

# Liebig or How to Popularize Chemistry

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**Abstract:** The popularization of chemistry was one of Liebig's major tasks. I examine why one of the most famous theoreticians and experimenters of organic chemistry came to this new and rather unusual project in the mid-19th century, and how he managed to create a new image of chemistry: no longer the servant of pharmacists and physicians, it must be considered the most useful of all sciences and the most popular.

**Keywords:** *popularization of chemistry, image of chemistry, 19th century, Justus Liebig.*

## 1. Introduction

Justus Liebig (1803-73) became famous as early as 1831 notably for his *Fünf-Kugel-Apparat*. The great number of his organic analyses, his theory of organic radicals, his personal and scientific battles, and the extraordinary activities in his international laboratory contributed altogether to make him one of the founders of the new organic chemistry, in opposition to Berzelius and in competition with Dumas and Laurent. Moreover, being a chemist his name was an exceptionally well-known throughout the world, and to this day. Even the European housemaid knew Liebig's soup! Although Laurent and Liebig worked in the same years, mostly on the same materials, thought about the same questions, stumbled on the same difficulties, Laurent's name is much lesser known than that of Liebig.

On his return from Great Britain in 1837, and in association with the project of writing a book on agriculture, Liebig suddenly started an energetic campaign. His idea was to communicate a new image of chemistry throughout the world. By studying texts, memoirs, and correspondence, I analyze the reasons for such a change in Liebig's preoccupation, from doing pure chemistry to constructing a new image of chemistry. I evaluate the implication of such a campaign to understand why his policy eventually worked out. An analysis of his overall approach shows Liebig as a very modern person. He was engaged in advertising, even marketing, and used his scientific repu-

tation to impose non-scientific assertions; and he discussed the relationships between pure and applied science, teaching and research, science and industry, and finally science and power.

## 2. A Break in Liebig's Trajectory

By the end of the 1830s, Liebig was considered one of the major chemists of the century. He had published great memoirs, including a series of papers in collaboration with Wöhler on bitter almond oil, benzoic acid, and the benzoic radical, which was considered as the dawn of a new period for vegetal chemistry;<sup>1</sup> the famous theoretical memoir on the constitution of organic acids, which questioned the interpretation of organic compounds prevailing since Lavoisier and adapted by the electro-dualistic system. And he continued working with Wöhler on uric acid, "which is beginning to solve the mystery of living substance chemistry"<sup>2</sup> and which announced the chemistry of artificial matters.<sup>3</sup>

Through the invention of his *Fünf-Kugel-Apparat* Liebig was also an established analyst. The apparatus permitted quick and easy measurements of the relative mass of carbon in small organic samples even by non-skilful chemists; a large number of organic analyses were published, which profoundly impressed Berzelius. These analyses were different from the French analyses, from those of Dumas, who made everything only to "glance"; from those of Dumas and Pelletier, who improved their results "with the pen"; and from those of "poor Henry and Plisson who are using bad methods of beginners".<sup>4</sup> Although Liebig's method of organic analyses was only an improvement upon the works of many previous chemists, his laboratory quickly became a place to which many chemists from around the world traveled.<sup>5</sup>

The publication of his *Anleitung zur Analyse organischer Körper* (1837) pushed Liebig to the center of the international stage and made him on par with the most eminent chemists of the time, Berzelius and Dumas. Liebig took over the 5<sup>th</sup> edition of Geiger's *Handbuch der Pharmacie*, which became the *Handbuch der Chemie* (1843), he edited the *Handwörterbuch der reinen und angewandten Chemie* (1842ff.), and since 1832 the *Annalen der Pharmacie*, which he used to make his own ideas widely known.

However, with the two violent pamphlets, 'Der Zustand der Chemie in Österreich' ('The State of Chemistry in Austria', 1838) and, particularly, 'Der Zustand der Chemie in Preussen' (1840, 'The State of Chemistry in Prussia'), Liebig began to act as a propagator of chemistry, a science that had to be known, to be taught, and to be valued. Up to then, chemistry "had

been the servant of the physician, because it provided purgatives and emetics [...] it did not exist in the universities apart from medicine and pharmacy". Useful to make soda and soap, to improve iron and steel, to prepare dyes for cotton and silk, it was not considered an element of intellectual education or research of nature (Liebig 1840). "Chemistry proceeds by answering questions, just as physics does. It teaches the way to know the various substances of which the crust of the earth consists, the constitution of animal and vegetable organisms." (Ibid., p. 112)

From 1840 on, Liebig's occupations began to change as reflected in the titles of his publications: *Organic Chemistry in its Applications to Agriculture and Physiology*, *Animal Chemistry or Organic chemistry in its Applications to Physiology and Pathology*, *Familiar Letters on Chemistry and its Relation to Commerce, Physiology and Agriculture*, *Chemische Briefe*, and *Nowvelles Lettres sur la Chimie*, while his scientific memoirs became less numerous. In addition, he traveled extensively to meetings and conferences and he became involved in many close correspondences. Since then, Liebig would describe chemistry as a universal science and the source of innumerable precious applications.

### 3. 1837: The Crucial Year

In 1837, five young foreign students were working in Liebig's Giessen laboratory. Three of them were English: T. Richardson, W. Eatwell, and T. Thomson, the son of the Glasgow professor of chemistry who invited Liebig to attend the meeting of the British Association for the Advancement of Science (BAAS), which took place in Liverpool in September 1837. The travel to Great Britain seems to have played an important role in changing Liebig's mind.

Liebig had an early interest in technology. During his study in Paris, he was impressed by Nicolas Clément's lectures and the applications of chemistry to the arts.<sup>6</sup> In 1832, on Liebig's insistence, Vieweg accepted the idea of publishing the *Handwörterbuch der reinen und angewandten Chemie* ('Dictionary of Pure and Applied Chemistry'), which would become of great help to technological chemists and manufacturers.<sup>7</sup> Liebig also pushed Vieweg to manufacture his own paper "as beautiful as English paper" and, after visiting the most important paper mills of Ireland, Scotland, and England, he advised Vieweg about the manufacturing technologies.<sup>8</sup>

On his way to the Liverpool meeting, Liebig took the opportunity to visit many factories of soda, sulfuric acid, soap, steel, and paper. He became more aware of the importance of chemistry in every sector of industry and of its

crucial importance to the prosperity of a country, “chemistry, the real mother of every industry” (Liebig 1838). He considered chemistry the most worthy science and the most useful matter of education: “If a person well trained in pure chemistry, but completely inexperienced, happens to manage soda, sulfuric acid, or sugar factories, dying industries or any other industry, he will be familiarized with the methods of fabrication within half an hour; and he will allow substantial improvements within the first hour.” Thanks to the knowledge of the bases and laws of science, applications were easy and would automatically follow (*ibid.*).

His visits of factories and his discussions with men such as W. Crum, J. Muspratt, Ch. Macintosh, and Trueman made Liebig more concerned with industrial problems than before. He became convinced that developing the teaching of chemistry and making it more popular at the state level as well as in the common mind, was the primary aim. Just after Liebig’s return to Giessen, Thomas Graham wrote to Liebig, “my ambition and the object of my life will be to raise something like a chemical school in London, and your example of success is my most efficient stimulus”.<sup>9</sup>

Another outcome of Liebig’s travel was the enthusiastic reception of his memoir on uric acid, read by Faraday himself. This made him conscious that he had to play a prominent role in the chemical scene in Europe. He was ensured of the alliance of “all the northern chemists”. Although “England was not the country of science”, he had to promote chemistry in this country where “the chemists are ashamed to be called chemists” and where the druggists, who are called chemists, are despised.<sup>10</sup> The acclamation of the English chemists, who asked him to write a Report on organic chemistry, made Liebig even more a leader in organic chemistry, which “exercises an immense influence over medicine, over manufactures, and over common life” (Liebig 1837).

Back in Giessen at the end of 1837, Liebig was convinced to play an important role in popularizing chemistry in Europe. Part of this project was to unite Dumas and Graham as co-editors of the *Annalen*: “Your grand idea of a chemical journal to be published in the three languages delights me. I see no other means so likely to revive an interest in true Chemistry in my own country.”<sup>11</sup> In 1840, the *Annalen der Pharmacie* became the *Annalen der Chemie und Pharmacie*.

The other leader of organic chemistry and another opponent of Berzelius’ school was Dumas, whom Liebig met on his way back to Germany. After an attempt to unite their forces, whether real or pretended, Liebig decided that he would start alone the campaign to make chemistry more popular. “You are powerful in Paris, but you have no influence elsewhere in the world as long as you are not at the head of a journal. Paris influence is little, to my

opinion, regarding Europe.”<sup>12</sup> Back in Giessen, Liebig was determined to become the leader and servant of chemistry worldwide.

#### 4. 1840: The Turning Point

In 1837, Liebig was still vigorous and enterprising in developing a new fruitful system of organic chemistry, but this slightly changed in 1840. His struggles became increasingly intense, leading to a rupture with Dumas and damaged relations with Berzelius. His attempts to create a new system based on radicals turned out to be impossible. “I am really afraid of theoretical discussions.”<sup>13</sup> The first volume of his the *Traité* (1840), where compounds were studied and classified according to their radicals, were followed by an outdated approach: acids, fatty compounds, and dyes (Liebig 1840-44). The revolution that Liebig intended to start in organic chemistry seemed impossible for the present. “The more I am thinking about the constitution of organic compounds, the more I become convinced that all our efforts are in vain to establish strong bases for a theory.<sup>14</sup> He would “turn to a completely different side of the science”.<sup>15</sup>

In 1840 he published two important publications of another type: ‘Der Zustand der Chemie in Preussen’ and *Die organische Chemie in ihrer Anwendung auf Agricultur und Physiologie* (‘Organic Chemistry in its Applications to Agriculture and Physiology’, henceforth called *Agricultural Chemistry*). First published in the *Annalen*, the first publication would also be published as a booklet by Vieweg, on Liebig’s demand: *Über das Studium der Naturwissenschaften* (1840, ‘On the Study of Science’). Likewise for the second publication, a booklet that was in fact the Introduction to his French *Traité de Chimie organique*, and imposed by Liebig on Vieweg, as a personal gift: “It will excite a great sensation.”<sup>16</sup>

Already in ‘Der Zustand der Chemie in Österreich’ (1837), Liebig had harshly criticized the teaching of chemistry, this real mother of every industry, and denounced professors of chemistry as no real chemists (Liebig 1838). Yet, ‘Der Zustand der Chemie in Preussen’ was his first official attempt to popularize chemistry.<sup>17</sup> Chemistry could no longer be considered the servant of physicians,<sup>18</sup> nor less important than mathematics, which was unable to verify the exactness of its assertion. Instead, chemistry answered questions about nature in the same way as physics did, using the language of phenomena. Chemistry was a ‘mother science’ because it was necessary for progress in physiology and medicine; it was a central science because it was necessary for the improvements of industries and trades and, particularly, agriculture. And chemistry was an important training of the mind, unlike

*Naturphilosophie* that abused the mind and falsified reasoning. Liebig wanted to make clear that chemistry was a fundamental science. Thanks to chemical methods, the problems of agriculture, physiology, and medicine could be solved by nourishing the people and restoring their health. “As you know, my intention is to make the nation see the real nature of chemistry.”<sup>19</sup>

Introduced to Vieweg as the “most appropriate prospectus to announce the publication of the *Agricultural Chemistry*”, ‘Der Zustand...’ began popularizing chemistry in a polemic tone. Liebig asked for 2-3000 copies to be sent “to all the kingdoms of the world”.<sup>20</sup> He announced that he would also try to publish it in major newspapers, as *Morgenblatt* and *Allgemeine Zeitung*, in order to “make more noise about it, if possible”. His *Agricultural Chemistry* tried to demonstrate that chemistry could explain every transformation in the living bodies and, therefore, could help improve a field if natural laws were respected. That should be possible by using a simple language and images comprehensible to everyone and without any chemical formulas and tables. Moreover, He aimed to show that between modern agriculture based on chemistry and the most traditional ones, like little farms or Chinese and Japanese agriculture, there was no hiatus. This tendency would intensify through the successive editions of the *Agricultural Chemistry*. There would be no matter of mistrust or fear about chemistry, as phenomena were neither mysterious nor irrational.

In fact, Liebig wanted everybody to believe that chemistry commanded every phenomenon in living nature: “Alles ist Chemie.” (‘Everything is chemistry.’) Knowing the laws of chemistry, everyone would be able to understand and improve. The first task was to prioritize the teaching of chemistry, particularly pure chemistry that he considered as the trunk of a tree. A prospectus that advertised the *Handwörterbuch* summarized Liebig’s points: “Nobody is able to do completely without chemistry, nobody has been studying chemistry without any profit at all: chemistry is closely related with trade and industry, with medicine and the natural sciences, with everything connected with life”.<sup>21</sup>

Liebig’s original *Organic Chemistry in its Application to Agriculture* did not promote agricultural chemistry as the title suggests; only the 7<sup>th</sup> edition of 1862 became the birth of the myth of Liebig, the founder of modern agriculture (Blondel-Mégrelis & Robin 2001). Instead, the book developed a new image of chemistry (Jas 2001).

## 5. The Instruments of Popularization

Teaching was, of course, a major instrument to diffuse chemistry. Already in 1838, Liebig had severely criticized the Austrian professors of chemistry. Even in Prussia, H. Rose was in Liebig's view "the only man who gives practical scientific lectures" and enjoyed to educate chemists. Now Liebig sought for a larger and more general audience that would be attracted by his growing international fame. Half a century before, Lavoisier already had a similar aspiration referring to the same sector of agriculture: "the experiences I am working on made me hope that I could contribute, one day, on the national prosperity, by acting on the public opinion with writings and facts" (Lavoisier 1792). This care for a larger audience became evident in the first months of 1840, when Liebig worked on his booklet for agriculturists.

In the middle of that year Liebig took care of every detail that could help the diffusion of his ideas: a tasteful print, an elegant type-foundry, a beautiful paper, and a well-composed dedication.<sup>22</sup> He insisted on being a Professor of Chemistry, a member of the Royal Society, and an honorary member of the city of Giessen.<sup>23</sup> And he carefully selected the priorities of his coveted audience.<sup>24</sup>

Of course writing was a major tool to popularize chemistry, which Liebig used by numerous editions. His friend and publisher Eduard Vieweg was a major aid in that regard. The multiple editions of Liebig's works, particularly after 1840 and with improved quality of paper and print, were a precious help in the popularization of chemistry. All the more since Liebig himself assisted in the diffusion. He requested that the *Agricultural Chemistry* be ready in the bookshops for the naturalists' meeting in Erlangen. When the agriculturists had a meeting in Brünn, Liebig managed to have the copies arrive in time. He went to Vienna to hand over copies to Metternich and Colowzat.

Liebig's pupils, especially foreigners, played an important role in the diffusion of his ideas. Although it is a matter of discussion whether he was a pupil of Liebig, Gerhardt translated into French most of Liebig's writings. In the English-speaking world, Liebig's pupils were extremely important. The *Agricultural Chemistry* was published in England as soon as 1840, translated in the Giessen laboratory by Playfair. Gregory, at the 1840 meeting of the BAAS, added, after Graham had read an abstract of the glorious book: "The object of the work was to show that, without a profound knowledge of chemistry, no real progress in Agriculture and Physiology was possible."<sup>25</sup> The first English edition was quickly introduced in America, pirated and sold very cheaply by an American editor. Liebig's views were popularized by the *Cultivator* as soon as 1841, and his theory of the fixation of ammonia quickly replaced Davy's (Rossiter 1975). In 1842, Gregory drew up a laudatory report on Liebig's *Physiology* pronouncing that chemical research had proved

some facts, “which the boldest imagination dared not have ventured to conceive”. He concluded that “there is no living philosopher to whom the Chemical Section could have more appropriately entrusted their investigation” (Playfair 1843).

Liebig frequently wrote articles for newspapers. In 1842 and 1843, he wrote a series of articles for the supplement of the *Augsburger Allgemeine Zeitung*. Some of them were united in a book on the suggestion of E. Diefenbach, one of his first pupils, and published in 1843 in an English edition: “I hope that this little offering may serve to make new friends to our beautiful and useful science.” Of course, a major impact made Liebig’s *Chemische Briefe*, which he wrote “for the special purpose of exciting the attention of governments, and an enlightened public, to the necessity of establishing Schools of Chemistry, and of promoting, by every means, the study of a science so intimately connected with the arts, pursuits, and social well-being of modern civilized nations.” (Paoloni 1968, p. 106) C. Paoloni (1968) has established the complete chronology of the multi-language editions of the *Familiar Letters*, as it was called in English: thanks to the services of his former pupils, it was translated into nine languages, with eleven editions in Italy alone. Brock (1998) has studied how this monument of German literature enlarged the public knowledge and raised a large interest in chemistry.

Another important means of propagating, if not popularizing, chemistry was the *Annalen*. In 1831 Liebig started as co-editor with Geiger the *Magazin für Pharmacie*, which in 1832 became the *Annalen der Pharmacie*. In 1838, he associated Dumas and Graham, which was only a formal co-editorship, ridiculed by Wöhler,<sup>26</sup> but an attempt to attract a European audience. It was also an important step of the time to make the German pharmacists, “who are on such a high level of education”, more involved in the advancement of chemistry: “This Journal will be preeminently devoted to the new chemistry, the organic chemistry, without excluding the most important discoveries in other parts of the science.”<sup>27</sup> In 1840, the journal title changed to *Annalen der Chemie und Pharmacie*.

Liebig also used his personal influence, contacts, friendships, and fame to diffuse his ideas. By all means he tried to make everyone in every country be acquainted with chemistry, including the readers of the *Allgemeiner Anzeiger* (Gotha), the chancellor of Hessen-Darmstadt, and Napoleon III. Finlay (1998) has described how Liebig’s international contacts and political connections helped him disseminate his ideas of chemistry across the world. Among the more curious means was an extract of meat that was marketed and branded ‘Liebig’s Fleischextrakt’, which propagated his name and, consequently, the image of chemistry. In university policy, he used his connection to Linde, the chancellor of the University of Giessen, “to raise the Institute of Natural Sciences of Giessen to a higher level than at any other German

University”, by intervening into material and financial issues of the building and into new appointments.<sup>28</sup> For instance, he was influential in the appointment of Buff to the chair of physics with a decent salary, because “an education in chemistry is impossible without a former accurate knowledge of physics”.<sup>29</sup>

Liebig was known as a polemicist seeking for quarrels and scandals, such that only a few chemists and friends escaped his quarrels. However, he deliberately used his scandals as a means to make himself and his ideas better known. For instance, his essay ‘Der Zustand...’ (Liebig 1840a) was meant to raise a scandal for the propagation of his new book (“The *Zustand* will be the best and most appropriate prospectus for our *Chemical Physiology*”<sup>30</sup>), which turned out to be successful: “The essay made much more noise than I hoped. The mathematicians, professors, philologists were irritated because of the disdainful manner they are treated, as they say.”<sup>31</sup>

Liebig also used simple words and clear sentences that anyone could understand, and thus contributed not only to the formation of the chemical language,<sup>32</sup> but also to the broader public education. In addition, he frequently used simple images and analogies drawn from ordinary life, particularly in his *Letters on Agriculture* and in the last editions of the *Agricultural Chemistry*. The first part of the first volume of the 7<sup>th</sup> edition of the *Agricultural Chemistry* was a model of simplicity and non-specialization, making clear to everyone the principles of his agriculture and the crucial importance of chemistry for improving crops without exhausting the earth. The farmer must respect the great principle of chemistry: nothing is left, nothing is created, everything changes. The prosperity of the ancient little farm, of Chinese agriculture, rested on the principle of restitution, the first law of the circulation of elements. Regarding manure as a magic remedy to save our exhausted fields was the same as seeking for the philosopher’s stone.

## 6. Conclusion

During the second half of his life, Liebig worked as a propagator of chemistry, partly at the expense of his scientific activity. He was determined to make his science known to the general public, as a primary service to chemistry. In 1851, he dedicated to Dumas his *Nouvelles Lettres sur la Chimie*: “I have tried to popularize the doctrines for which you played such an important part.” (Liebig 1852) However, he was never really in agreement with Dumas’s doctrines. Rather than teaching doctrines, Liebig placed chemistry in the very center of everybody’s daily life. Since ‘*alles ist Chemie*’, everybody had to know chemistry. Without any of our modern means of mass commu-

nication, Liebig managed to make his message heard beyond borders in space, time, and societies. As Brock (1997, p. 266) wrote, “Liebig worked to make chemistry the fundamental science to modern societies”. Popularizing was part of the task, not the least important.

## Notes

- <sup>1</sup> Berzelius to Liebig and Wöhler, 2 Sept. 1832. For manuscripts and unpublished letters, the following archives have been consulted: Archives de l'Académie des Sciences, Dossier Liebig, and Archiv der Justus Liebig Gesellschaft, Giessen.
- <sup>2</sup> Berzelius to Liebig, 14 Aug. 1839.
- <sup>3</sup> “It must be viewed not only as probable but as certain that we shall produce organic substances in our laboratories. Sugar, salicin and morphine will be artificially produced.” (Wöhler & Liebig 1838).
- <sup>4</sup> Berzelius to Liebig, 8 Jan. 1831, 8 May 1831.
- <sup>5</sup> Cf. Wöhler to Liebig, 8 May 1839.
- <sup>6</sup> Liebig to Schleiermacher, 17 Feb. 1823, in Brock 1997, p. 29.
- <sup>7</sup> Liebig to Vieweg, 3. Nov. 1832.
- <sup>8</sup> Liebig to Vieweg, 1837-8.
- <sup>9</sup> Graham to Liebig, 17 Oct. 1837.
- <sup>10</sup> Liebig to Berzelius, 26 Nov. 1837.
- <sup>11</sup> Graham to Liebig, 25 Nov. 1837.
- <sup>12</sup> Liebig to Dumas, 18 March 1838.
- <sup>13</sup> Liebig to Berzelius, 28 July 1839.
- <sup>14</sup> Liebig to Berzelius, 10 March 1839.
- <sup>15</sup> Liebig to Berzelius, 26 Apr. 1840.
- <sup>16</sup> Liebig to Vieweg, 17 March 1840, see also Blondel-Mégrelis 2005.
- <sup>17</sup> Regine Zott (1993) has discussed the relationship between the two famous publications of 1840.
- <sup>18</sup> Liebig kept on writing that chemistry could no longer be considered a servant, that it had to be considered in its own right (e.g. Liebig 1840, p. 102; Liebig to Linde, 26 Apr. 1840).
- <sup>19</sup> Liebig to Wöhler, 3 July 1840.
- <sup>20</sup> Liebig to Vieweg, 28 May 1840.
- <sup>21</sup> Vieweg, F. und Sohn: ‘Prospectus: Handwörterbuch der reinen und angewandten Chemie’, 1842.
- <sup>22</sup> For the choice of the dedication in the English version, see Gregory to Liebig, 25 May 1842.
- <sup>23</sup> “On the title of the *Physiology* [Agricultural Chemistry], Professor of Chemistry has to be inserted, as well as honorary citizen of the town of Giessen; then, after

- membership of the Royal Society, must be written member of the British Association for the Advancement of Science.” (Liebig to Vieweg, 25 July 1840).
- <sup>24</sup> “Write above it: to Chemists (before that 1), Pharmacists (before that 5), Agronomists (before that 4), Physiologists (before that 2), and Botanists (before that 3), and Physicians (before that 6)” (Liebig to Vieweg, 3 July 1840).
- <sup>25</sup> Gregory to Liebig, 25 Sept. 1840.
- <sup>26</sup> Wöhler to Berzelius, 30 July 1838.
- <sup>27</sup> Liebig’s ‘Vorbericht’ (1 Jan. 1838) in *Annalen der Pharmacie*. Note that his essay ‘Der Zustand der Chemie in Österreich’ was published in the same volume.
- <sup>28</sup> Liebig to Linde, 22 May 1839.
- <sup>29</sup> Liebig to Linde, Nov. and Dec. 1837.
- <sup>30</sup> Liebig to Vieweg, May and June 1840.
- <sup>31</sup> Liebig to Vieweg, 12 June 1840.
- <sup>32</sup> Brock (1997, p. 223) quotes the brothers Grimms’ homage in their *Deutsches Wörterbuch*: in Liebig’s mouth, chemistry becomes ‘*Sprachgewalt*’.

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