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0521417759 - Enlightenment Science in the Romantic Era: The Chemistry of Berzelius and its Cultural Setting

Edited by Evan M. Melhado and Tore Frängsmyr

Excerpt

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## INTRODUCTION

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EVAN M. MELHADO AND TORE FRÄNGSMYR

In Chapter 1 of this volume, the late Sten Lindroth notes that Jacob Berzelius (1779–1848), though occupying a towering position within Swedish culture, has been admired for the most part from afar. Unlike Carl von Linné (1707–1778), the other principal giant of Swedish science, Lindroth tells us, Berzelius devoted himself to a subject sufficiently recondite to defy ready appreciation by outsiders to his fields of endeavor. We may add that it is not only Swedes for whom Berzelius has been a prominent but inaccessible icon and that the difficulty of Berzelius's science has been but one cause of his remoteness. The literature on Berzelius is indeed often technically difficult; but it is also widely scattered, and, for the non-Swedish audience, much of it is linguistically out of reach.

Moreover, though it is easy enough to list the areas in which Berzelius was most active and productive (atomic theory, chemical analysis, determination of atomic and molecular weights and formulas, chemical symbolism and nomenclature, electrochemical theory, mineralogy, crystallography, organic chemistry), it is far from easy to state succinctly just why Berzelius should have cut so prominent and imposing a figure for both his own time and for posterity. His thought was synthetic, pulling together disparate strands from his own and others' work, and there is no single achievement, no "Berzelius's law" that by its very name epitomizes his accomplishments. Indeed, as Evan Melhado remarks in his contribution to this volume (Chapter 6), traditional accounts of Berzelius, for which nineteenth-century chemists-turned-historian set the pattern, have minimized his originality and tended to identify as the only enduring outcomes of his work the empirical information he developed. What precisely Berzelius accomplished and what he stood for, for his own and subsequent generations, have escaped concise characterization.

With this volume, we have attempted to render Berzelius approachable and his contemporary significance clearer by making broadly available the results of much modern scholarship emanating from both Sweden and elsewhere, and in the process suggesting topics for further study and

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*Evan M. Melhado and Tore Frängsmyr*

research. By modern scholarship, we mean largely two genres of writing that transcend the nineteenth-century mold, particularly Swedish works in the historiographic tradition of Johan Nordström and studies crafted largely in the spirit of what might be called (for lack of a better term) the anglophone historiography that until recently dominated the history of science.<sup>1</sup> More recent methodologies, such as social history, social constructivism, discourse analysis, and those portraying science as practice (as opposed to knowledge) are not represented here (though some of the essays bear traces of their influence) because their practitioners thus far have not brought Berzelius into their purview. Existing scholarship, even if not marked by the latest methodological trends, is nevertheless of high quality, and when assembled in a volume such as this, can give a broad, if still incomplete, view of Berzelius and his place in the scientific world of his own country and of Europe. The gaps in that view also serve the purpose of suggesting topics for further investigation, particularly those that may be amenable to the newer historiographic approaches.

Lindroth's essay is a good place to begin. A towering figure of the history of science in Sweden, Sten Lindroth (1914–1980) succeeded in 1957 to the first Swedish professorial chair in the history of science (*idé- och lärdoms historia*, more accurately translated as “history of ideas and learning”), created in 1932 for his mentor, Johan Nordström (1891–1967).<sup>2</sup> Despite his early training in the natural sciences, Lindroth shared with Nordström a profoundly humanistic perspective on science. That perspective gave greater breadth to the scholarly tradition they inaugurated than many of its foreign models and steered it away from the positivism, whiggishness, and internalism that marked the historiography of science pursued elsewhere. Instead, they practiced a methodologically unselfconscious immersion in the primary sources, aimed to link science, technology, and medicine with broader cultural themes, and cultivated a

1 The Nordström tradition is briefly characterized in subsequent discussion. With the term “anglophone historiography” we refer to the largely internalist or intellectual history of science that emphasizes the empirical and theoretical content of science; selects, in its treatment of external factors, primarily the intellectual ones; and analyzes controversies and theory change in science chiefly in terms of its rational and empirical elements. See Tore Frängsmyr, “Science or History: George Sarton and the Positivist Tradition in History of Science,” *Lychnos*, 1973/74:104–144; and Thomas S. Kuhn, “Mathematical versus Experimental Traditions in the Development of Physical Science,” *Journal of Interdisciplinary History*, 1976, 7:1–31, reprinted in Thomas S. Kuhn, *The Essential Tension: Selected Studies in Scientific Tradition and Change* (Chicago: University of Chicago Press, 1977), pp. 31–65. Though the origin of this approach cannot be traced exclusively to anglophone scholars, it became dominant among them, and their example inspired much similar work elsewhere.

2 Tore Frängsmyr, ed., *History of Science in Sweden: The Growth of a Discipline, 1932–1982*. Uppsala Studies in the History of Science, Vol. 2 (Stockholm: Almqvist & Wiksell, 1984).

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style calculated to express the richness and nuances of the past.<sup>3</sup> The methodological debates so prevalent in both anglophone and franco-phone historiography thus scarcely characterize the work descending from Nordström, which is marked instead by a profound appreciation for the complexity of the past, a keen instinct for the central themes, and a developed talent (shown above all by Lindroth) to illuminate those themes by deft exploitation of rich detail. However, the Nordström tradition does share the anglophone view of science as knowledge and of controversy and theory change as matters defined chiefly by the intellectual and empirical dimensions of science. In conjoining these two traditions, this volume offers a view of Berzelius that sets him within the broad context of contemporary intellectual culture, both philosophical and scientific, and portrays the evolution of ideas and work in the light of his own and his contemporaries' intellectual and empirical commitments.

The translation of Lindroth's essay has been updated and annotated and supplied with references to subsequent scholarship that has qualified some details offered in the original. However, even without modification, as a portrait of Berzelius Lindroth's piece has stood the test of time. It remains a masterly account of Berzelius's personality and beliefs, and virtually all of the themes it develops are pursued by other authors in this collection: Berzelius's passionate engagement, his combativeness, his experiences on travels abroad, his commitment to pure research and the emphasis he placed on applied science, his Enlightenment heritage, his views about method and about the nature of matter and life, his ideas about education, and his battles with Romanticism. Lindroth has brought to life a formidable personality, struggling to uphold the values of the Enlightenment in a culture increasingly saturated with a far different spirit.

Chapters 2, 3, and 4, by Sven-Eric Liedman, Gunnar Eriksson, and Anders Lundgren, are also products of the Nordström tradition (though Lundgren's exhibits traces of other historiographic modes). Their studies and that of Alan Rocke (Chapter 5) pursue three philosophical themes raised by Lindroth, Berzelius's battles against the Romantics, his atomism, and his views of vitalism and materialism.

Liedman analyzes the Romanticism of early nineteenth-century Swedish science and Berzelius's attitude toward it by exploring Berzelius's connections with two prominent Swedish contemporaries, Carl Adolph Agardh (1785–1859) and Israel Hwasser (1790–1860). Focusing on controversy about educational reform, Liedman shows that Berzelius was not necessarily completely at odds with the Romantics. However, unquestionably

3 Gunnar Eriksson, "Introduction: Sten Lindroth (1914–1980)," in Sten Lindroth, *Les chemins du savoir en Suède de la fondation de l'université d'Uppsala à Jacob Berzelius: Études et portraits*. Ed. and tr. Jean-François Batail. Archives internationales d'histoire des idées, Vol. 126 (Boston: Martinus Nijhoff, 1988), pp. 1–11.

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his position was to carry forward the Enlightenment tradition that, while valuing pure science, anticipated practical applications from the sciences and sought to foster them in appropriate educational institutions. As for the philosophy of science, Liedman illustrates Berzelius's complete impatience with the Romantics' habit of ignoring the substantive achievements of the Enlightenment style of science and substituting a florid sort of speculation. These cases amply illustrate Lindroth's observation that Berzelius, in representing eighteenth-century values, belonged to the old school.

Eriksson explores the deep background to Berzelius's atomism and his differences with the Romantics about the structure of matter. In his essay, a revised and updated translation of a piece first published in Swedish in 1967, he identifies the two leading philosophical approaches to the nature of matter: classical atomism (couched in vague terms and linked with Newtonian physics) and dynamism (articulated by Kant as a way of interpreting matter and its properties in terms of the opposition of attractive and repulsive force). Eriksson's treatment is one of the few that touch on the implications of the dynamic tradition for chemistry. From several of its German and Danish adherents, dynamism entered Sweden, flourishing, *inter alia*, in the circles of Uppsala in which the young Berzelius moved. Eriksson shows that at times Berzelius displayed certain affinities for dynamism, particularly in his use of the volume theory as a way to avoid the pitfalls of Daltonian atoms and in his predilection for speculation about what remained unknown of the physical world. Nevertheless, Eriksson finds that Berzelius's position was firmly rooted in the classical tradition of atomism.

Lundgren takes a different approach to Berzelius's atomism. He finds the determinants of Berzelius's views not so much in the antecedent philosophical debate as in the traditions and requirements of chemical practice. He therefore emphasizes the instrumentalism of Berzelius's principal forebears, Torbern Bergman and Lavoisier, and the common-sense requirements of practical chemistry. From this perspective, Berzelius appears as one who could scarcely dispense with atomism, but out of respect for his own empirical findings found himself obliged to reject Dalton's theory. Instead, he sought an atomism that could both explain and accommodate the laws of proportions and the empirical results of chemical analysis. Eventually, Berzelius adopted the instrumentalist position that accepted an atomic theory as a useful, if imperfect, representation of matter largely consistent with both the needs of practice and the empirical findings.

Rocke, the first of the authors here representing the anglophone tradition, proceeds mindful of historians' difficulty in characterizing Berzelius's views about the nature of life and of the substances composing liv-

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ing things. He finds a resolution to their dilemma by placing Berzelius within the tradition of vital materialism, which combines elements of vitalistic and materialist thought. Like Eriksson, Rocke points back to Kant, in this case, his philosophy of biology, and to figures such as Blumenbach and Reil, who pursued Kant's ideas; and he also finds roots of Berzelius's position in such figures as Haller, as well as in a variety of French physiological and medical thinkers. Hoping to lodge himself between two poles of opinion that he regarded as equally distasteful, Berzelius established not only his approach to physiological chemistry but also his position with regard to major philosophical and religious themes. In addition, Rocke finds that Berzelius's early and persistent interest in "animal chemistry" inspired his organic chemistry, informed its central themes, and thus stamped the whole field of organic chemistry in the early nineteenth century.

If Lindroth introduces Berzelius's personality and intellectual commitments, Evan Melhado, in the first of three essays on the substance of Berzelius's science, introduces the main lines of his chemistry. In Chapter 6 Melhado rejects the traditional historiography that regards Berzelius as the consolidator of revolutionary gains achieved by his predecessors and portrays his science as completely outmoded by the 1840s. Instead, he winnows Berzelius's chemistry to establish more clearly the role tradition played in it and to identify the nature of its novelties. Taking a genetic approach, he shows that Berzelius's system may be understood as an attempt to solve a fundamental problem pursued in a variety of contexts in the eighteenth century, discriminating kinds of matter. The outcomes of Berzelius's efforts to meet this goal were not fully implicit in the work of Lavoisier and Dalton, but rested on significant departures from these antecedents. By 1819 Berzelius had placed chemistry on rigorous stoichiometric foundations, he had provided a series of laws and semiempirical rules permitting the specification of most mineral substances, and he articulated the foundations that would have to underlie any effort to distinguish species of organic matter.

The next two essays, by Hans-Werner Schütt and John Brooke, pursue themes in the mineral and organic chemistry of Berzelius. Schütt, in Chapter 7, examines an important episode in the development of Berzelius's inorganic chemistry and mineralogy: the discovery of isomorphism by Eilhard Mitscherlich (1794–1863). Isomorphs are substances having the same (or very nearly the same) crystal form, and isomorphism, as understood by Mitscherlich, is a link between community of form and analogy in composition. Stoichiometrically analogous arsenate and phosphate salts, for example, possess the same crystal form. Schütt uses this case to illustrate the nature of Berzelius's chemistry and mineralogy and to exhibit Berzelius's ability, as a figure of great prestige, to develop and disseminate

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nate knowledge about the discovery and its consequences for both these sciences. To these ends, Berzelius was able to exploit his numerous personal contacts abroad, the annual progress reports he prepared as perpetual secretary of the Royal Swedish Academy of Sciences, and the laboratory facilities in which he gave Mitscherlich himself further training and set his own students to exploring the impact of Mitscherlich's discovery. By thus using the personal and professional resources at his disposal, Berzelius could powerfully affect the development of two sciences in accordance with his own interests.

In treating organic chemistry, Brooke, in Chapter 8, pursues several themes raised by other authors here: Berzelius's underlying views about the theory and practice of organic chemistry and the nature of his differences with his successors. Brooke takes issue with prevailing views about Berzelius's attitude toward vitalism, finding him cautious about the role of a vital force and constrained by empirical observations about the similarities and differences between organic and inorganic matter. The central question was whether the phenomena of inorganic chemistry ought to be taken as inevitably paradigmatic of organic chemistry, as Berzelius believed, or whether the phenomena of organic chemistry could be the source of generalizations about inorganic chemistry, as opponents, such as Auguste Laurent (1807–1853), maintained. Brooke finds through a close analysis that Berzelius's approach was far more productive than traditional accounts have suggested, that Berzelius himself was far less rigid than he has been portrayed, and that his successors owed him more than they cared to admit (or at least were able to recognize).

Finally, in Chapter 9, another portrait of Berzelius, very different from Lindroth's, closes this volume. Carl Gustaf Bernhard is not a historian of science but one of Berzelius's successors as perpetual secretary of the Royal Swedish Academy of Sciences. Having followed Berzelius on his numerous travels, Bernhard adduces a more personal and intimate sort of detail than Lindroth, and he uses it to illuminate three themes. Berzelius's avidity for travel was unusual in a day when a trip abroad was still an onerous undertaking; if he submitted to the burdens despite problems with migraine and rheumatism, it was as much for professional goals as for pleasure. By traveling, Bernhard suggests, Berzelius could supplement his extensive correspondence as a means to establish and cultivate professional connections. Moreover, by recounting Berzelius's multifaceted activities and recording his reactions to his hosts and their culture, Bernhard succeeds in exhibiting (in a way perhaps not otherwise possible) the diversity of Berzelius's interests, his keenness as an observer, and the immense esteem with which he was regarded in European scientific circles. Finally, Bernhard portrays the not always admirable, but assuredly very

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human qualities of a figure typically seen as unrelentingly tough and aggressive.

The image of Berzelius and his science that emerges from these essays is surely richer and more finely grained than the customary picture. They reveal how the context provided by the scientific and philosophical culture of both Sweden and Europe informed Berzelius's life and work; they discard the persistent nineteenth-century image of Berzelius, which finds him unoriginal and inflexible and his chemistry narrowly confining; they show his views of various philosophical themes such as the nature of life and matter to be more complex than previously recognized; and they provide an enhanced image of the originality and endurance of his achievements. These innovations in the study of Berzelius emerged in a scattered and linguistically diverse professional literature that has often been as inaccessible as Berzelius himself. We hope with these essays to have made him and his science more approachable and more fully appreciated.

We also hope to suggest topics for additional research; at least three loom large. First, the usual focal point of Berzelius studies, his chemistry, can still benefit from analysis, but now from the standpoint of scientific practice. Though the numerous empirical investigations that Berzelius undertook are well known, the manner in which he prosecuted them has scarcely been explored. There is no doubt that his methods, particularly for quantitative analysis of small samples, were not well preceded among chemists (though they may have been informed by practices prevailing among mineralogists). A study of the relationship among his explicit rational goals, his empirical results, and his experimental procedures may reveal that the ends of Berzelius's research were as much informed as served by his methods and that the Berzelian stamp acquired by the science of chemistry during the first half of the nineteenth century was as much a function of practice as of theory.

Second, Berzelius's role as an influential within his own country merits attention. For 30 years, Berzelius served as perpetual secretary of the Royal Swedish Academy of Sciences and in that capacity dominated the Swedish scientific world.<sup>4</sup> Early in his tenure, he undertook to modernize and reorganize the institution to emphasize pure science over economics and commerce. He made its *Annual Reports*, through their German and French translations, required reading throughout the scientific world. Berzelius and the academy doubtless stood in a mutually supportive re-

4 See Wilhelm Odelberg, "Berzelius as Perpetual Secretary," in *Science in Sweden: The Royal Swedish Academy of Sciences, 1739–1989*, ed. Tore Frangsmyr (Canton, MA: Science History Publications, 1989), pp. 124–147.

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lationship, Berzelius using it as his institutional base and a source of prestige and the academy itself benefiting from his reputation, vigor, and commitment. Yet no thorough study exists of his role at the academy and its importance to the man or of the man to the institution. More broadly, Berzelius's place and role in the civic and cultural life of his nation also remain to be explored.

Third, perhaps the most striking feature of Berzelius's career, the immense influence he wielded on the Continent, especially after about 1820, has nowhere been assessed (though some of the elements of this story are suggested by the essays of Schütt and Bernhard), and it calls out for study in the light of the newer methodologies. How a figure located on the northern fringe of Europe, who lacked large numbers of foreign students, could so dominate the chemistry profession of the Continent is a puzzle well worth exploring. The significance, quality, and breadth of his scientific achievements doubtless garnered him great prestige, but the mechanisms for converting prestige into authority remain to be elucidated. Berzelius delivered Olympian judgments about the science of his day through the pages of the academy's widely translated *Annual Reports*; he defined the scope, content, and method of his discipline in the *Textbook of Chemistry*, which went through numerous editions and translations; he made himself the core of a network of correspondence; he developed professional contacts and influence through his frequent travels; and, though his students were few, they often proved influential bearers of his method, vision, and style. Few figures have exerted so profound an influence over an entire discipline over a period as long as two generations. The story of this achievement should reveal much about the use of social, cultural, and material resources in the advancement of scientific careers and the growth of scientific disciplines.

Berzelius therefore need not remain a remote icon viewed from afar. This volume brings him clearly into view and suggests additional studies for which the newer methodologies seem particularly apt. Though, unfortunately, linguistic barriers may persist in inhibiting additional scholarship on the career of Berzelius, the newly established Center for the History of Science at the Royal Swedish Academy of Sciences would make a congenial and attractive setting for scholars interested in further studies.



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## 1

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**Berzelius and His Time**

STEN LINDROTH

Jöns Jacob Berzelius – or Jacob Berzelius as he probably ought to be called – is one of the greatest names in Swedish science; only Carl von Linné can be compared with him. Yet, somehow, he is remarkably little known, though to some extent this may be explained naturally enough. Chemistry, the science to which Berzelius devoted his life, may never become as popular as botany or natural history – it is not immediately captivating or pleasurable. Even if Berzelius briefly succeeded in making chemistry something of a fashionable science in the aristocratic circles of the capital – Crown Prince Oscar and his retinue followed his experiments attentively – this was a very temporary phenomenon and primarily a tribute to Berzelius's growing international reputation. Berzelius has always been chiefly a concern of chemists and historians of chemistry; we others respect him from afar, as a monument marking the start of enormous advances made by modern chemistry in the nineteenth century.

For Berzelius himself, too, actual scientific work in the laboratory was all that really mattered. He was the pure researcher, with no other goal. For a limited period of almost unbelievable creativity, from about 1805 to 1820, he developed, on the strength of innumerable analyses and experiments, the ideas and theories that brought chemistry into a new and triumphant era: the law of constant chemical proportions and the system of chemical symbols, the contested but deeply influential electrochemical theory, the chemical classification of minerals, and physiology as a sci-

Translated by Bernard Vowles from Sten Lindroth, "Berzelius och hans tid," Vetenskaps-societeten in Lund, Årsbok, 1964:15–40.

Address given at the annual general meeting of the Scientific Society of Lund, Saturday, 23 November 1963; published here [in Swedish in the Yearbook of the society for 1964, pp. 15–40] in somewhat expanded form and provided with a minimal number of references to the sources. [The preceding note is Lindroth's; the editors' own notes or additions to Lindroth's appear in brackets; they aim to explain or clarify items Lindroth assumed were familiar to his Swedish readers. The editors have also inserted into the text a few rubrics lacking in the original.]

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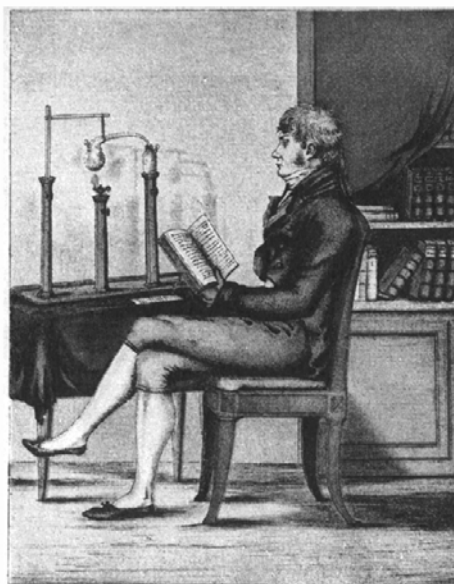
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*Sten Lindroth*

This portrait has been called “the hungry Berzelius,” showing the young, poor, and ambitious student at Uppsala University. From the archives of the Royal Swedish Academy of Sciences, used with permission.

ence of chemically determined processes. With his monumental textbook of chemistry, the sixth and final volume of which appeared in 1830, Berzelius crowned his scientific lifework and spoke as the highest authority among the world’s chemists. But no more than other sciences can chemistry exist by itself, in the laboratory. Its fundamental problems are, in the last resort, philosophical and epistemological; they concern the structure of matter and the phenomenon of life. Berzelius was therefore compelled time and again to declare his position with regard to the important philosophical questions of the day. He did so very willingly. If ever a scientist was pugnacious and game for a fight, it was Berzelius. He took pleasure in putting his adversaries on the spot, not only his fellow chemists, but perpetrators of folly and irresponsibility wherever he might encounter them. He assumed the role of scientific arbiter and judge.

Berzelius thus became an intellectual critic, one of the most impassioned in Sweden at a time filled with aesthetic, philosophical, and political conflict. This has, of course, always been well known. The material, or at least most of it, is scattered in different parts of H. G. Söderbaum’s exhaustive biography of Berzelius,<sup>1</sup> and his protracted feud with Israel

1 [Söderbaum, *Levnadsteckning*; see List of Abbreviations.]