archives had just begun to be exploited by a young American doctoral student Bernard Gustin, whose Chicago thesis of 1975 questioned the traditional portrait of Liebig as the founder of practical chemistry teaching. It was Gustin who first drew English-speaking historians to the hitherto unaddressed significance of pharmacy, both in Liebig's teaching career and in the industrialisation of Germany. Gustin's work has been ably continued by Pat Munday, whose stimulating Cornell thesis of 1990, again based upon the critical use of archives, offered a reappraisal of Liebig's early training in Germany and Paris, the creation of his Giessen laboratory, and his decision in the late 1830s to abandon pure organic chemistry and move into what would now be recognized as biochemistry and its applications to agriculture, medicine, and nutrition. I gladly acknowledge the way my own study has benefitted from the research of Holmes, Rossiter, Morrell, Gustin, and Munday, as well as from the excellent studies of Liebig's agricultural work made by Vance Hall and Mark R. Finlay, and the illuminating analysis of Liebig's many pupils made by Professor Joseph S. Fruton. All Liebig scholars are also permanently indebted to the bibliographical work of Carlo Paoloni.

In a review of Liebig studies in 1981, I drew attention to the richness of the archival remains of Liebig in the hope that it would stimulate further work. I like to think that it has. Apart from my own edition of the correspondence between Liebig and Hofmann (1984), a good deal of the regular correspondence between Liebig and his pupils and friends has now been carefully transcribed and published through the dedicated scholarship of Dr. Emil Heuser (Leverkusen), with the backing and magnificent support of Dr. Heinrich Propfe. Sadly, neither of them has lived to read this biography. With the forthcoming edition of the complete and unexpurgated correspondence of Liebig and Wöhler edited by Professor Christoph Meinel, there will perhaps remain only the daunting task of publishing the extensive correspondence of Liebig and Kopp concerning the editing and publishing of *Annalen der Chemie*. Much else has been done in recent years to reestablish the significance of Liebig in German and world scientific culture by the activities of the revamped Liebig

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Gesellschaft and its associated wonderful Liebig Museum at Giessen. Here the quiet authority of Professor Konrad Mengel, Dr. Siegfried Heilenz, and their team of helpers, and especially the dedicated enthusiasm of Wilhelm Lewicki, a descendant of Liebig's daughter Nanny Thiersch, have very considerably aided the professional activities of historians such as myself.

In addition to the historians and Liebig lovers already mentioned and to whom I am indebted, it is a pleasure to acknowledge the award of an Edelstein International Fellowship in the History of the Chemical Sciences, which enabled me to spend ten months in Philadelphia at the Chemical Heritage Foundation in 1990–91 and two months in Jerusalem at the Edelstein Center for the History of Science, Technology, and Medicine in 1992. Although these periods in America and Israel were primarily dedicated to the completion of my *Fontana History of Chemistry* (London, 1992), which was published in the United States as *The Norton History of Chemistry* (New York, 1993), they also gave me time to consolidate my thoughts on Liebig. A further period of leave from the University of Leicester in the autumn of 1993, again spent in Philadelphia, saw the completion of over half of the text. The remainder was finished at Leicester betwixt teaching and administration. I am enormously grateful to Professor A. Thackray and Dr. O. T. Benfey and the other staff at Philadelphia, Dr. A. S. Travis at Jerusalem, as well as the University of Leicester for leave of absence. Finally, I owe D. M. Knight, J. B. Morrell, C. A. Russell, and W. A. Smeaton my warm thanks for their support and encouragement over more than thirty years of our mutually sustaining interests in the history of chemistry.



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He was not the maker of that road; he was not the discoverer of that road; he was not the person who first surveyed and mapped that road. But he was the person who first called public attention to an inexhaustible mine of wealth, which had been utterly neglected, and which was accessible by that road alone. By doing so he caused that road, which had previously been trodden only by peasants and higglers, to be frequented by a higher order of travellers.

Macaulay on Francis Bacon, quoted by Liebig of his own role in agricultural chemistry, *J. Roy. Agri. Soc. of England*, 17(1856), 326

Liebig himself seems to have occupied the role of a gate.

Thomas Pynchon, *Gravity's Rainbow* (1973; Penguin edition 1987), p. 411