

# Justus von Liebig

The Chemical Gatekeeper

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# 1

## *From Pharmacy to Chemistry*

Chemical laboratories, in which instruction in chemical analysis was imparted, existed nowhere at that time. What passed by that name were more like kitchens. . . . No one really understood how to teach it.<sup>1</sup>

In 1890, when sifting through his father's papers, Georg von Liebig came across an autobiographical sketch written by Justus von Liebig on or soon after his sixtieth birthday in 1863. Published by Georg in the *Berichte der Deutschen chemischen Gesellschaft* in 1890, the sketch was rapidly translated into English by the Liverpool chemist and historian of chemistry, J. Campbell Brown. These reminiscences became the basis of most later accounts of Liebig's early life and career. Like most reconstructions of a person's life written half a century after childhood, Liebig's autobiography has to be treated with circumspection. His treatment of his family's circumstances may well have been distorted by his parents' reminiscences as much as by his own inclination as a baron of Hessen-Darmstadt, to "improve on" his birthright. These factors, together with his desire to illustrate certain educational precepts through personal anecdotes, all tended to produce an account that does not entirely dovetail with what the historian can discover from other sources.

Liebig tells us nothing about his birth and childhood before he reached the age of fourteen, except to say that his father, Johann Georg Liebig (1775–1850), was a drysalter and hardware merchant (*Materialist*) in the ducal city of Darmstadt, who dealt in and made up varnishes, paints, boot and grate polishes and pigments for householders and various local trades and businesses.<sup>2</sup> For this purpose Johann had fitted up a laboratory-cum-

1. Georg von Liebig, "Liebig: Eigenhändige biographische Aufzeichnungen," *Berichte* 23 (1890), Referat pp. 785–816, and *Deutsche Rundschau* (17 January 1891), 30–39; English translation by J. Campbell Brown, *Chemical News* 63 (1891), 265–66, 276–77; *Annual Reports Smithsonian Institution* (Washington, D.C., 1893), pp. 257–68, from which citations are made.

2. Liebig sent Hofmann a recipe for the boot polish by which his father had earned a tidy sum each year. See Liebig to Hofmann, 28 January 1852, in W. H. Brock, ed., *Justus von*

workshop in an allotment garden not far from his home, where the young Liebig was inducted into the ancient mysteries of “bucket” chemistry. All this can be verified, but as Pat Munday has demonstrated, nothing in Liebig’s early life is quite straightforward.<sup>3</sup> Even the date of Liebig’s birth is controversial. Different sources give 3 May 1803 (his mother), 8 May (a Munich gravestone), and 14 May (church records); following A. W. Hofmann, Liebig’s greatest student, historians have opted for 10 May 1803.<sup>4</sup> Interestingly, the church recorder wrote Liebig’s father’s name as it was pronounced: “Liebich.”

Liebig’s birthplace survived until it became unsafe in 1920, when it was carefully dismantled and rebuilt as the “Liebighaus,” which opened in 1928. This museum was completely destroyed in the Allied bombing of Darmstadt in 1944, though the museum’s publications provide a good picture of what it was like.<sup>5</sup> Situated at 30 Grosse Kaplaneigasse, Liebig’s terraced home opened directly onto a narrow hallway that led to a paved courtyard at the rear. There were three small rooms to the right of the hall, one of which served as the shop. A narrow staircase led to three more small rooms on the first floor and a further three bedrooms in the attics. From one of these attic rooms there was a clear view of the royal palace and Court Library. Although it was “pokey” by modern standards, there must have been ample space and accommodation for the Liebigs and their five surviving children.

Justus Liebig was Johann’s second child and son. The older brother, Johann Ludwig “Louis” (1801–30), seems to have been a disappointment to his parents. It was obviously intended that he should inherit the family business and extend its range and status by making it a pharmacy. In 1816 Louis was apprenticed to a manufacturer in Frankfurt but was sent back the following year to be reapprenticed to a pharmacist in St. Goar, following which he worked in many German towns before his early death, having made it clear to his father in 1822 that he did not want to return to Darmstadt. Another younger brother died at the age of five, and four sisters died in infancy. By the time Justus Liebig had become famous in 1830, therefore, his only siblings were two younger brothers Johann Georg (1811–43) and Karl (1818–70) and a sister Elizabeth (1820–90),

*Liebig und August Wilhelm Hofmann in ihrer Briefen* (Weinheim, 1984), pp. 123–24.

3. P. Munday, *Sturm und Dung. Justus von Liebig and the Chemistry of Agriculture* (PhD thesis, Cornell University, 1990); and “Sturm and Dung,” *Ambix* 37(1990), 1–19.
4. A. W. Hofmann, Faraday Lecture for 1875, *The Life Work of Liebig* (London, 1876), frontispiece and p. 50. Reprinted in *Faraday Lectures of the Chemical Society* (London, 1928).
5. H. Hohmann, *Justus von Liebig’s Geburtshaus* (Darmstadt, c. 1928); Ernst Berl, “The Liebig House and the Kekulé Room at Darmstadt,” *J. Chem. Educ.* 6 (1929), 1869–81.



Photograph of Liebig's birthplace in Darmstadt taken in the 1920s before the house was transformed into a museum. (Courtesy W. Lewicki)

who later married Liebig's Giessen colleague Friedrich Knapp. In place of Louis's refusal to take over the family business and because of Justus's academic aspirations, the family hopes were placed on Karl, who studied pharmacy at the University of Giessen under his brother in 1842 before taking over the family's materials business the following year. The shop's name "Georg Liebig & Sohn" was retained after Karl's death in 1870, and the business was still in the hands of Karl's son Georg Liebig, when Volhard (1909) published the standard German biography of Justus Liebig. By then the family's business also included a factory in Hannover.

Liebig's mother, Maria Caroline Möser (1781–1855), who ran the hardware shop, was the illegitimate child of an itinerant Swabian tailor Christoph Einselin and the daughter of a Darmstadt farmer named Fuchs. Caroline, as she was familiarly known, had been adopted by the Möasers,

whose name she had taken.<sup>6</sup> That Liebig's mother, who was noted for her quick wit, had Jewish ancestry seems likely; there were anxious attempts by Aryan local historians in the 1930s to extinguish the possibility that Liebig had descended from anything but pure Hessian stock. Liebig's prominent peasant's nose (*Bauernnase*) and impressive eyes were undoubtedly inherited from his mother. She also had a calming influence on her husband, whose impetuosity and occasional vehemence were to be unfortunate characteristics of their son Justus.

Hessen is one of the *Länder* (administrative regions) of modern Germany. Situated on the Rhine, it was formerly divided into numerous independent principalities, but toward the end of the eighteenth century it had been partitioned into the two dominions of Hessen-Kassel ruled by an electoral prince, with its university situated in Marburg; and Hessen-Darmstadt, a grand duchy devoted to agriculture and viniculture with its Lutheran University at Giessen. Although Hessen-Kassel was absorbed by Prussia in 1866, Hessen-Darmstadt retained its independence in return for a loose alliance with France. With the outbreak of the Franco-Prussian war in 1870, Hessen-Darmstadt joined the German Federation and thus became part of the United German Empire. The original grand duke of Hessen-Darmstadt, Ludewig (or Ludwig) I (1753–1848), was pro-French; indeed, he owed his duchy's independence to Napoleon.<sup>7</sup> Liebig was to benefit from this connection and allegiance. Although Ludwig freed the peasantry from serfdom in 1812 and gave his subjects a written constitution in 1820, these reforms did little to reduce the traditional feudal powers of the local Hessen nobility, and despite some desultory attempts to introduce machinery and industry to the state, much of the peasantry continued to live in poverty little better than serfdom. Hessen-Darmstadt was said to have more nobility with extensive estates than any other part of Germany. While studying with Liebig at Giessen in 1846, the American student Eben Horsford was horrified by the poverty he witnessed in the countryside around Giessen.<sup>8</sup>

During the reign of Ludwig II, who succeeded as Landgrave after his father's abdication in 1830, the country's political and economic stagnation worsened, leading to a series of disturbances that culminated in the 1848 revolution. Having inherited his father's considerable debts, Ludwig II raised taxes and quashed a parliamentary rebellion by calling an election, which he rigged to ensure a loyal parliamentary following. Famines, and the fact that the countryside no longer seemed able to support the

6. See E. Berl, "Justus von Liebig," *J. Chem. Educ.* 15 (1938), 553–62.

7. Ludwig's portrait appears in *J. Chem. Educ.* 13 (1936), 315.

8. S. Reznick, "Horsford," *Technology and Culture* 11 (1970), 376.

peasantry that had returned from Napoleonic battlefields, had also increased the pressure to emigrate. Emigration was officially opposed in 1826, though rising prices, cholera, and general disorder led to a wave of emigration to America in the 1830s.<sup>9</sup> Such actions radicalised a considerable number of students at the University of Giessen in the 1830s, though Liebig himself appears to have been largely oblivious to these events. Not until the 1850s did he begin to view them in Malthusian terms of overpopulation. A factor here was the death of Ludwig II in 1848; he was succeeded by another Ludwig who survived until 1877. Ludwig III was not to Liebig's liking, and this was one of the several factors that was to prompt Liebig's move from the University of Giessen to the University of Munich in 1852.

Johann Liebig was by all accounts an inventive man. The son of a shoemaker, whose Hessian Oberwald ancestors can be traced back to 1577, he belonged to the shopkeepers' guild in Darmstadt, taught himself sufficient chemistry to manufacture useful chemicals on a small scale and to acquire a certain fame locally during the 1820s for illuminating his home (or was it only the shop?) with acetylene gas prepared from heated bones.<sup>10</sup> He was ambitious that his two elder sons should rise socially from the family's lower-middle-class ranks (*Kleinbürger*) to that of the upper middle class (*Bildungsbürger*). In Liebig's youth, Darmstadt's population was about 15,000 people. Times were undoubtedly hard for Liebig's family during the Napoleonic wars that stretched through Liebig's childhood until he was twelve in 1815, and during the recriminations that followed in their wake. The tiny duchy, allied to France, had to help Napoleon with supplies and army recruits. Cut off from raw materials by Britain's effective blockade of the Continent, Johann Liebig's business must have suffered, although supplies of sulphur astutely bought by Frau Liebig before the blockade began had proved profitable.

Any family hardship did not, however, prevent Johann Liebig from sending the young Justus Liebig to Darmstadt's Ludwig-Georgs-Gymnasium, a fine traditional grammar school run on strictly classical lines by a scholar-headmaster, Johann Zimmermann (1754–1829).<sup>11</sup> This was apparently after some earlier schooling with a Dr. Graul. Both Justus and his older brother Louis entered the Gymnasium at Easter 1811. Liebig was only eight, and since the average age in the first class was ten, he must

9. H. Lindenberger, *Georg Büchner* (Carbondale, 1964), pp. 5–9; A. H. J. Knight, *Georg Büchner* (Oxford, 1951), p. 30; Mark Walker, *Germany and the Emigration 1816–1885* (Cambridge, Mass., 1964).

10. Liebig to his father 25 February 1821, in E. Berl, *Briefe von Justus von Liebig nach neuen Funden* (Giessen, 1928), pp. 17–18.

11. *Hessische Biographien*, vol. 3 (Darmstadt, 1934; reprint Wiesbaden, 1973), p. 100.



have been precocious to have coped. Surviving records examined by Volhard show that at the end of the fourth form (*Tertia*) in 1813, Liebig was placed twenty-third out of twenty-eight, and when he was in the fifth form (*Sekunda*) at Easter 1815 he was seventeenth out of twenty-seven. This does not suggest the complete indifference to the curriculum that he expressed mockingly in his autobiography, especially if we bear in mind that Liebig was always almost two years younger than the average age of his form throughout his schooling.

With this [observational and empirical] bent of mind it is easy to understand that my position at school was very deplorable; I had no ear memory, and retained nothing or very little of what is learned through this sense. I found myself in the most uncomfortable position in which a boy could possibly be; languages and everything that is acquired by their means, that gains praise and honour in the school were out of my reach; and when the venerable rector of the Gymnasium, on one occasion of his examination of my class, came to me and made a most cutting remonstrance with me for my want of diligence, how I was the plague of my teachers and the sorrow of my parents, and what did I think was to become of me, and when I answered that I would be a chemist, the whole school and the good old man himself broke into an uncontrollable fit of laughter, for no one at that time had any idea that chemistry was a thing that could be studied.<sup>12</sup>

The anecdote is plausible enough – especially the headmaster’s raillery – though whether Liebig himself really understood the difference between pharmacy and chemistry at this time is doubtful. In another anecdote collected by Kohut, the assistant headmaster Johann Storck accused Liebig of being a sheep’s head (*Schafskopf*), and this became Liebig’s playground nickname.<sup>13</sup>

In fact the Darmstadt school was a good one; a notable earlier pupil had been Emmanuel Merck (1794–1855), who took over his father’s long-established Darmstadt pharmacy in 1816 after studying with Trommsdorff at Erfurt.<sup>14</sup> Liebig and Merck were to become collaborators in the 1820s. Three others of Liebig’s immediate classroom contemporaries were Georg Gervinus, Jacob Kaup, and Ludwig Reuling. All three became distinguished men: Gervinus as a historian, Kaup as a naturalist and

12. Liebig, “Autobiography,” p. 260.

13. A. Kohut, *Justus von Liebig* (Giessen, 1904), p. 9. Kohut, who unlike Volhard was a professional historian, was not given access to Liebig’s papers. Nevertheless, his biography is an interesting complement to Volhard’s.

14. Fritz Ebner, *Merck und Darmstadt* (Darmstadt, undated).

Darwinian,<sup>15</sup> and Reuling as a conductor of the Imperial Opera House in Vienna.<sup>16</sup>

The implication of Liebig's autobiography is that he dropped out of the Darmstadt Gymnasium in 1817 when he was fourteen because the curriculum so clearly did not suit him.<sup>17</sup> A more likely reason is that his father could no longer afford the fees, for following Napoleon's defeat in 1815, tough measures were taken by Metternich at the Vienna Congress against Hessen-Darmstadt for having supported the French. Rich agricultural areas of the duchy were ceded to other states, taxes were increased, and appalling weather in 1816 and 1817 caused crop failures and famine. For the next forty years Hessen-Darmstadt became the poorhouse of Germany, which fed political radicalism and stimulated peasant emigration on a wide scale.

Having left school at fourteen without taking his *Abitur*, or leaving certificate, Liebig's chances of preferment were grim; entry to a university would be difficult (though, as we shall see, not impossible), and teaching and the civil service would be beyond the pale. Given Liebig's evident interest in his father's chemical preparations and the fact that the profession of apothecary had, since the eighteenth century, become a position of esteem, Johann decided to apprentice his second son to the apothecary Gottfried Pirsch (1792–1870), who kept a business at Heppenheim in Baden-Württemberg to the south of Darmstadt and a few miles to the north of Heidelberg.<sup>18</sup>

Liebig's reminiscences again tell only half the story:

Since the ordinary career of a gymnasium student was not open to me, my father took me to an apothecary at Heppenheim, in the Hessian Bergstrasse; but at the end of ten months [in fact only six months] he was so tired of me that he sent me home again to my father. I wished to be a chemist, but not a druggist. The ten months [sic] sufficed to make me completely acquainted alike with the use and manifold

15. For Gervinus and Kaup, see *Allgemeine Deutsche Biographie* (Munich, 1875–1912), vols. 9 and 15.

16. Reuling (1802–79) composed seventeen operas. See *Baker's Biographical Dictionary of Musicians*, 7th ed. (Oxford, 1984), p. 1883.

17. J. Volhard, *Justus von Liebig*, 2 vols. (Leipzig, 1909), hereafter "Volhard, *Liebig*," noted a memorandum of 1852 in Liebig's handwriting which claimed he left school when he was seventeen; the school's records did not confirm this date. See Volhard, *Liebig*, vol. I, p. 15.

18. Munday, *Sturm und Dung*, p. 20. This handsome timbered pharmacy, subsequently renamed the Liebig-Apotheker on the basis of Liebig's brief connection, survives in the Bergstrasse as a restaurant. See W. H. Hein, *Die Deutsche Apotheke* (Stuttgart, 1960), p. 176; and Kohut, *Justus von Liebig*, p. 3.

applications of the thousand and one different things which are found in a druggist's shop.<sup>19</sup>

In fact, as surviving correspondence between Pirsch and Liebig's father shows, times were too hard for Johann Liebig to pay the indenture fee. Despite gifts of tobacco, with no fee and no apprenticeship agreement ever made, Pirsch simply returned Liebig to his father, just as Louis had been earlier. The successful adult Baron Liebig obviously found his boyhood poverty embarrassing and so he invented stories of causing explosions in the pharmacy that had earned him dismissal as an unruly apprentice. This episode formed one of the scenes from Liebig's life pictured in the *Liebigbilder* advertising cards that were circulated by the Liebig Meat Company in the 1880s and that was taken over and embroidered by Volhard in his standard biography.<sup>20</sup>

For the next two years, from 1817 to 1819, and until he was seventeen, Liebig remained at home, helping his father and reading chemistry books that he was able to borrow from Duke Ludwig's Court Library. This privilege seems to have developed from the fact that his father, who presumably had the equivalent of a British "by Royal Appointment" with Duke Ludwig, was allowed to borrow technical books from the Court Library, and young Justus was often sent to return them.

The lively interest that I took in my father's labours naturally led me to read the books which guided him in his experiments, and such a passion for these books was gradually developed in me that I became indifferent to every other thing that ordinarily attracts children. Since I did not fail to fetch the books from the Court Library myself, I became acquainted with the librarian, Hess,<sup>21</sup> who occupied himself successfully with botany, and as he took a fancy to the little fellow [*sic*, Liebig was probably a teenager]. I got, through him, all the books I could desire for my own use. Of course the reading of books went on without any system. I read the books just as they stood upon the shelves, whether from below upwards or from right to left was all the same to me; my 14-year-old head was like an ostrich stomach for their contents, and amongst them I found side by side upon the shelves the thirty-two volumes of Macquer's "Chemical Dictionary,"<sup>22</sup> Basil Valentine's "Triumphal Chariot of Antimony," Stahl's "Phlogistic

19. Liebig, "Autobiography," p. 260.

20. Volhard, *Liebig*, vol. I, p. 17.

21. Johannes Hess (1786–1837), architect and botanist, as well as Court Librarian. See *Hessische Biographien*, vol. 3, p. 121.

22. P. J. Macquer, *Dictionnaire de chymie*, 2 vols. (Paris, 1766); 2nd ed., 4 vols. (Paris, 1778); *Chemisches Wörterbuch*, 6 vols. (Leipzig, 1781–83; 2nd ed., 7 vols., 1788–90). Liebig may have been using a mixed edition that looked like 12 volumes.

Chemistry," thousands of essays and treatises in Götting's periodicals,<sup>23</sup> the works of Kirwan, Cavendish, etc.<sup>24</sup>

In the light of our earlier scepticism towards parts of Liebig's autobiography, we might well be suspicious as to whether the son of a local hardwareman would be allowed to borrow books from an aristocratic library. However, Liebig undoubtedly speaks the truth here, though there is no reason to think that he was as privileged a borrower as he implies. Ludwig's library seems to have functioned more as a state or public library than as a private one, and there are independent sources that confirm that other Darmstadtters were allowed to use it. On the other hand, if Liebig's memory of his browsing is accurate, then his reading was out of date; apart from a picture of more recent chemistry that he could have obtained from Götting's *Almanach oder Taschenbuch für Scheidekünstler und Apotheker* (1780–1802), his reading material was pre-Lavoisian. Nevertheless, although the reading was useless as far as current chemistry was concerned, in retrospect Liebig believed that he benefited closely from it.

It developed in me the faculty, which is peculiar to chemists more than to other natural philosophers, of thinking in terms of phenomena; it is not very easy to give a clear idea of phenomena to anyone who cannot recall in his imagination a mental picture of what he sees and hears, – like the poet and artist, for example. Most closely akin is the peculiar power of the musician, who while composing thinks in tones which are as much connected by laws as the logically arranged conceptions in a conclusion or series of conclusions. There is in the chemist a form of thought by which all ideas become visible in the mind as the strains of an imagined piece of music. This form of thought is developed in Faraday in the highest degree, whence it arises that to one who is not acquainted with this method of thinking, his scientific works seem barren and dry, and merely a series of researches strung together, while his oral discourse when he teaches or explains is intellectual, elegant, and of wonderful clearness.<sup>25</sup>

To achieve this faculty, however, it was necessary to combine reading with practice:

23. B. Valentine (pseud.), *Triumph Wagen Antimoni* (Leipzig, 1604) and later editions; E. Stahl, *Fundamenta Chymiae Dogmatico-Rationalis et Experimentalis* (Nürnberg, 1723); Götting (1755–1809), Professor of Chemistry at Jena, published a large number of practical pharmacy texts. J. R. Partington, *A History of Chemistry*, vol. iii (London, 1962), pp. 595–96. R. Kirwan (1733–1812) and H. Cavendish (1731–1810) both published on pneumatic chemistry.

24. Liebig, "Autobiography," pp. 257–58.

25. *Ibid.*, p. 258.

The faculty of thinking in phenomena can only be cultivated if the mind is constantly trained, and this was effected in my case by my endeavouring to perform, so far as my means would allow me, all the experiments whose description I read in the books. These means were very limited, and hence it arose that, in order to satisfy my inclinations, I repeated such experiments as I was able to make, a countless number of times, until I ceased to see anything new in the process, or till I knew thoroughly every aspect of the phenomenon which presented itself. The natural consequence of this was the development of a memory of the sense, that is to say of the sight, a clear perception of the resemblance or differences of things or of phenomena, which afterwards stood me in good stead.<sup>26</sup>

All chemists will recognize this as a valid description of the eye and ear memory that is so essential in the successful practitioner and that today is needfully reinforced by a good three-dimensional sense of the shapes of molecules.

By the time he was seventeen, trade had improved and Liebig decided that he would be a pharmaceutical chemist and possibly an industrialist. One of Liebig's chemical notebooks from this period, from 1819 to 1821, has survived and shows him taking a lively interest in recipes for dye stuffs, pigments, and varnishes, though not in the fulminates that his reminiscences imply he had been fascinated by since a schoolboy. As Munday has commented: "At this point in [Liebig's] life, chemistry was significant only for its immediate application to the apothecary trade or to a manufactory like his father's."<sup>27</sup> Liebig was still doing bucket chemistry, as his work on fulminates illustrates. He had witnessed a pedlar in the Darmstadt market prepare a mercury fulminate for the toy torpedoes or firecrackers that he was selling. Recognising the ingredients as mercury, nitric acid, and alcohol, it had been a simple matter for Liebig to make up his own crackers as an exciting sales item for his parents' shop.<sup>28</sup>

The term *fulmination* had been used by the alchemists to refer to explosions, and gold and silver fulminates may well have been accidentally prepared during the seventeenth century. However, the powerful detonating silver fulminate was only formally discovered by Berthollet in France in 1789 when he added ammonia to silver oxide in an attempt to discover the composition of ammonia. Subsequently, in 1800, an English aristocratic inventor Charles Howard (1774–1816), as well as the Italian Luigi Brugnatelli (1761–1818), had prepared mercury and silver fulminates by a variety of methods. There was much confused discussion in the litera-

26. *Ibid.*, p. 258.

27. Munday, *Sturm und Dung*, p. 22.

28. Volhard, *Liebig*, vol. i, p. 11.

ture of the period, which Liebig picked on, as to whether these fulminates contained ammonia.<sup>29</sup> Here was an appropriate subject for elucidation for anyone foolhardy enough to investigate. This rather dangerous work, which had cost other investigators eyes and fingers and which must have been done in his father's workshop, led to Liebig's first paper, published in J. A. Buchner's *Repertorium für die Pharmacie* in 1822. This Bavarian journal, founded by the reforming pharmacist A. F. Gehlen (1775–1815) in the year of his death, was much concerned with raising the professional status of pharmacists, a campaign that Liebig was soon to join.

Liebig's first paper, which was little more than a demonstration of the identity of composition of the various silver fulminate preparations described in formularies, together with his own recommendation of a foolproof method for preparing silver fulminate, was actually submitted to Buchner by the professor of chemistry at the University of Erlangen, K. W. G. Kastner (1783–1857), who included a curious, fulsome introductory note:

These first proofs of the experimental diligence of a young chemist are commended to the reader's indulgence. The author has already dedicated himself to chemistry at Bonn with enthusiasm and intends to go about it in the same spirit here in Erlangen.<sup>30</sup>

Kastner writes like an indulgent father; indeed, he was Liebig's *in loco parentis* from 1821.

### The University of Bonn

The University of Berlin had been established in the Prussian capital city of Berlin in 1809 to offset the closure of the prestigious University of Halle by Napoleon. As Friedrich Schleiermacher wrote at the time, it was founded to demonstrate "that Prussia, instead of surrendering the function it had so long practised, that of striving above all else for a higher intellectual culture as the source of power, proposed to begin anew; that Prussia . . . would not allow itself to be isolated, but desired, rather, in this respect also, to remain in living union with the whole of natural Germany."<sup>31</sup> Underwritten by the educational philosophy of freedom of

29. Partington, *History of Chemistry*, vol. iv (London, 1964), pp. 257–58.

30. J. Liebig, "Einige Bemerkungen über die Bereitung und Zusammensetzung des Brugnatellischen und Howardischen Knallsilbers," *Büchners Repertorium der Pharmacie* 12 (1822), 412–26. Kastner's remark prefaces the article.

31. F. Schleiermacher, *Gelegenheit Gedanken über Universitäten* (Berlin, 1808), cited in F. Paulsen, *German Universities* (London, 1906), p. 50. See Charles E. McClelland, *State, Society, and University in Germany 1700–1914* (Cambridge, 1980).

learning and teaching, and of learning for its own sake rather than for a career (*Brotstudien*), Berlin became the model for other Prussian universities, including Bonn. A Catholic University had been created at Bonn in 1786, only to be suppressed by the French. However, after Bonn was ceded to Prussia, following the Congress of Vienna in 1815, King Friedrich Wilhelm III seized the opportunity of re-creating the university in the former Electoral Palace and at the neighbouring Poppelsdorff Schloss. His adviser, the Prussian minister of culture Karl Altenstein, was determined that the new university should cultivate the sciences as well as the humanities and theology (there were both a Protestant and a Catholic faculty of theology). To this end he seems to have deliberately sought to hire members of Germany's oldest and most prestigious learned society, the Leopoldina, which had been founded in 1672. This brought Kastner from Halle and several other Professors from the University of Erlangen, including the chemical geologist Karl Bischof (1792–1870), who was to succeed Kastner in 1822, and the great botanist Christian Nees von Esenbeck (1776–1858). The policy was so successful that the Leopoldina library and natural science and history collections were also brought from Erlangen to Bonn.<sup>32</sup> The rebirth of the Leopoldina at Bonn was also to lead Nees's fellow naturalist Lorenz Oken to the idea of annual gatherings of doctors and scientists in different German university towns. Although Liebig was only a cursory attender at these meetings of the *Gesellschaft Deutsche Naturforscher und Aerzte*, which began at Leipzig in 1822, they marked the blossoming of German science and formed a model for the meetings of the British Association for the Advancement of Science (BAAS) that Liebig did attend.

Although now virtually unknown, in the 1820s Kastner must have been regarded in many quarters along with Wolfgang Döbereiner (1780–1849) at Jena and Friedrich Stromeyer (1776–1835) at Göttingen, as a leading chemist among all the German states. The author of three or four texts, he was successively professor of chemistry at the University of Heidelberg (1805–12), the university of Halle (1812–18), the new Prussian University of Bonn (1818–21), and the Protestant University of Erlangen (1821–57). While at Halle he must have got to know Liebig's father as a supplier of chemicals, for in 1818, Johann Liebig contributed a paper to Kastner's periodical, *Die deutsche Gewerbsfreund* (The German Tradesman) on the best time of year to apply liquid manure. This little-studied but significant

32. C. Renger, *Die Gründung und Einrichtung der Universität Bonn* (Bonn, 1982). J. Bargon, "August Kekulé and the Kekulé Building at the University of Bonn," in J. Wotiz, ed., *The Kekulé Riddle* (Clearwater, Fla., 1993), pp. 33–47.

journal was used by Kastner to argue that it was the business of chemistry and of chemists to further trade and the prosperity of nations.<sup>33</sup> This was precisely the message that Liebig was to elaborate upon in the 1840s.

It is possible that Kastner passed through Darmstadt on his way to Bonn in 1818 and was sufficiently impressed by the academic keenness of Justus that he offered to take him on as his personal assistant and to train him in chemistry. Matriculation at the local University of Giessen, where chemistry was desultorily taught to medical students, was out of the question because Liebig had no *Abitur*. The situation at the new University of Bonn was either more relaxed, or Kastner, as its first professor of chemistry, had sufficient clout to engineer Liebig's matriculation. The major problem was financial, but Johann overcame this through his friendship with the grand-duke's chancellor, Ernst Schleiermacher (1755–1844), who arranged for Liebig to receive a small stipend. He, too, must have been strongly persuaded of the young man's potential. In practice, Liebig seems to have worked his way through his first semester at Bonn in 1820 as a kind of unofficial and extremely youthful Privatdocent, offering lessons to other undergraduates. He started up a student group to read and discuss contemporary chemical publications and worked extremely hard. One of his fellow students was the son of the then well-known German chemist, C. F. Buchholz, who became a close friend. Buchholz (1770–1818) was professor of pharmacy at Erfurt.

Liebig's wonderfully informative letters to his parents can be liberally quoted from to illustrate his life and activities as an undergraduate who did not drink and who devoted himself entirely to his studies.

This semester I have taken experimental chemistry, experimental physics, and pharmaceutical chemistry. I take these courses and I also audit meteorology, and encyclopaedia of the natural sciences. I am rather busy this winter. In summer I may take mineralogy, and so forth. Kastner promised me that I may be present as an assistant or Famulus in his private experiments. This would be a wonderful opportunity if he keeps his promise. I see him from time to time. I told him also about my treatment of cobalt ores and the very peculiar phenomena which happen thereby. He desires now to analyze this ore in my presence and he asks me to bring him more of it. Therefore, send me at once at least four ounces and add at least two lots of the mineral green from Gotha and two lots of our self-produced myrin and my solution of the cobalt ore and the yellow residue from the

33. For Kastner's journal, see O. P. Krätz, "Die Chemiker in den Gründungsjahren," in E. Schmauderer, ed., *Der Chemiker im Wandel der Zeiten* (Weinheim, 1973), pp. 259–84, esp. pp. 262–63.