

THE CONTROVERSY BETWEEN JACOB BERZELIUS AND JUSTUS VON LIEBIG ¹

From the preface of the published facsimil edition of

Berzelius und Liebig – Ihre Briefe 1831-1845 ²

The life of a chemist in the laboratory may many times be frustrating, but in the long term his efforts will often be very rewarding. The first experiment for atomic weight determinations did not turn out as expected for the young Jacob Berzelius.

I frequently was misled because of the difficulty of bringing an insoluble precipitated compound to its correct saturation point. I had to repeat analyses many times in order to find the method which would lead to correct results: in short I must, through my own mistakes, be led into procedures which are now so generally known that all immediately turn to them, and I must stand by the principle, that of so choosing my analytical method that the result would depend as little as possible on the operator's skill in manipulation.³

Jacob Berzelius was very careful when planning and performing his experiments. His opinion was based upon his own experience. In analyses, he tried to select methods which depended as little as possible on the manipulation skill of the chemist. The scientific interests of Berzelius comprised the whole of chemistry. On his own initiative he summarized and reviewed critically the scientific work done all over the world in his annual reports to the Royal Academy of Sciences on the progress of physical sciences (the famous "Jahresberichte"). Berzelius gave his whole life to the service of science with great tenacity of purpose and effectiveness in execution. With an engagement and diligence in his task Berzelius was destined to be one of the leading chemists of all time. As a collaborator and friend Berzelius was generous and open and his friendliness had a great and lasting influence upon those who had the fortune to work with him. The grand creative genius of Berzelius and the joy he had in his work are not only apparent in his experimental researches, but are evident also in his activity as teacher or in his writing. The style of his writings exhibits great freedom, force and beauty.⁴

After finished his medical studies in Uppsala Berzelius became a teacher for medical students in Stockholm. He was teaching medicine and pharmacy and in order to fulfil the requirements he felt obliged to do some research in the area of animal chemistry. The results of these early studies on animal products were compiled as *Lectures in Animal Chemistry*, printed in two volumes in 1806 and 1808 respectively. He soon became disgusted with the general unreliability of the chemical analyses of animal products and

¹ Justus von Liebig (1803-1873), friherre, professor i Giessen 1824-1852, upptäckte en rad nya ämnen, förbättrade den organiska elementaranalysen, sysslade med frågor rörande växters och djurs ämnesomsättning och anses ha lagt grunden till lantbrukskemin.

² The facsimil edition was published by Jan Trofast (Schriftenreihe der Berzelius Gesellschaft Nr 3, Jürgen Cromm Verlag Göttingen-Augsburg (1995)) and based upon Justus Carrière, *Berzelius und Liebig – Ihre Briefe von 1831-1845 mit erläuternden Einschaltungen aus gleichzeitigen Briefen von Liebig und Wöhler*, Zweite Auflage, München (1898).

³ J. J. Berzelius, *Autobiographical Notes*, translated by Olof Larsell, Williams & Wilkins Co, Baltimore, (1934), 63

⁴ See e.g. Erik Jorpes, *Jac. Berzelius – His Life and Work*, Uppsala (1970) and Harald Hartley, *Studies in the History of Chemistry*, Oxford University Press (1971).

left the area for many years. His early researches on the blood, bile, and urine, are however astonishingly laudable for their acuteness, sound reasoning, and accuracy of manipulation. The *Animal Chemistry* could be characterized as a textbook on physiological chemistry and chemical physiology. In the preface he announced his philosophy of work, which became his guidance throughout his entire life:

I have everywhere tried to avoid hypotheses and when I sometimes have ventured insignificant guesses, they are all of the kind that they soon enough will be verified by experience. I rather like to say, this is totally unknown to us than to try to conceal an imperfection of our knowledge with a collection of probabilities.⁵

In view of the state of science at the time when Berzelius published his work in the beginning of the nineteenth century he was well before his time. His expectations to obtain thorough results in animal chemistry were disappointing. He soon became aware of the difficulties of studying the organic compounds participating in the living organism. He had to find the composition of the organic compounds before any progress could be expected and this could not occur until the elementary analyses were further developed – methods that also were developed by Berzelius. The difficulty to get new insight into the living nature made Berzelius under certain periods of time doubt the existence of a vital force.

However, he returned almost immediately to his earlier thoughts about the structure and function of the living organism and Friedrich Wöhler's synthesis of urea may have affected this direction of thought. Berzelius work in physiological chemistry was not only a matter of chemical analysis. He also laid a new, more profitable direction of research.

Since my predecessors not always have started from the same point of view or aimed at the same objective, many things from them have been neglected, which easily could have been discovered. Thus I have, in the research I have had the opportunity to do, succeeded in discovering or proving a fairly large number of significant unknown facts or less well-known circumstances. I foresee with joy that when more skillful men than I in the future will devote themselves to animal chemistry following the same strategy, Science will reach a development we neither can anticipate nor can hope for.⁶

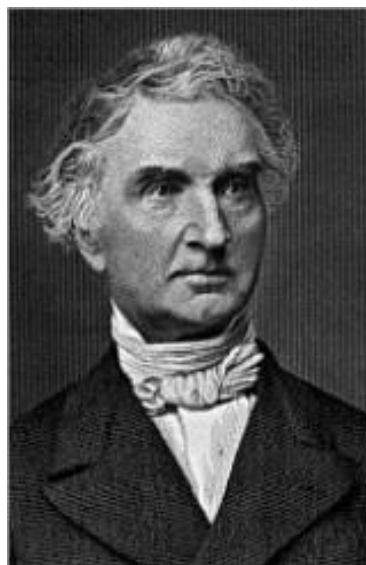
Before Berzelius entrance in the realm of animal chemistry, the subject was occupied by analyses of different animal products and to a certain extent some reflections on the economy of the animal body. Berzelius tried to link the chemical and anatomical properties to a unit and gave it a physiological direction. By establishing this linkage Berzelius was able to find many new important and unknown phenomena.

⁵ J. J. Berzelius, *Föreläsningar i djurkemien*, Stockholm, I (1806), preface.

⁶ J. J. Berzelius, *Öfversigt af Djur-Kemiens framsteg och närvarande tillstånd*, Stockholm (1812) (181§0), 83.



Jacob Berzelius (1779-1848)



Justus von Liebig (1803-1873)

Berzelius visited together with some other Swedish scientists the scientific meeting in Hamburg in 1830. The most important event for Berzelius at this meeting was the personal meeting with Justus Liebig. It is extremely rare that Berzelius expresses his feelings in such an open-hearted way as after this meeting:

Wie erfreut bin ich, Liebig's persönliche Bekantschaft gemacht zu haben! Das war ohne Frage das interessanteste Resultat meines Aufenthaltes in Hamburg. Der Mann verbindet eine ganz ungewöhnliche anspruchlose Liebenswürdigkeit mit nicht gewöhnlicher wissenschaftlicher Tüchtigkeit. Ich danke Hrn. Prof. sehr, dass er mir diese Bekantschaft verschafft hat.⁷

Liebig felt the same about Berzelius as stated in a letter to Wöhler:

Berzelius hat mich sehr wohlwollend aufgenommen und mir erlaubt, ihm zuweilen Mittheilungen machen zu dürfen... Seine anspruchlose und liebenswürdige Persönlichkeit hat mir ganz ihm zu eigen gemacht, dies ist etwas, was ich bei den Franzosen stets vermisst habe. Ich begreife jetzt auch, warum Ihr Leute so sehr an ihm hängt.⁸

The correspondence between Berzelius and Wöhler reflects the work of Liebig in a vivid way:

Dass Liebig "geschwind und unvollständig" zu seinem Wahlspruch hat, wie Hr. Professor andeutet, das habe ich aus seiner Abhandlung über die Hippursäure ersehen, die Wahrhaftig sehr nachlässig gemacht ist... Dagegen gefällt mir sehr seine Abhandlung über das schwarze Platin, welches Alkohol entzündet, obgleich auch sie nur halbfertig ist.⁹

⁷ J. Berzelius to F. Wöhler, 14 October 1830.

⁸ J. Liebig to F. Wöhler 12 October 1830.

⁹ J. Berzelius to F. Wöhler 9 April 1830.

Somewhat later in the same year:

Ich gebe nun Herrn Professor vollkommen Recht in dem Urteil, dass Liebig "Geschwind und halb-schlecht" zum Motto hat. Seine Abhandlung über die Hippursäure und seine Analyse der Apfelsäure sind beide so nachlässig gemacht, dass er dafür "handplagga" verdiente. Aber der Kerl ist arbeitsam und hat einem klaren Kopf.¹⁰

Berzelius und Liebig had quite a different background and qualifications although they were almost contemporaries. It was however a time, when chemistry changed tremendously and Berzelius was one of the main builders. The progress of chemistry – theoretical as well as practical – had advanced quite substantially during the first decades of the nineteenth century. The milestones of this rapid progress were laid in the second half of the preceding century, but Berzelius had through his experimental work and theoretical combinations established the foundations of chemistry, on which Liebig and other chemists could continue. Everything was not perfectly explained – and Berzelius was fully aware of this fact – new theories were gladly evaluated by Berzelius. He was quite critical and the young generation of chemists had to prove more than once their new theories in order to convince Berzelius. Some people believe, that Berzelius inhibited further progress of chemistry due to his dominating position, but I am convinced that chemistry was lucky to have the encyclopedic mind, the judgment, the craftsmanship, and the watchful eye of Berzelius to guide its career.

However, as the years passed by, several events occurred that affected the friendly atmosphere between Berzelius and Liebig.



Justus von Liebig's laboratory in Giessen (1841)

¹⁰ J. Berzelius to F. Wöhler 9 July 1830.

Catalysis

Several chemists had studied the action of metals on different substances: platinum wire glows in a mixture of hydrogen and air, ammonia decomposed when passed through a red-hot porcelain tube but only if either iron, copper, silver, gold or platinum was present in the tube. Eilhard Mitscherlich showed that when alcohol was run into dilute sulphuric acid at 140°C, a mixture of ether and water distilled. In the Annual Report for 1835 Berzelius reviewed a number of reactions which take place in the presence of a substance which remains unaffected, having apparently taken no part in the change. This phenomenon was quite different from ordinary affinity.

This is a new power to produce chemical activity belonging to both inorganic and organic nature, which is surely more widespread than we have hitherto believed and the nature of which is still concealed from us... I shall therefore, using a derivation well-known in chemistry, call it the catalytic power of the substances, and the decomposition by means of this power catalysis.¹¹

Berzelius also applied the new idea to the chemical processes of living organisms. In a letter to Liebig in 1835 Berzelius reveals his deep insight into the living processes when he says that it is extremely probable that this catalytic force play a major part in living organisms, and that many chemical changes in the secretory organs of animals and plants are caused entirely by substances on the inner coating of those organs which bring about changes in the liquids through them.¹²

We can now assume on very good grounds that in living plants and animals thousands of catalytic processes take place between tissues and fluids thus giving rise to multitudes of chemical compounds.¹³

Liebig was judging the new concept. In his criticism he said that the creation of a new force by a new word explained nothing and that such a behavior was harmful to future progress of science.¹⁴

Animal chemistry

Liebig soon became tired of the innumerable discussions about radicals, substitutions and types in organic chemistry and he turned his interest to the use of chemistry in agriculture and physiology. The knowledge of elementary composition and of respiration inspired scientists in their efforts to search for chemical explanations of biological phenomena.

Why did Liebig turn to the more complex physiological application of chemistry instead of staying in organic chemistry where he had been so successful? The new area of research was open to even more speculations, and was, according to Berzelius bringing chemistry far away from traditional thinking and how modern chemistry should be performed.

It is astonishing to find Liebig's negative attitude towards J. B. Dumas and his substitution theory. Liebig presumed that Dumas exploited the theory primarily to publicize himself. Berzelius thought the same about Liebig some years later. Liebig was

¹¹ J. Berzelius, *Årsberättelse om framstegen i fysik och kemi*, Stockholm (1835), 245.

¹² J. Berzelius to J. Liebig 10 April 1835.

¹³ D. Keilin, *The History of Cell Respiration and Cytochrome*, University Press, Cambridge (1966)

¹⁴ J. Liebig to F. Wöhler 2 June 1837.

rarely able to preserve a distinction between intellectual disagreements and personal attacks.

The first result of the new direction was the publication in 1840 of the book *Die organische Chemie angewandt auf Agrikultur und Physiologie*. Berzelius reviewed the book in his sincere, but perhaps not always most diplomatic way. He gave his opinion to his friend H. G. Trolle Wachtmeister:

Your Excellency, you must know this piece of work not because it is good but because it is odd to read. It is the poetic dreams of a great chemist, a poem in free form, where imagination is let loose and thus leads to dim results but sometimes lets flashes of genius spring forth from which the learned can be enlightened. The unlearned will be misled by this piece of work in the most vulgar way.¹⁵

At this time Liebig had published his views on the state of chemistry in Austria and Prussia. These condescending and critical papers caused serious discussions. The content was in agreement with Berzelius point of view e.g. his criticism of natural philosophy, but he was biding his time. He communicated his views on Liebig's action in a letter to Mitscherlich:

Liebig's ill-advised and rude attacks on Zeise, Hess, Fritzsche, Laurent and others have taken the sting out of everything he has written or will write. In this way he himself suffers the most. If you take my advice, let him be. The way he is now making and where he uses more skill and poetic imagination than profundity, piles up the ants which will eat him since he has not got the self-control to give and to take criticism.¹⁶

The same attitudes were heard among chemists all over Europe when Liebig published his frequently appearing papers e.g. "Ueber die Stickstoffnahrungsmittel des Pflanzenreichs" (1841).

Liebig's investigations about tissues and liquids such as flesh and fat, blood and bile, were however a successful continuation of the earlier work of Berzelius. The time between 1810 and 1840 was characterized by a slow development within animal chemistry, but the analytical methods were improved so as conditions were created for better conclusions of the results obtained. During the 1840s a remarkable growth in activity was founded and among the famous names could be mentioned Carl Ludwig, Emil de Bois-Reymond, Ernst Brücke, Hermann Helmholtz and Claude Bernard.

The single event that effected the development the most was the publication in 1842 of the book *Die organische Chemie ihrer Anwendung auf Physiologie und Pathologie* written by Justus Liebig. Liebig expressed in his Animal Chemistry a rather speculative scheme of the specific metabolic processes as well as the physical and chemical processes underlying physiological functions in animals. The book has been further penetrated in modern times by Fredric L. Holmes in a facsimile edition of Liebig's *Animal Chemistry*.¹⁷ In spite of the rising controversies Liebig had strong feelings for Berzelius and saw him as the most authoritative person within the area of animal chemistry. Liebig therefore dedicated the work to Berzelius with the words "Meinem Freunde J. J. Berzelius als ein

¹⁵ J. Berzelius to H. G. Trolle Wachtmeister 1 January 1841.

¹⁶ J. Berzelius to E. Mitscherlich 3 September 1841.

¹⁷ J. Liebig, *Animal Chemistry or Organic Chemistry in its Application to Physiology and Pathology*, The Source of Science, No 4, Johnson Reprint Corporation, New York (1964).

Zeichen inniger Zuneigung und aufrichtiger Hochachtung gewidmet". Berzelius criticism against the work was however powerful, which could very explicit be seen in a letter to Heinrich Rose:

You ask what I think of Liebig's physiological-chemical speculations. To tell you the truth: I rather dislike them. He displays as in the application of chemistry on agriculture, that he has not studied this subject before in which he now wants to become the chemical legislator. He has brain enough to make interesting comparisons and hasty calculations but not enough consideration to investigate, if they are useful and correct. He thinks he himself is superior to others who walk the laborious way of research and he sat down at his desk to become a legislator, and transformed into a scientific swindler. It hurts to say this about an excellent chemist, whom I have had good reason to love for his pleasant manners and to estimate for the discoveries he has made and tested in his laboratory.¹⁸

Berzelius tried to warn the chemical society of this probability philosophy of physiology being a false direction of the science itself. Several of Liebig's colleagues expressed their seriousness over his irritability and many of them wrote to Berzelius asking him not to put forward severe criticism. Berzelius was not a person who could think these thoughts, for him it was necessary to analyze the new results in a scientific way. Berzelius recommended that Liebig should make a journey in order to rest, a prescription he had tried himself several times, giving recreation and new appetite for chemical research.

Liebig was very anxious to know the opinion of Berzelius. As usual Berzelius made his comments in the Annual Report for 1843. Liebig had, according to Berzelius, used his convincing way of writing in order to get new hypotheses to look as verified facts. For example, Liebig used the elementary composition of fibrine, albumin and other proteins as basis for the calculations, in spite of the fact that there existed several other analytical results for these compounds. Liebig received the critical views with anger and bitterness, and he responded with his typical personal attacks. Berzelius had foreseen this behavior, since he had repeated his scientific and fundamental principles in a footnote in the Annual Report for 1843.

Different opinions in a matter, between two friends, should never be regarded as proof of less individual respect and affection nor of lost friendship. It is a disaster if it happens but the interests of Science should never be neglected because of individual considerations.¹⁹

Highly speculative but prosperous circumstances gave the book a lasting influence on the development of physiological chemistry. The book contained several falsifications, but after all it had a great influence and importance to the future. The reason may be that Liebig's attitude and writings were in contrast to the past and he started a new and intensive discussion, even though he was not always objective. Berzelius took this with equanimity, because he knew the mental health of the German chemist. Liebig turned to a romantic temperament and was lacking the reliability that was so characteristic of Berzelius. The early and cordial friendship was soon to be broken due to their different scientific and personal behavior. This situation was very painful for their mutual friend Wöhler, who tried in many ways to bring about a reconciliation. Some years later – after the death of Berzelius – Liebig seems to have penetrated the criticism, when he is writing to Wöhler:

¹⁸ J. Berzelius to H. Rose 22 February 1842

¹⁹ J. Berzelius, *Årsberättelse om framstegen i kemi och mineralogi*, Stockholm (1842), 422.

Es ist wirklich auffallend, wie wenig man eigentlich die Thiersubstanzen kennt.²⁰

Berzelius pupil Nils Johan Berlin (1812-1891) sent information about Liebig during his visit in Germany in 1843:

...he [Liebig] is responsible for everything that take place in his laboratory, and the one, who dares to doubt the reliability of the work being done there, L. attacks him personally and will get him involved. It is unbelievable which enormous despotism Liebig will exert and to a certain degree really exerts on part of the German chemical society; I really do not want to give support for it in writing and even less mention Liebig's enormous attacks against the greatest scientific name in Europe, which attacks may better to be forgotten, as if they really were in silence and darkness put together and realized.²¹

Liebig was generally feared for his reckless impetuosity and hot temperament. If Liebig had left emotional writing and only criticized Berzelius opinion about the progress animal chemistry had made since Berzelius did his main experimental work. I am convinced that Berzelius would have continued an interesting and rewarding discussion about the reliability of the new theories in the same manner as he had done in the controversies with Humphry Davy about the nature of chlorine in the 1810's. One should also keep in mind that Berzelius had followed the progress of organic chemistry for many years.

Not bitter, but I think it was hard for Berzelius to accept the new generation, particularly if they came from another school of chemistry. He supported his own pupils as much as he could. Heinrich Rose did not manage to arrange a personal meeting either. The main reason this time could have been the publication by Liebig of the paper "Berzelius und die Probabilitätstheorien" (1844), or as it was named as a specific publication *Bemerkungen über das Verhältniss der Thierchemie zur Thier-Physiologie*. This book was a direct attack on Berzelius and it was so full of events and excitements that also the friends of Liebig rejected it. One example is the expression by C. M. Kersten:

Liebig's article on the probability theories has in Germany not at all made the impression Liebig expected – and it merely demonstrates the worth of sober experimental research!²²

Berzelius was trying to keep up appearances, but his statements indicate that he was more anxious than he would confessed to himself. Liebig's ambitions were magnificent. His emotional nature was hurt by the rather severe criticism by Berzelius of the physiological-chemical work. Berzelius tried, as usual, to make a distinction between person and thing. When Liebig accused Berzelius as a person, the limit was exceeded of what Berzelius could handle and there was no longer any hope for reconciliation.

Forty years after the publication of Berzelius "Animal Chemistry" Friedrich Wöhler carried away by his admiration of this work, exclaimed:

Kürzlich bekam ich zufällig Berzelius *Föreläsningar i Djurkemien* zur Hand, die ich auch noch nicht kannte. Ich war da erstaunt über den Reichthum an eigenen

²⁰ J Liebig to F. Wöhler 30 November 1848.

²¹ N. J. Berlin to J. Berzelius 2 July 1843.

²² C. M. Kersten to J. Berzelius 20 February 1845.

Beobachtungen und Tatsachen, die das Werk enthält, über das, was dieser Mann in seinem Leben auf diesem Gebiete geleistet hat, namentlich wenn man bedenkt, dass diese Vorlesungen schon in den Jahren 1803-5 gehalten worden sind.²³

Berzelius created a framework in the form of new and fruitful chemical conceptions for apparently divergent and contradictory ideas. He served the progress of science in a manner that can hardly be sufficiently appreciated. The spirit of Berzelius will always stay alive and be active as long as Man is engaged in the pursuit of chemical science.

Wöhler translated many of Berzelius literary writings into German and that became one of the foundations to the authority of Berzelius. Wöhler, although educated in the spirit of Berzelius was performing his chemical research because of his knowledge but also for his contribution in the compromising between Berzelius and the younger opportunist Liebig in their innumerable disputes.

Suggested references for further reading:

Alan J. Rocke, "Berzelius's Animal Chemistry: From Physiology to Organic Chemistry (1805-1814)", *Enlightenment Science in the Romantic Era – The chemistry of Berzelius & its cultural setting*, edited by Evan M. Melhado & Tore Frängsmyr, Cambridge University Press (1992), paperback edition (2002), 107-131.

William H. Brock, *Justus von Liebig – The Chemical Gatekeeper*, Cambridge University Press, (1997), 183-214.

Robert Keen, *The Life and Work of Friedrich Wöhler (1800-1882)*, edited by Johannes Büttner, edition Lewicki-Büttner, vol 2, Verlag Traugott Bautz GmbH, Nordhausen (2005), 227-252.

Jan Trofast

²³ F. Wöhler to J. Liebig 1 April 1847