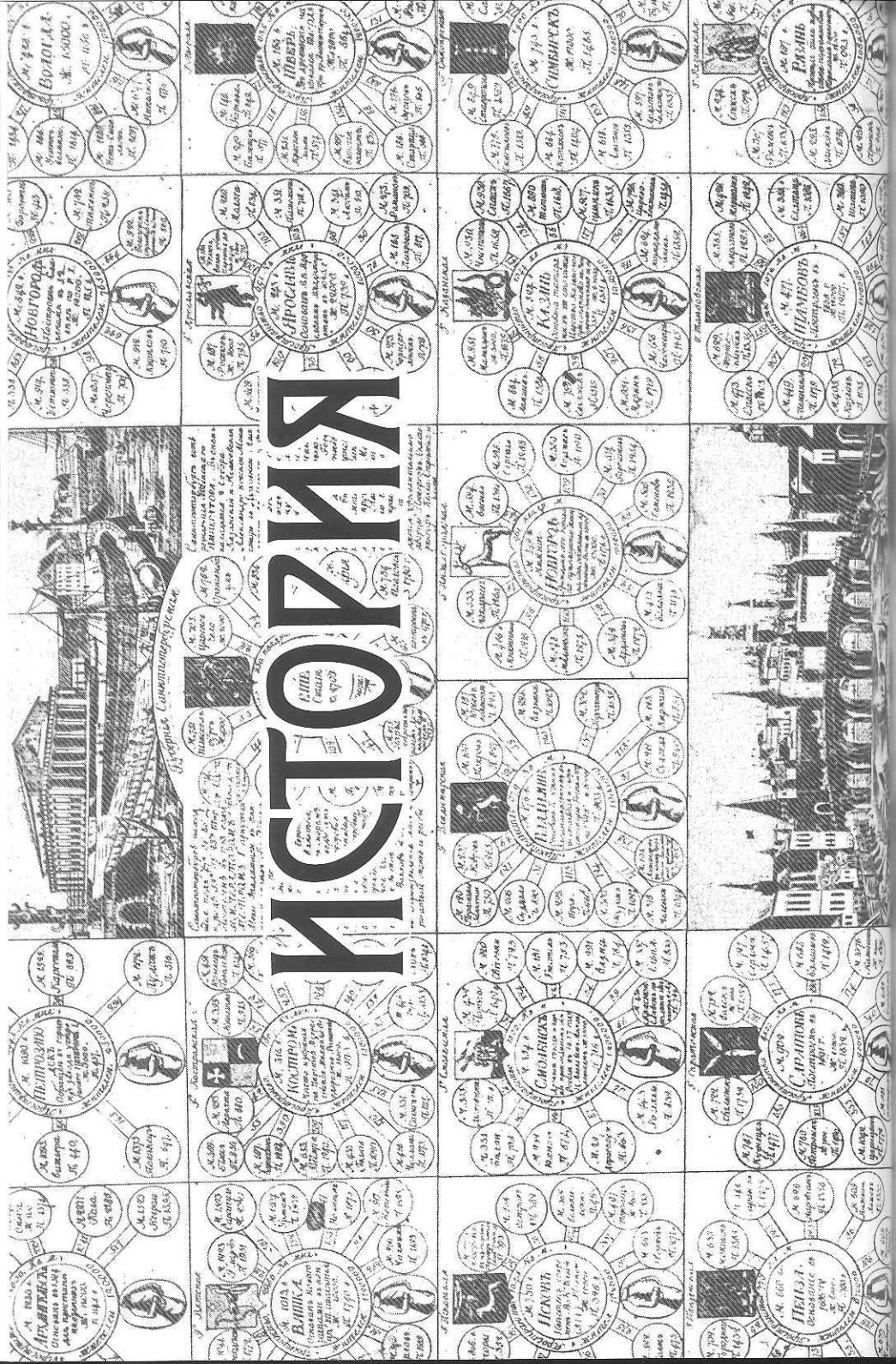


Michael D. GORDIN

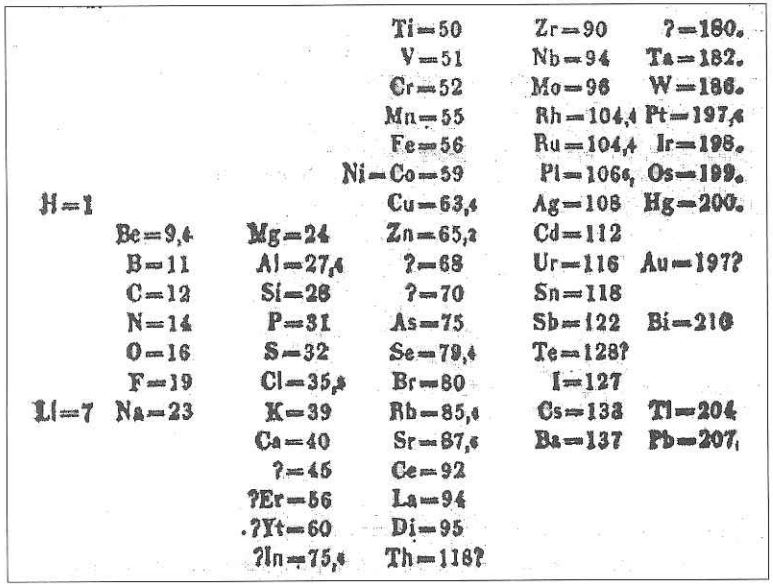
THE TABLE AND THE WORD: TRANSLATION, PRIORITY, AND THE PERIODIC SYSTEM OF CHEMICAL ELEMENTS*

In February 1869, Dmitrii Ivanovich Mendeleev (1834–1907) had an idea in his apartments in St. Petersburg, the capital of imperial Russia, as he dove deeper into the writing of the second volume of his textbook, *The Principles of Chemistry* (Osnovy khimii). He had packed the manuscript of volume 1 – which would eventually be several hundred printed pages – off to the publisher in December 1868, and now he was working on organizing volume 2. At first, it was hard going, since there were so many elements (fifty-five!) that needed to be treated in the same space with which he had covered only eight elements in meticulous detail in the first volume. Then he started comparing the atomic weights of groups of chemical elements. One thing led to another, and on February 17 (by the Russian old-style [O.S.] calendar; March 1 by the West European one[1]) he sent a cleaned-up sheet to the printers for them to offset so he could mail it to various chemists

* The author gratefully acknowledges the anonymous reviewers for their comments and suggestions on an earlier version of this article.

[1] In the nineteenth century, the Russian calendar lagged twelve days behind the new-style Gregorian calendar standard in Western Europe. In this article, Russian dates are indicated with "(O.S.)" for "Old Style"; unmodified dates are to be understood as Gregorian (with the exception of the titles of quoted documents).

both in Russia and in Europe.[2] The resulting image, Figure 1, when rotated 90 degrees clockwise and reflected in a mirror, clearly shows us what it is: Mendeleev's first published periodic system of chemical elements.



			Ti=50	Zr=90	?=180.
			V=51	Nb=94	Ta=182.
			Cr=52	Mo=96	W=186.
			Mn=55	Rh=104,4	Pt=197,4
			Fe=56	Ru=104,4	Ir=198.
			Ni=Co=59	Pl=106,4	Os=199.
H=1			Cu=63,4	Ag=108	Hg=200.
	Be=9,4	Mg=24	Zn=65,2	Cd=112	
	B=11	Al=27,4	?=68	Ur=116	Au=197?
	C=12	Si=28	?=70	Sn=118	
	N=14	P=31	As=75	Sb=122	Bi=210
	O=16	S=32	Se=79,4	Te=128?	
	F=19	Cl=35,5	Br=80	I=127	
Li=7	Na=23	K=39	Rb=85,4	Cs=133	Tl=204
		Ca=40	Sr=87,6	Ba=137	Pb=207.
		?=45	Ce=92		
		?Er=56	La=94		
		?Yt=60	Di=95		
		?In=75,6	Th=118?		

Fig. 1. The first published version of Mendeleev's periodic system, dated February 17, 1869 (O.S.), produced while composing *Principles of Chemistry*.[3]

This system, suitably expanded, revised, and reformatted, now hangs in every chemistry classroom on the planet and is widely known as the "periodic table" in English. (This is somewhat of a misnomer, since there are roughly 100 topologically distinct representations of the elements in two or three dimensions, and the ostensibly standard "table" is only one such version.)[4]

Mendeleev needed a title for his printed sheet, and he dubbed it, in Russian, "Attempt at a system of elements, based on their atomic weights and

[2] The history of the creation of the periodic system is a vast topic, and the account given here is drawn from Michael D. Gordin. A Well-Ordered Thing: Dmitrii I. Mendeleev and the Shadow of the Periodic Table. New York, 2004. Chapter 2. There are many other accounts, which largely agree in terms of empirical sequence of events but disagree about timing and intellectual motivation. A thorough list in English, Russian, German, and French can be found in the references to the above.

[3] Source: Periodicheskii zakon. Klassiki nauki (Sb. dok.) / Comp. B. M. Kedrov. Moscow, 1958. P. 9.

[4] On the various representations of the system, see Edward G. Mazurs. Graphic Representations of the Periodic System during One Hundred Years. Tuscaloosa, AL, 1974 [1957].

chemical affinity." He requested that the printer produce 150 copies for distribution to colleagues in Russia – a whopping proportion of the number of active chemists in imperial Russia. But he realized that although a foreign chemist might be able to figure out what the image represented by staring at it for a while, the title would be meaningless to Western Europeans – the arbiters of chemical credit – and so he also requested fifty copies (he crossed out the first digit of the original "250" he had penned on the rough manuscript) with an alternative French title, a translation from the Russian: "Essai d'une système d'éléments d'après leurs poids atomiques et fonctions chimiques."[5] French was a good choice: although Mendeleev was uncomfortable in all foreign languages, this was his best, and along with German and English it was one of the three languages that all chemists were expected to be able to read.[6]

There was, however, a slight problem with one word in the French. He called what he was producing "a system" – "une système" – but in French he used the *feminine* indefinite article with the masculine noun. What happened? At first, Mendeleev wanted to call his image a "classification" in French (in Russian *raspredelenie*), and that noun is in fact feminine, so he used the appropriate article. When he replaced the noun, he neglected to repair the article. This is a completely understandable mistake. While Russian has gendered nouns (three different genders rather than the two of French), it notoriously lacks direct and indirect articles. It was challenging enough to decide whether one needed "the" or "a/an" before a noun; once Mendeleev had correctly figured it out, he never went back to correct its gender. In this, Mendeleev's first foreign publication on his periodic system, there was a mistake in one word of the title translation, but it was an error entirely without consequence. There would, however, later in 1869 appear one other foreign publication on Mendeleev's periodic system, also with a single mistake in the translation, and that error triggered one of the most vehement and inflammatory priority disputes of the nineteenth century in any science. This article tells the story of that fight.

[5] Novye materialy po istorii otkrytiia periodicheskogo zakona (Sb. Dok.) / Ed. N. A. Figurovskii. Moscow, 1950. Image 2.

[6] On the history of scientific languages, see: Michael D. Gordin. Scientific Babel. Chicago, forthcoming 2015; Scott L. Montgomery. Science in Translation: Movements of Knowledge through Cultures and Time. Chicago, 2000; Ulrich Ammon (Ed.). The Dominance of English as a Language of Science. Hawthorne, New York, 2001; and Sabine Skudlik. Sprachen in den Wissenschaften: Deutsch und Englisch in der internationalen Kommunikation. Tübingen, 1990.

Priority disputes – arguments over which scientist had come to a particular finding first – are endemic to science, and many of the landmark discoveries in its history are scorched by such conflicts: consider calculus, conservation of energy, and evolution by natural selection, to name just three prominent examples.[7] The periodic system was the single most important discovery of inorganic chemistry in the nineteenth century – and quite possibly of chemistry in general, in any century – and credit for such an achievement would bring professional status, historical immortality, and national prestige. It was a prize to be fought over, and Dmitrii Mendeleev is now universally awarded the laurels.[8] But, as noted almost fifty years ago in what remains the most comprehensive history of the periodic system by J. W. van Spronsen, "once the time was ripe, the periodic system of elements was discovered almost simultaneously in the most leading countries of Europe and in North America." He apportioned the credit between no fewer than *six* individuals: Alexandre-Émile Béguyer de Chancourtois, William Odling, John Newlands, Gustavus Hinrichs, Lothar Meyer, and Dmitrii Mendeleev.[9] There is no question, however, that the most vociferous contest at the time was between Mendeleev and Meyer, and historians have revisited these events repeatedly over the past 150 years to adjudicate the matter, often with jingoistic or nationalistic overtones.[10]

[7] For an introduction to these three conflicts, see, respectively, Domenico Bertoloni Meli. Equivalence and Priority: Newton versus Leibniz. Oxford, 1993; Thomas S. Kuhn. Energy Conservation as an Example of Simultaneous Discovery // Idem. The Essential Tension: Selected Studies in Scientific Tradition and Change. Chicago, 1977. Pp. 66-104; and Janet Browne. Charles Darwin: The Power of Place. Princeton, 2002. Chapter 1. One of the earliest publications to raise the "priority dispute" to the status of a fruitful and productive site for historical and sociological investigation, and that still merits reading, is Robert K. Merton. Priorities in Scientific Discovery: A Chapter in the Sociology of Science // American Sociological Review. 1957. Vol. 22. No. 6. Pp. 635-659.

[8] See Michael D. Gordin. The Textbook Case of a Priority Dispute: D. I. Mendeleev, Lothar Meyer, and the Periodic System // Jessica Riskin and Mario Biagioli (Eds.). Nature Engaged: Science in Practice from the Renaissance to the Present. New York, 2012. Pp. 59-82.

[9] J. W. van Spronsen. The Periodic System of Chemical Elements: A History of the First Hundred Years. Amsterdam, 1969. P. 1, and Pp. 142-143. He discusses the actual history of these disputes at length in Chapter 6. See also Eric R. Scerri. The Periodic Table: Its Story and Significance. New York, 2007.

[10] The question of assigning nationalist priority credit has become distinctly unfashionable, and the best recent scholarship focuses on more detailed reconstruction of the process of the system's development, rather than figuring out who crossed the finish line first. For an excellent account in the recent vein, see especially I. S. Dmitriev. Nauchnoe otkrytie

This article chronicles the priority dispute between Lothar Meyer and Dmitrii Mendeleev, but it is not fundamentally *about* that dispute. Instead, I wish to use the story of this conflict between two chemists, which became a Russian-German standoff, to dramatize the clash between Russian and German as scientific languages. By roughly 1850, the cacophony of new languages brought about by the demotion of Latin – the babble of Dutch and Swedish alongside the more prominent French and English – had softened and compressed into three major scientific languages: English, French, and German.[11] Among themselves, these three languages comprised the vast majority of publishing in the natural sciences, and in particular in chemistry. As the next most significant languages, Italian and Latin (still), slid into obscurity, how could any language break into this tight club of three? Of course, one could simply publish in Czech or Greek, but that would not help with regard to the all-important issue of credit, the very notion that animates every priority dispute.[12] In order to count as a significant language of sci-

in statu nascendi // Voprosy istorii estestvoznaniia i tekhniki. 2001. No. 1. Pp. 31-82. When these debates were most prominent, there was a general regularity to them: Russian-language publications insisted on Mendeleev's sole priority, often equating dissenting views with contemporary depredations by Germany, such as the Nazi invasion of the Soviet Union. For this last point, see I. L. Chasovnikov. K semidesiatipiatiletiiu so dnia opublikovaniia periodicheskoi sistemy D. I. Mendeleeva // Uspekhi khimii. 1944. No. 2. Pp. 85-89; and A. P. Okatov. Bor'ba za prioritet periodicheskogo zakona // Uspekhi khimii. 1945. No. 5. Pp. 427-432. For milder-mannered Russian support, see Paul Walden. Dmitri Iwanowitsch Mendelejeff // Berichte der Deutschen Chemischen Gesellschaft. 1908. No. 5. Pp. 4719-4800, on P. 4744; and L. A. Chugaev. Periodicheskaia sistema khimicheskikh elementov. St. Petersburg, 1913. For German and East German accounts, which tended to split the credit between the two, see Curt Schmidt. Das periodische System der chemischen Elemente. Leipzig, 1917; Eugen Rabinowitsch und Erich Thilo. Periodisches System: Geschichte und Theorie. Stuttgart, 1930; and Klaus Danzer. Dmitri I. Mendelejew und Lothar Meyer: Die Schöpfer des Periodensystems der chemischen Elemente. Biographien hervorragender Naturwissenschaftler und Techniker. No. 8. Leipzig, 1974. For a rare Russian-language account that grants Meyer the slightest share, see A. A. Makarenia. Vklad Lotara Meiera v razrabotku periodicheskogo zakona // Voprosy istorii estestvoznaniia i tekhniki. 1969. No. 4 (29). Pp. 77-82.

[11] There is an enormous literature on the decline of Latin in early modern Europe, as well as its long survivals. For two important works, see Peter Burke. Languages and Communities in Early Modern Europe. Cambridge, 2004; and Françoise Waquet. Latin, or the Empire of a Sign: From the Sixteenth to the Twentieth Centuries / Tr. John Howe. London, 2001.

[12] For an interesting discussion of the role of "credit" in scientific debates that explicitly works out the financial analogy, see Mario Biagioli. Galileo's Instruments of Credit: Telescopes, Imagery, Secrecy. Chicago, 2006.

ence, it was not enough simply to be written in, others had to be persuaded to *read* it. And if almost no practicing, established scientists outside of your own country knew your language – or even, in the case of Russian, your alphabet – how could you make them pay attention, persuade them to invest some time to learn how to understand your new tongue?

In short, we are confronted with the problem of the introduction of a new language of science, told from the perspective of the "marginal" community (in this instance, that living in the largest country not just in Europe, but on the globe) trying to make their publications in their native tongue *count* from the perspective of Anglophones, Francophones, and Germanophones. This has only happened twice since the creation of the triumvirate: in the mid-nineteenth century with Russian, and in the mid-twentieth century with Japanese. Both of these languages became members of the minuscule community of scientific languages, although to be sure at first as junior partners. There are two stages to the process of inclusion, which happened in the case of Russian partially simultaneously but in a rather counterintuitive inverse order. First, the Russians had to make the Europeans take notice, to convince them that there was something being produced in Russian that was worth reading – or, at the very least, that a publication in Russian served as adequate announcement of a discovery, whether or not a Western scientist could actually understand it. And second, chemists had to actively *construct* Russian as a scientific language, make it able to "hold" science by endowing it with a nomenclature and other linguistic elements that made the process of mutual translation between it and the three main languages more straightforward. This article focuses on the first of these two movements.[13]

Tracing the story of Mendeleev's periodic system will bring us directly to the vagaries of publication in Russian in the second half of the nineteenth century, a subset of the general issues associated with written communication that will predominate here. (In this particular case, spoken communication was essentially irrelevant, although of course a full picture of the history of a scientific language would have to include this important aspect.) The Mendeleev–Meyer dispute was not simply a controversy about publication (specifically, the *language* of publication); it quickly escalated into a nationalist border war between two scientific communities. Seeing how these

[13] On the creation of a Russian chemical nomenclature, see Gordin. Scientific Babel. Chapter 3; and Viktor A. Kritsman. Die Entstehung der russischen chemischen Nomenklatur im europäischen Kontext: Die Frühgeschichte // Bernard Fritscher and Gerhard Brey (Eds.). Cosmographica et Geographica: Festschrift für Heribert M. Nobis zum 70. Geburtstag. München, 1994. Pp. 199-218.

groups interacted provides a glimpse at the intricately textured fabric of European chemistry and enables us to see how much can hinge on a single word, one that slipped past the translator's pen with barely a second glance. It would be over a decade before the dust began to settle.

A Small Mistake

The February 1869 leaflet was all well and good, but it was hardly sufficient. If Mendeleev really wanted to receive credit for his system of elements, his classification that he believed would enable him to correct previous misconceptions about atomic weights and also perhaps to predict the properties of yet-undiscovered elements, he knew he needed to do more than print one table underneath a single line of text. Rather, he had to explicate the system, produce a series of articles in scholarly journals that explained his process of reasoning and drew out the implications; anything less would be a chemical curio, a rearrangement of data of no potential lasting contribution to knowledge. Mendeleev was a young chemist on the make in the imperial capital, and he thought this system might make a splash if pitched just right, and for that he needed the imprimatur of two different audiences: Russian chemists, especially those in St. Petersburg who would be involved in decisions about professional advancement; and the international chemical community, which would surely not even notice anything published in Russian. That meant not one publication, but at least two.

Publishing in Russian had become almost trivially easy since the establishment of the Russian Chemical Society the previous autumn, complete with its own Russian-language *Journal of the Russian Chemical Society*, then in its first year. The printed minutes in that journal of the meeting of March 6, 1869 (March 18 on the Western calendar), the first monthly meeting after his formulation of his periodic system, announced as its first point: "N[ikolai] Menshutkin" – the secretary of the society, editor of the journal, and Mendeleev's colleague at St. Petersburg University – "reports on behalf of D. Mendeleev an attempt at a system of elements, based on their atomic weight and chemical affinity. In the absence of D. Mendeleev" – who was visiting cheese cooperatives as a consultant – "the discussion of this report is deferred to the following meeting."[14] That first announcement was followed by articles in both the April and August issues of the journal, expanding upon and deepening the implications of this new system of elements.

[14] Minutes of the Russian Chemical Society meeting of March 6, 1869 // Zhurnal Russkogo khimicheskogo obshchestva. 1869. No. 1. P. 35.

Taking care of the second community was almost as easy, with a ready outlet for translations of Russian into German in the form of the *Zeitschrift für Chemie*. One of the editors of this Göttingen-based journal was Friedrich Konrad Beilstein (1838–1906), whose name advertised his German ancestry but who was in fact born in St. Petersburg and was entirely bilingual in Russian and German. He had often promoted the idea of the *Zeitschrift* as a venue for publishing the work of Russian chemists before the Russian Chemical Society's own organ came into existence, and there was no reason Mendeleev should not avail himself of that opportunity now.[15] Mendeleev took his ten-page article from the April issue, shrunk it to a page-long abstract, and handed the Russian text over to Beilstein, who arranged for a translation and sent it off to Germany.

In the summer of 1869, Lothar Meyer (1830–1895) had been making very good progress in his own chemical research, until he was taken aback by a letter from St. Petersburg. His close friend Friedrich Beilstein had sent him a translated abstract from Petersburg featuring a system of chemical elements, and asked Meyer to see to it that this was placed in the *Zeitschrift*.[16] Meyer did such tasks routinely, working as Beilstein's man on the ground from his own position at Karlsruhe Polytechnic. Meyer transmitted the piece to the printers, but he could not have failed to despair. He had been working on such a system of elements – almost identical to the one produced by this "Mendelejeff," who was scarcely known outside of Petersburg. In the first edition of his widely read textbook, *Die modernen Theorien der Chemie*, published in 1864, he had explored the correlations between families of elements, including a "table [that] gives such relations for six groups of elements well characterized as belonging together."[17] It was not complete, true, but one can see from Figure 2 that it indeed was quite similar to Mendeleev's, and dated five years earlier.

[15] Mendeleev's findings were also reported in German in the flagship journal of the fledging German Chemical Society, but in much briefer form: V. von Richter. [Korrespondenz] // Berichte der Deutschen Chemischen Gesellschaft. 1869. No. 2. Pp. 552-554.

[16] On Beilstein's relationship with Meyer, see his letter to Jakob Volhard lamenting the death of his friend, on May 30/June 11, 1895, reproduced in Elena Roussanova. Friedrich Konrad Beilstein, Chemiker zweier Nationen: Sein Leben und Werk sowie einige Aspekte der deutsch-russischen Wissenschaftsbeziehungen in der zweiten Hälfte des 19. Jahrhunderts im Spiegel seines brieflichen Nachlasses. Vol. 2. Hamburg, 2007. P. 429.

[17] Lothar Meyer. Die modernen Theorien der Chemie und ihre Bedeutung für die chemische Statik. Breslau, 1864. P. 136.

	4 werthig	3 werthig	2 werthig	1 werthig	1 werthig	2 werthig
	—	—	—	—	Li = 7,03	(Be = 9,3?)
Differenz =	—	—	—	—	16,02	(14,7)
	C = 12,0	N = 14,04	O = 16,00	Fl = 19,0	Na = 23,05	Mg = 24,0
Differenz =	16,5	16,96	16,07	16,46	16,08	16,0
	Si = 28,5	P = 31,0	S = 32,07	Cl = 35,46	K = 39,13	Ca = 40,0
Differenz =	$\frac{89,1}{2}$ = 44,55	44,0	46,7	44,51	46,3	47,6
	—	As = 75,0	Se = 78,8	Br = 79,97	Rb = 85,4	Sr = 87,6
Differenz =	$\frac{89,1}{2}$ = 44,55	45,61	49,5	46,8	47,6	49,5
	Sn = 117,6	Sb = 120,6	Te = 128,3	J = 126,8	Cs = 133,0	Ba = 137,1
Differenz =	89,4 = 2.44,7	87,4 = 2.43,7	—	—	(Tl = 2.85,5)	—
	Pb = 207,0	Bi = 208,0	—	—	(Tl = 204?)	—

Fig. 2. Lothar Meyer's table of elements from the first edition of *Modern Theories of Chemistry* (1864).[18]

In fact, in 1868, he had developed a complete table of elements – published only posthumously by his student and friend Karl Seubert – which he was writing up for a journal, albeit slowly.[19] And now he had been scooped before he could make his own findings public.

Or had he? There was something odd about the abstract published in the *Zeitschrift für Chemie*, something missing… Oh, that was it! In the one-page abstract, spread across the bottom half of one page and the top half of its verso, Meyer reviewed the series of numbered points where Mendeleev drew out the implications of this table of elements. The very first of them read: "1. The elements ordered according to the magnitude of their atomic weights show a phased (*stufenweise*) change in properties."[20] Meyer had for some time been developing a notion that the system of elements was in fact *periodic*, displaying a repetition of properties that recurred much like a sine wave; it seems that Mendeleev had only noticed that there was a stepwise or phased change in the properties, not the precise character of that relationship. Meyer took out his pen and continued revising his essay on his own system of elements, to be published in the most prestigious chemical journal

[18] Source: Lothar Meyer. Die modernen Theorien der Chemie und ihre Bedeutung für die chemische Statik. Breslau, 1864. P. 137.

[19] Karl Seubert. Zur Geschichte des periodischen Systems // Zeitschrift für Anorganische Chemie. 1985. No. 9. Pp. 334-338.

[20] D. Mendelejeff. Ueber die Beziehungen der Eigenschaften zu den Atomgewichten der Elemente // Zeitschrift für Chemie. 1869. No. 5 (N.S.). P. 405.

of the day, the Munich-based *Annalen der Chemie und Pharmacie*, known universally as *Liebig's Annalen* after its founder and long-term editor, Justus von Liebig. Citing Mendeleev's *Zeitschrift* piece generously, Meyer noted that the Russian had observed that when "one orders the atomic weights of all elements without arbitrary selection in a single row, this row splits into sections, and these fall into an unchanging succession one after another." Mendeleev's contribution was important, but Meyer's emendation was more significant, because in his rendition "we take from the table that the properties of the elements are mostly *periodic* functions of the atomic weights," and that "[o]ne immediately sees from the course of the curve [Figure 3] that the volume of the elements, just as their chemical behavior, is a periodic function of the magnitude of their atomic weights."[21]

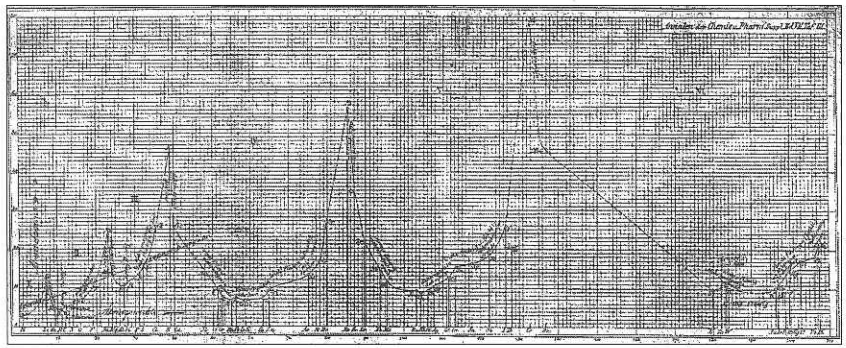


Fig. 3. Lothar Meyer's atomic-volume curve.[22]

Opening his own copy of the *Annalen* back in Petersburg, now it was Mendeleev's turn to sit stunned. What did Meyer mean that *he* was the one to introduce the word "periodic." You could see right in the original April 1869 article that Mendeleev had considered periodicity *the* crucial feature of the table from the very beginning. In that very first article, in the enumerated list of conclusions at the end of the article, the corresponding first item read: "1. The elements, arrayed by the magnitude of their atomic weights, present a distinct *periodicity* of properties."[23] It was even

[21] Lothar Meyer. Die Natur der chemischen Elemente als Function ihrer Atomgewichte // Annalen der Chemie und Pharmacie. 1870. Supp. VII. Pp. 355-356, 358.

[22] Source: Lothar Meyer. Die Natur der chemischen Elemente als Function ihrer Atomgewichte. Pp. 354-364, insert.

[23] D. Mendeleev. Sootnoshenie svoistv s atomnym vesom elementov // Zhurnal Russkogo khimicheskogo obshchestva. 1869. No. 1. P. 76, reproduced in Periodicheskii Zakon. Klassiki Nauki (Sb. dok.) / Sost. B. M. Kedrov. Moscow, 1958. P. 30. Emphasis in original.

italicized. How had the word "periodic" come to be rendered as "phased" (*stufenweise*)?

Mendeleev blamed Beilstein, for "periodicity" – in Russian *periodichnost'*, which should have been rendered in German as "periodische" – was certainly in the original piece.[24] And perhaps it really was Beilstein's fault, because he was in charge. The editor was flooded by Russian-language abstracts, handed to him with the dual request that he both arrange for their translation *and* publish them as rapidly as possible – two charges that could not both be met simultaneously, since careful translation took time. Beilstein handed Mendeleev's abstract to A. A. Ferman, an assistant then working in his laboratory at the Technological Institute in St. Petersburg, and asked him to translate it. With speed as the chief goal, he raced through it, not considering the word "periodic" to be of particular importance and substituting "phased" instead, a choice he confessed to and lamented as an audience member at a lecture on the priority dispute in 1911, long after Mendeleev, Meyer, and Beilstein were all safely dead.[25]

The damage had been done, and Meyer was in print claiming to have made a central innovation on Mendeleev's system of elements, now universally called a "periodic system" in both German and Russian. In 1870, Mendeleev was even willing to cite Meyer and grant him limited credit when he published further articles on the system *in Russian*.[26] Yet when it came to the high stakes of his massive reprise of the periodic system to be placed in *Liebig's Annalen* the year after Meyer's, Mendeleev would be more circumspect. As usual, Mendeleev wrote the lengthy piece in Russian, but this time he had his trusted friend Felix Wreden render it carefully into German, just as Wreden almost certainly translated the cover letter to the *Annalen*'s new editor (and Mendeleev's acquaintance from the early 1860s when they both spent time in Heidelberg), Emil Erlenmeyer. Insisting once again on the importance of the original Russian publications, even in this letter Mendeleev declared

[24] Mendeleev himself would highlight the damage of this translation error in a German article in 1873: D. Mendelejeff. Zur Frage über das System der Elemente // Berichte der Deutschen Chemischen Gesellschaft. 1871. No. 4. P. 351. This issue has only rarely and all too briefly been noted in the massive scholarship on the history of the periodic system, and its implications have never been fully explored. See V. A. Krotikov. Dve oshibki v pervykh publikatsiiakh o periodicheskom zakone D. I. Mendeleevym // Voprosy istorii estestvoznaniia i tekhniki. 1969. No. 4 (29). Pp. 129-131; and Van Spronsen. The Periodic System of Chemical Elements. P. 127.

[25] Quoted in K. Bening. D. I. Mendeleev. Kazan, 1911. P. ii.

[26] Mendeleev. Ob atomnom ob"eme prostykh tel (1870 g.) // Periodicheskii zakon. Klassiki nauki. Pp. 48-49; Mendeleev. O meste tseriia v sisteme elementov // Ibid. P. 59.

that the German article before Erlenmeyer could not be considered final: "Despite its size the present article does not report the course of my ideas in all the details, which are developed more completely and gradually in my Russian articles and in my 'Principles of Chemistry,' and which I would happily share with the German public."[27] In the article Mendeleev hit the theme – and, crucially, the *word* – of periodicity repeatedly:

> From the foregoing, as well as from other surveys introduced by me to this point, it follows that all functions, by which the dependence of properties upon the weight of the atom are expressed, mark themselves as *periodic*.[...] Thus the periodic law can be expressed in the following manner: *the properties of the elements* (as a result of the simple and compound bodies out of which they are formed) *find themselves in a periodic dependence from their atomic weights*.[28]

This, he hoped, ought to the settle the issue of credit and priority. Meyer did not completely agree, and while in the second issue of his *Modern Theories* textbook, published in 1872, he granted Mendeleev the lion's share of the credit and fulsome praise, in the 1876 third edition he still insisted that he himself had contributed a great deal to the development of the system, and that Mendeleev's "schema at that time [i.e., 1869] contained in itself still much arbitrariness and lack of regularity, which were later eliminated."[29] He believed that they really ought to share the credit. And aside from minor sniping in articles across the 1870s, the issue lay quiet, but smoldering.

Until Adolphe Wurtz (1817–1884), professor of chemistry at the Sorbonne and the most distinguished chemist in France, decided to douse the whole affair in kerosene. In 1877, Wurtz wrote privately to Mendeleev to express "my opinion on your admirable works on atomic weights, which I consider the most important progress that the atomic theory has made for a long time."[30] In his history of atomism, published two years later in French, Wurtz upped the ante by publicly emphasizing Mendeleev's invention of periodicity and

[27] Mendeleev to Erlenmeyer, [August 1871?], in Otto Krätz. Zwei Briefe Dmitri Iwanowitsch Mendelejeffs an Emil Erlenmeyer // Physis. 1970. No. 12. P. 351.

[28] D. Mendelejeff. Die periodische Gesetzmässigkeit der chemischen Elemente // Nauchnyi arkhiv. Vol. 1. Periodicheskii zakon / Ed. B. M. Kedrov. Moscow, 1953. P. 361. Emphasis in original.

[29] Lothar Meyer. Die modernen Theorien der Chemie und ihre Bedeutung für die chemische Statik, 3d. ed. Breslau, 1876. P. 291n. On the second edition, see Idem. Die modernen Theorien der Chemie und ihre Bedeutung für die chemische Statik, 2d. ed. Breslau, 1872. P. 298.

[30] Adolphe Wurtz to Mendeleev, July 27, 1877 // Museum-Archive of D. I. Mendeleev at St. Petersburg State University. I-V-23-1-27.

his Russian identity, relegating Meyer to secondary status: "Recently, the works of M. Mendéléff have opened a new day on the relations which exist between the atomic weights of simple bodies and their properties. The latter are a function of their atomic weights, and this function is *periodic*. That is the proposition put forward by the Russian chemist."[31] Wurtz was certainly entitled to his opinion, at least when publishing in French. In January 1880 the *Berichte* of the German Chemical Society published a letter from the French chemist that complained about the German translation of his *La théorie atomique*. Apparently, the German translator, a certain C. Siebert from Wiesbaden, had permitted an unauthorized preface and textual emendations – without seeking Wurtz's permission – which gave Lothar Meyer a greater share of credit in the periodic system. Wurtz sent a letter to the loudest megaphone to the German chemical community he could find in order to state his views that this revisionist position was "not well founded."[32]

Lothar Meyer responded to the salvo twice. First, he wrote a letter of his own to the council of the society, declaring that he had been irritated by the similarity of Wurtz's book to his own *Modern Theories* – and without adequate citation by the Frenchman – and his publisher insisted on inserting a correction. (Wurtz considered this defense preposterous.)[33] At the end of his letter, however, Meyer also added a note about credit: "Occasionally I had also suspected that Mr. *Würtz* had not entirely correctly distinguished Mr. *Mendelejeff*'s and my contribution to the development of the new atomic theory from each other.[...] Since this is now touched upon, I want to make this historically entirely clear to him in a note to the *Berichte*."[34] Meyer's second rebuttal, dated January 29, 1880, from his final post at the University of Tübingen in southern Germany, declared that any "unprejudiced judge" could look at the first edition of his *Modern Theories* and see that the essence of the periodic system was already present. He then noted that the original abstract in the *Zeitschrift für Chemie* had left an important point ambiguous:

> In the accompanying text it was said that the elements ordered according to the magnitude of their atomic weights showed a phased

[31] Adolphe Wurtz. La théorie atomique. Paris, 1879. P. 112. On Meyer, see Pp. 118 and 122.

[32] Adolf Wurtz to German Chemical Society, December 29, 1879, as printed in minutes of the meeting of January 11, 1880. Berichte der Deutschen Chemischen Gesellschaft. 1880. No. 13. P. 7.

[33] Adolphe Wurtz to German Chemical Society, March 1, 1880, as printed in Berichte der Deutschen Chemischen Gesellschaft. 1880. No. 13. Pp. 453-454.

[34] Lothar Meyer to the Vorstand of the German Chemical Society, January 25, 1880, as printed in Berichte der Deutschen Chemischen Gesellschaft. 1880. No. 13. P. 221.

> (*stufenweise*) change in their properties, that the magnitudes of the atomic weights determine the properties, that certain atomic weights are in need of correction and that the discovery of new elements was predictable; in addition to still other less important comments. Mr. *Mendelejeff* published these points of view in any event before me and probably altogether for the first time.[35]

He thus granted Mendeleev credit, but insisted that periodicity was his own independent innovation, lamenting only that the editors of the *Annalen* had not granted him enough space in 1870 to elaborate upon the differences between their two theories.

Mendeleev had been irritated before; now, he was furious. In an annotation to his bibliography that he penned late in life, he noted of his reaction that "I cannot stand this polemic of priorities, but the Germans forced me to answer."[36] He had encouragement; Wurtz wrote to Mendeleev's colleague Aleksandr M. Butlerov wondering whether Mendeleev would "respond to Mr. Lothar Meyer's attack?"[37] Mendeleev devoted the bulk of his own retort to Meyer, published later in 1880 in the same volume of the *Berichte*, to translated quotations from various original Russian publications. Borrowing a rhetorical device deployed in his textbook, *The Principles of Chemistry*, Mendeleev confined most of his own commentary on the significance of these translations to the footnotes, observing that "The word *periodicity* is emphasized in the original," and that the repetition of this word throughout the article "clearly shows that I at the very beginning (March 1869) considered periodicity as the fundamental property of the system of elements I had offered. Here it is clearly seen that I did not borrow this word from Mr. L. Meyer." He concluded by noting that the citation to the original was prominently displayed in the *Zeitschrift* publication, and "could have been known therefore to Mr. *L. Meyer*," and thus that "Mr. *L. Meyer* did not have the periodic law in mind before I did, and introduced nothing new afterward."[38]

[35] Lothar Meyer. Zur Geschichte der periodischen Atomistik [I] // Berichte der Deutschen Chemischen Gesellschaft. 1880. No. 13. P. 261; on "unprejudiced judge" P. 259.

[36] Mendeleev. Spisok moikh sochinenii // Arkhiv D. I. Mendeleeva. Vol. 1: Avtobiograficheskie materialy, sbornik dokumentov / Comp. P. A. Shchukarev and S. N. Valk. Leningrad, 1951. P. 67.

[37] Wurtz to Butlerov, March 14, 1880, reproduced in G. V. Bykov and J. Jacques. Deux pionniers de la chimie moderne, Adolphe Wurtz et Alexandre M. Boutlerov, d'après une correspondance inédite // Revue d'Historie des Sciences. 1960. No. 13. P. 129.

[38] D. Mendelejeff. Zur Geschichte des periodischen Gesetzes // Berichte der Deutschen Chemischen Gesellschaft. 1880. No. 13. Pp. 1799n1, 1800n3, 1797, and 1801.

This fight was thus still going on more than ten years after it had begun. Meyer had hoped that his historical rejoinder to Wurtz – that he considered admirably dispassionate and objective – would have taken care of this mess. After all, he had already ceded most of the credit to Mendeleev, only despairing that the Russian had not cited his 1870 work more generously. But Mendeleev wanted *all* of the credit, and his claim to that hinged on evaluating the status of that April 1869 publication *as* a scientific publication. It was longer, more detailed, and crucially *earlier* than the *Zeitschrift* abstract, but it was also, Meyer observed, written in Russian. This, he believed, was an important difference:

> I had found what I wrote in December 1869 about the periodicity of properties before the published abstract from Mr. *Mendelejeff*'s work in the *Zeitschrift für Chemie* in that same year came to my attention. Naturally, however, I only claimed for myself what that piece did not contain and what seemed to me to need improvement in it. Mr. *Mendelejeff* now claims that his articles which had then appeared in the *Russian* language contained everything that I had improved and introduced, and reproached me for not getting hold of his original articles. It seems to me an excessive demand that we German chemists read, besides those articles appearing in the Germanic and Romance languages, also those in the Slavic languages, and should monitor the accuracy of the German reports about their contents.[39]

Now it was out in the open. Mendeleev had published, but he had published in Russian. In an important sense, this meant it did not *count* – that Meyer was not responsible for acknowledging or even granting credit for what had appeared in it – for Russian was not yet a scientific language. Here was the bedrock issue behind this fight over priority: the status of Russian as a scientific language. Could the Russians consider articles written in their incomprehensible tongue and national journals as *equivalent* to those printed in established languages like German, French, and English – or even Italian? In the 1870s, this was an open question.

Let Them Read German

Imagine a chemist at the heart of the Russian Empire, St. Petersburg, in 1861, in the months after the Emancipation of the Serfs in February, or perhaps even after the liberalization of the tsarist censorship in 1865. Where

[39] Lothar Meyer. Zur Geschichte der periodischen Atomistik [II] // Berichte der Deutschen Chemischen Gesellschaft. 1880. No. 13. P. 2043. Emphasis in original.

would he – in this century, with vanishingly few exceptions, chemists were almost invariably "he" – be able to publish his original research, his efforts to advance the science of chemistry? Russian-language technical journals were few and far between (quite in contrast to literary journals, which proliferated across the century, and with special vigor in the 1860s). In 1804 the St. Petersburg Academy of Sciences published a *Technical Journal* (Tekhnicheskii zhurnal) for a few years, but its main outlet remained its *Bulletin*, which printed pieces in French and German for the first half of the nineteenth century (in the previous century the obligatory language had largely been Latin), and in any event one had to have the endorsement of an academician to publish there, which set a pretty high bar. The *Mining Journal* (Gornyi zhurnal) began publication in 1825, and for the rest of the century remained a significant outlet for works in applied chemistry and metallurgy. The problem was that almost no one read it or cited it – certainly not in Western Europe, but even among the elite scientists of the capital. There were other experiments in both Petersburg and Moscow in the 1820s and 1830s, but they remained more devoted to popularization than original research.[40] The solution seemed simple for the rather thin stratum of aspiring chemists, clustered around the several universities of the Empire: write your article in French or German (or, very rarely, English), and send it abroad for publication. Chemical publishing had a serious distribution problem; there were no adequate outlets in the Russian language.

In 1859, two chemists based in Petersburg – Aleksandr N. Engel'gardt (1832–1893), a talented organic chemist with rather substantial economic resources from his patrimonial estate, and Nikolai N. Sokolov (1826–1877), an ambitious theorist with an affinity for Auguste Comte's philosophy of Positivism – made an effort to remedy the situation.[41] First, they set up a private chemical laboratory on Galernaia Street, not far from the Winter Palace where the Hermitage Museum now sits, so researchers could conduct their research, for a fee. This relieved some pressure on the University and Academy laboratories, the latter of which was closed anyway to nonacademicians. Then, the two of them established *N. Sokolov and A. Engel'gardt's Chemical Journal* (Khimicheskii zhurnal N. Sokolova i A. Engel'gardta), the first Russian-language journal explicitly and exclusively devoted to the science of chemistry. The price for a year, composed of twelve separate

[40] Iu. I. Solov'ev. Istoriia khimii v Rossii: Nauchnye tsentry i osnovnye napravleniia issledovaniia. Moscow, 1985. Pp. 79-81.

[41] Nathan M. Brooks. Russian Chemistry in the 1850s: A Failed Attempt at Institutionalization // Annals of Science. 1995. Vol. 52. Pp. 577-589.

issues, was an affordable 5 rubles, and home delivery in St. Petersburg or Moscow was available for an additional ruble a year (other addresses commanded an additional fee). The first issue was graced by a high-minded epigraph by distinguished historian Augustin Thierry, offered, *naturellement*, in French: "There is something in the world that is worth more than material pleasures, more than fortune, more than health itself – it is the development of science."[42]

In their introduction to the first issue, Sokolov and Engel'gardt professed the highest of motives: the creation of a Russian chemical community. The journal was an essential part of that, not because there was no chemical information reaching the Russian public, but rather that there was too much, and not necessarily of the best kind. The journal "will give our public the opportunity above all to toss out from the majority of the diverse essays on chemistry all the rubbish, all the unnecessary, part of it even harmful, that is published unfortunately in enormous quantity in all literatures, and to select only that which has indubitable merit in some respect."[43] Here, readers would be supplied with original works by Russian chemists, translations of important chemical works in other languages, selected abstracts and summaries, and news of interest to chemists.

It was a high-minded effort, and pretty much a disaster. Initially, the two editors published their dissertations serially in the journal, and a few other Russian chemists, such as Mendeleev, submitted original work. But only a few. As the first year transitioned into the second, an increasing portion of the journal was devoted to lengthy articles summarizing the research of foreign chemists, often with several articles mashed up into one single review essay.[44] Even more striking, the editors were obliged to fill their issues with translations of articles written by Russian chemists but published abroad in journals like *Liebig's Annalen*.[45] But, of course, Russian chemists could already read the originals in French and German – and, more important, so could the European chemists they perceived as their primary audience – so there was less and less demand for the *Chemical Journal*. Even those who

[42] Khimicheskii zhurnal N. Sokolova i A. Engel'gardta. 1859. No. 1. Front cover.

[43] N. Sokolov and A. Engel'gardt. Ot redaktsii // Khimicheskii zhurnal N. Sokolova i A. Engel'gardta. 1859. No. 1. P. ix.

[44] August Hofmann. O dvuatomnykh i triatomnykh ammiakakh // Khimicheskii zhurnal N. Sokolova i A. Engel'gardta. 1860. No. 3. Pp. 55-74; Edward Frankland, Auguste Cahours, and George Buckton. O metallorganicheskikh soedineniiakh // Khimicheskii zhurnal N. Sokolova i A. Engel'gardta. 1860. No. 3. Pp. 109-129.

[45] For example, A. M. Butlerov. O nekotorykh produktakh deistviia al'kogoliata natriia na iodoform // Khimicheskii zhurnal N. Sokolova i A. Engel'gardta. 1860. No. 3. Pp. 340-351.

did use it, like Mendeleev, found it difficult to obtain copies while abroad on postdoctoral research trips; Sokolov shrugged off complaints, noting only that "the sending of Russian books abroad is attended here, as they say, by unusual difficulties."[46] In the end, the fiery Sokolov decided enough was enough: he dissolved the private laboratory, donated its material resources to St. Petersburg University, and moved to a teaching job there (which he held until 1864, when he stormed out of the capital as well). The journal collapsed in 1860, after only two years of publication. As far as Sokolov was concerned, the Russian chemical community he was trying to summon into being had failed him. The *Chemical Journal* had foundered because Russian chemistry did not exist.

The evidence does not support Sokolov's pique. As the pages of his own journal attested, there were plenty of active researchers generating original findings in both experimental and theoretical chemistry, and they were eager to publish. It was simply that, when given a choice in the 1860s about where to do so, Russian chemists overwhelmingly chose to publish in German. And not just in any journal, but overwhelmingly and consistently in one relatively marginal chemical periodical that we have already encountered: the *Zeitschrift für Chemie*.

The *Zeitschrift* was not originally supposed to be a chemical journal, and it was certainly never intended to cater to Russians. When it was established in Heidelberg in 1858 by the quartet of August Kekulé, Gustav Lewinstein, Friedrich Eisenlohr, and Moritz Cantor as the *Kritische Zeitschrift für Chemie, Physik und Mathematik*, it was as a review journal, which would publish critical commentary on recent publications in a wide variety of fields. Kekulé – soon to become one of the founders of the structure theory of organic molecules and eventually a titan of German chemistry – defended the venture to the grand man of chemical publishing, Justus von Liebig, by claiming that "through detailed abstracts a service will be rendered to the public and that only thus can a dam be placed against the incessantly increasing slime-literature."[47] Instead of erecting that barrier, it soon joined the slimy ranks; three of the four original editors abandoned the journal by the following year, and Gustav Lewinstein was joined on the masthead by pharmacist-turned-chemist Emil Erlenmeyer, who had just begun a lecture-

[46] N. N. Sokolov to Mendeleev, January 28, 1860 // Museum-Archive of D. I. Mendeleev at St. Petersburg State University. I-V-44-1-12.

[47] Quoted in Richard Anschütz. August Kekulé. Vol. 1. Berlin, 1929. P. 130. See also the opening editorial in the first issue: A. Kekulé, G. Lewinstein, F. Eisenlohr, and M. Cantor. Kritische Zeitschrift für Chemie, Physik und Mathematik. 1858. No. 1. Pp. 3-7.

ship in organic chemistry at the local university. Over the next five years, the journal, now a typical specialist journal renamed the *Zeitschrift für Chemie und Pharmacie*, would become so heavily identified with Erlenmeyer (Lewinstein soon decamped as well) that many library catalogs would simply refer to it as "Erlenmeyer's Zeitschrift."[48]

The identification with Erlenmeyer was a mixed blessing. He was a talented theoretical chemist but a rather obnoxious editor. He published original pieces in the *Zeitschrift*, but he also reprinted abstracts of articles from other journals, and these he would pepper with sarcastic editorial comments, appendices, and interlinear exclamation points of disdain, earning him considerable enmity from the German chemical community.[49] But, on the other hand, he socialized extensively with the sizable group of Russian chemists who spent postdoctoral research visits in Heidelberg – most famously Mendeleev, but also the chemist-cum-composer Aleksandr Borodin and dozens of others – and published German-language articles by them in great number.[50] (For his services to the roughly sixty Russians who passed through his small laboratory on Karpfengasse in Heidelberg, he was awarded the Order of St. Anna by the tsarist government in 1865.)[51]

[48] Otto Krätz (Ed.). Beilstein-Erlenmeyer: Briefe zur Geschichte der chemischen Dokumentation und des chemischen Zeitschriftenwesens. München, 1972. P. 11.

[49] On Erlenmeyer's sense of humor, see Richard Meyer. Emil Erlenmeyer // Chemiker-Zeitung. 1909. February 13. Vol. 19. No. 23. P. 161. Intrusive editorializing was not atypical in several of the most prominent scientific journals of the day. On the norms and practices of mid-century chemical publishing, see J. P. Phillips. Liebig and Kolbe, Critical Editors // Chymia. 1966. Vol. 2. Pp. 89-97. For contemporary complaints, see the letter from Kekulé to Erlenmeyer, November 8, 1871, quoted in Anschütz. August Kekulé. P. 407; and Beilstein to Butlerov, November 24, 1866 (O.S.), reproduced in G. W. Bykow and L. M. Bekassowa. Beiträge zur Geschichte der Chemie der 60-er Jahre des XIX. Jahrhunderts: II. F. Beilsteins Briefe an A. M. Butlerow // Physis. 1960. No. 8. P. 281.

[50] On the Russian contributions to the *Zeitschrift*, and a general history, see G. V. Bykov and Z. I. Sheptunova. Nemetskii "Zhurnal khimii" (1858–1871) i russkie khimiki (K istorii khimicheskoi periodiki) // Trudy Instituta istorii estestvoznaniia i tekhniki. 1960. No. 30. Pp. 97-110. On Russian students in Heidelberg, see Gesa Bock. Studenten des russischen Reichs an der Universität Heidelberg (1862/63–1914) / Diplomarbeit. Heidelberg, 1991; Willy Birkenmaier. Das russische Heidelberg: Zur Geschichte der deutsch-russischen Beziehungen im 19. Jahrhundert. Heidelberg, 1995; and Annette Nolte. D. I. Mendeleev in Heidelberg (=Russica Palatina 23). Heidelberg, 1993. On Borodin, see Michael D. Gordin. The Weekday Chemist: The Training of Aleksandr Borodin // Jed Z. Buchwald (Ed.). A Master of Science History: Essays in Honor of Charles Coulston Gillispie. Berlin, 2012. Pp. 137-164.

[51] Otto Krätz. Emil Erlenmeyer, 1825–1909 // Chemie in unserer Zeit. 1972. No. 6. P. 55; M. Conrad. Emil Erlenmeyer // Berichte der Deutschen Chemischen Gesellschaft. 1910. No. 43. P. 3647.

The affiliation with the young Russians – and their evident affection for the man they dubbed "Eremich" – almost certainly prolonged the life of the journal, as Germans abandoned Erlenmeyer to his sneering. Although it was cumbersome to obtain the *Zeitschrift* within Russia (one had to make special arrangements with booksellers, in addition to the typical problems with the Russian mails), roughly 150 Russians subscribed to the journal by 1865, dwarfing the German or West European orders. As Beilstein would remark the following year, "Erlenmeyer's Zeitschrift was more popular in Russia than in Germany."[52] The finances of the journal were suffering, and Erlenmeyer was desperate to offload it to someone else. As he wrote to Aleksandr Butlerov, then professor of chemistry at Kazan but shortly to move to St. Petersburg: "Indeed, dear friend, I would like to induce you to consider whether you would not want to take this up yourself and make it into a Russian journal, but one that is printed in the German language. Perhaps you could thus unite a Russian chemical society that made the *Zeitschrift* into its organ."[53] Butlerov passed, but Erlenmeyer eventually found his successors in three young chemists at Göttingen: Hans Hübner, Rudolf Fittig, and Friedrich Konrad Beilstein.

It was the choice of Beilstein, who would move back to his native city of St. Petersburg in 1866 to assume a post at the Technological Institute, that would cement the Russians further to the *Zeitschrift*, with implications for the fate of the periodic system as described earlier.[54] He was an inspired choice to navigate the changing face of European chemistry: a native speaker of German and Russian, he was also fluent in English and French, and managed reasonably well in Swedish and Italian to boot.[55] He was also incredibly

[52] Beilstein to Butlerov, 24 November 1866 (O.S.), reproduced in Bykow and Bekassowa. Beiträge zur Geschichte. P. 281. On postal and ordering issues, see Beilstein to Butlerov, 29/17 January 1865, reproduced in Ibid. P. 270; and V. V. Markovnikov to A. M. Butlerov, December 10, [1867] // Pis'ma russkikh khimikov k A. M. Butlerovu (Sb. dok.) / Comp. G. V. Bykov (=Nauchnoe nasledstvo. No. 4). Moscow, 1961. P. 248. See also the discussion in Alan J. Rocke. The Quiet Revolution: Hermann Kolbe and the Science of Organic Chemistry. Berkeley, 1993. Pp. 255, 258.

[53] Erlenmeyer to Butlerov, March 25, 1864, reproduced in G. W. Bykow and L. M. Bekassowa. Beiträge zur Geschichte der Chemie der 60-er Jahre des XIX. Jahrhunderts: I. Briefwechsel zwischen E. Erlenmeyer und A. M. Butlerow (von 1862 bis 1876) // Physis. 1966. No. 8. Pp. 190-191.

[54] On Beilstein's biography, see Michael D. Gordin. Beilstein Unbound: The Pedagogical Unraveling of a Man and His *Handbuch* // David Kaiser (Ed.). Pedagogy and the Practice of Science: Historical and Contemporary Perspectives. Cambridge, MA, 2005. Pp. 11-39.

[55] Krätz. Beilstein-Erlenmeyer. P. 7.

industrious and a gifted organic chemist, both of which stood him in good stead as he and his colleagues attempted to revive the periodical Erlenmeyer had handed on to them. "My God!" he lamented to Kekulé on November 3, 1865. "If I had been able to guess that one would earn for so much hard and bitter work so much unhappiness, dissatisfaction, and ingratitude, I would have sent *Erlenmeyer* home when he offered me the continuation of his rag last year."[56] The Göttingen triumvirate began to rebrand the journal as one that published much more *quickly* than the leading journal, *Liebig's Annalen*, and so it became the venue of choice for certain chemists seeking rapid publication to vouchsafe their priority in chemical discoveries. That was one reason why Mendeleev had chosen it.

But not the main reason. Beilstein carried on his duties as an editor for the *Zeitschrift* when he left Göttingen, but he acquired an additional responsibility: "I take everything Russian, since I remain the correspondent for Russia."[57] Much like Erlenmeyer had, Beilstein realized that the support and contributions of Russian chemists, who had no national chemical journal of their own in the mid-1860s, was crucial for the financial solvency of the journal. As he wrote in a revealing letter to Butlerov in January 1865, shortly after assuming the role of editor:

> I will in conclusion emphasize again that the "Zeitschrift" possesses in my person a warm representative of Russia's interests. I wish, that the Russian chemists not just laboriously work themselves to death with a Russian edition of their works (for you, who write German so expertly, this is truly not necessary!). But many might thus put off the publication of works, and thus I beg that they send me only the *Russian* articles. I wish to bear the burden of a correct translation.[...] Chemists speak only *one* language and thus one should also know in German what newly appears in Russia.[58]

He practiced what he preached – in fact, he had been doing so for years. When Aleksandr Engel'gardt neglected to publish his research anywhere but in his doomed *Chemical Journal*, Beilstein summarized them in German and placed a report into the *Zeitschrift* even while Erlenmeyer was still

[56] Beilstein to Kekulé, November 3, 1865, quoted in Friedrich Richter. K. F. Beilstein, sein Werk und seine Zeit: Zur Erinnerung an die 100. Wiederkehr seines Geburtstages // Berichte der Deutschen Chemischen Gesellschaft. 1938. No. 71A. P. 42. Emphasis in original.

[57] Beilstein to Butlerov, November 18/6, 1866, reproduced in Bykow and Bekassowa. Beiträge zur Geschichte der Chemie... II. P. 279.

[58] Beilstein to Butlerov, January 29/17, 1865, reproduced in Bykow and Bekassowa. Beiträge zur Geschichte der Chemie...II. P. 271. Emphasis in original.

editor.[59] He did the same for Mendeleev's 1864 Russian doctoral dissertation on alcohol-water solutions, adding that he hoped the author would publish a more extended version of his findings in another language, thereby "making his classic work also known to the remaining public."[60] It is clear from his correspondence that he worried extensively over the quality of the translations he commissioned or performed himself, and the *Zeitschrift* under his editorship continued to be the German-language periodical of choice for Russian chemists, the only national community to so favor it.

Unfortunately, it was not enough. In 1871, the *Zeitschrift* closed up shop, ending this experiment in transnational chemistry. As always, there was plenty of blame to go around, but the editors consistently fingered one culprit. In 1867, even before the unification of the country that would come to be called "Germany," the German Chemical Society was founded, and soon began publishing its journal, the *Berichte*. The *Berichte* also had to compete with the *Annalen*, and saw a niche in rapid publication of shorter articles, the very same strategy undertaken by the *Zeitschrift*. It was bigger, however, and more prestigious, and subscribers to the latter began leaching away. "There remains no doubt: the *Zeitschrift für Chemie* can no longer be conducted the *way* it has been until now," Beilstein wrote to Erlenmeyer in 1871. "Through the successful activity of the Berliner *Berichte* one of the chief tasks of the *Zeitschrift* – to publish rapidly – is effectively solved."[61] The blame that is, lay with the Germans, who were centralizing cultural authority along with political authority in Berlin.

There was much truth to this account, but Beilstein and his fellow editors neglected another competitor to the *Zeitschrift*, one that peeled off its most loyal adherents: the creation of the Russian Chemical Society the year after the German, and the sudden appearance the following year of the *Journal of the Russian Chemical Society*, described in the society's charter thus: "this publication will include the works of Russian chemists, printed in the

[59] Friedrich Beilstein. O rabotakh chlenov Russkogo fiziko-khimcheskogo obshchestva po aromaticheskomu riadu // Russkoe khimicheskoe obshchestvo. 1894. P. 48; Beilstein. Signed footnote in A. Engelhardt. Ueber die Einwirkung der wasserfreien Schwefelsäure auf einige organische Verbindungen // Zeitschrift für Chemie und Pharmacie. 1864. No. 7. P. 42n2.

[60] Beilstein. Comment on D. Mendelejeff. Ueber die Verbindung des Weingeistes mit Wasser // Zeitschrift für Chemie. 1865. No. 1 (N.S.). P. 264.

[61] Beilstein to Erlenmeyer, April 26/14, 1871, reproduced in Krätz. Beilstein-Erlenmeyer. P. 16. See also Rudolph Fittig to Erlenmeyer, January 2, 1872, Tübingen // Hofbibliothek Aschaffenburg.

Russian language."[62] Unlike the doomed venture of the *Chemical Journal* a decade earlier, the journal has continued, under a number of name changes, down to the present, becoming one of the most successful periodicals in the history of chemistry. It was not at first obvious that things would turn out this way.

In its first year, the journal printed a total of eighty copies, including the sixty issues reserved for society members, most of whom were concentrated in St. Petersburg.[63] This meant, in short, that no one outside of the same small circle of Russian chemists was reading it. Mendeleev lamented the state of affairs in 1871, no doubt influenced by his recent tangles with Lothar Meyer, and he suggested that "[i]n view of the fact that many of the works printed in the Society's journal remain partly unknown abroad, partly known only through short extracts," the society should be careful to send copies to be reported in the *Jahresbericht*, the German annual report of chemical publications.[64] Mendeleev's worry was that Germans remained unaware of Russian publications; his contemporary Vladimir Markovnikov of Moscow University was more concerned about the *Russians*. As he wrote to his mentor Butlerov in 1874: "Tell me, please, why have all the Petersburg chemists begun again to publish their works in foreign journals, and even earlier than in Russian? Why on Earth do our Society and Journal exist? I find this completely tactless and, if this continues, I'll quit the Society."[65] (To remedy this problem, the Society even created prizes such as the Zinin/Voskresenskii prize and the Sokolov prize, both established in 1880, which were to be awarded only for works printed in Russian.[66])

Chemists working in Russia were keenly aware of local sensitivity on this question. For example, Beilstein wrote to Erlenmeyer, now an editor at the *Annalen*, that he hoped the latter could delay a forthcoming article on naphthalene: "Namely, I would not want this article to appear earlier by

[62] Quoted in V. V. Kozlov and A. I. Lazarev. Tri chetverti veka Russkogo Khimicheskogo Obshchestva // 75 let periodicheskogo zakona D. I. Mendeleeva i Russkogo Khimicheskogo Obshchestva: Sb. dok. / Eds. P. I. Vol'fkovich and V. P. Kiselev. Moscow, 1947. P. 128.

[63] N. A. Menshutkin and G. Shmidt. Otchet o deiatel'nosti Russkogo khimicheskogo obshchestva v 1869 g. // Zhurnal Russkogo khimicheskogo obshchestva. 1870. No. 2. P. 5.

[64] Minutes of Russian Chemical Society meeting of March 4, 1871 // Zhurnal Russkogo khimicheskogo obshchestva. 1871. No. 3. P. 93.

[65] V. V. Markovnikov to A. M. Butlerov, October 9, 1874 // Pis'ma russkikh khimikov k A. M. Butlerovu. P. 272.

[66] Minutes of Russian Chemical Society meeting of April 3, 1880 // Zhurnal Russkogo fiziko-khimicheskogo obshchestva. 1880. No. 12. Pp. 182-183.

you than in our Russian journal. My patriotic friends would raise a stink if I were not to provide the national organ with original articles."[67] Or, as Butlerov's student Aleksandr Popov wrote to his adviser: "Would you approve of my intention to place in our chemical journal my works that I am producing here in Bonn and that at the same time will be printed in German journals? I intend to send to our journal a more detailed description than for the Germans."[68] If anything the debates over the periodic system only highlighted these concerns, besides the general problems with the Russian mail and the tardy publication of several early issues of the journal – occasionally Russians had to learn what was in their own journal by reading the abstracts in the *Berichte*.[69]

Yet Russians now seemed willing to back their own journal in their own language, and thus the *Zeitschrift* lost its prime clients. Markovnikov suggested a division of labor in 1870 – "It is proposed to publish the works of Russian chemists by the degree of the accumulation of materials; shorter reports, made at the meetings of the Society, should be printed in the *Zeitschrift*" – but it was too little, too late.[70] Beilstein, for one, was frantic that this insistence on publishing in Russian would doom the Russians to the prior neglect indicated by Engel'gardt's obscurity in Western Europe, and turned to Erlenmeyer in 1872 with an impassioned plea:

> In any case I would like to make you aware how much it would lie in the interests of the readers of the *Annalen* if you reported on the *Journal of the Russian Chemical Society*. Since the New Year, however, following the news from *Hübner*, I have laid aside my pen [at the *Zeitschrift*]. The *Annalen* must bring the works out completely. Now, however, the Russians have all become great patriots: they no longer want to write up their articles in foreign languages. Only a few, for example, Menshutkin, are so considerate as to worry about a translation themselves. Thus it is predictable that much useful work will be lost. *You* will earn a great merit if you tame this evil.[71]

[67] Beilstein to Erlenmeyer, September 23/October 5, 1873, reproduced in Krätz. Beilstein-Erlenmeyer. P. 41.

[68] A. N. Popov to A. M. Butlerov, December 30, 1871 // Pis'ma russkikh khimikov k A. M. Butlerovu. P. 340.

[69] V. V. Markovnikov to A. M. Butlerov, January 13, [1870] // Pis'ma russkikh khimikov k A. M. Butlerovu. P. 259; M. D. L'vov to A. M. Butlerov, July 11, 1873 // Ibid. P. 200.

[70] V. V. Markovnikov to A. M. Butlerov, 17 January [1868] // Pis'ma russkikh khimikov k A. M. Butlerovu. P. 252.

[71] Beilstein to Erlenmeyer, April 29/May 11, 1872, reproduced in Krätz. Beilstein-Erlenmeyer. P. 26. Emphasis in original.

Erlenmeyer was willing to help, but only if the responsibility for translations was assumed by the Russians. "I am of the view to ask the authors themselves to send us their articles in German or French. It is greatly preferable to me, if people concerned send their things themselves; they thus at the same time assume the responsibility for what stands written."[72] After all, Erlenmeyer was observing the priority dispute unfolding between Meyer and Mendeleev in the pages of his own *Annalen*. He would hate to be blamed for something like that.

Solomon's Baby

There was probably no way to avoid a priority dispute about the periodic system of chemical elements. There were so many people approaching some version of an arrangement of the elements along the two axes of weight and chemical properties, that any two of them might have found themselves struggling to assume the credit. But history did not unfold in an imagined parallel universe, and instead of a different priority dispute – or, however unlikely, no dispute at all – European chemists witnessed a sustained decade of angry sallies and counterthrusts over the proper attribution of the discovery to either Dmitrii Mendeleev or Lothar Meyer.

Just as there could have been many different contenders for priority – others, such as John Newlands, who repeatedly attempted to claim credit for himself, might not have been summarily ignored by all – the Meyer–Mendeleev conflict could have unfolded in a number of different ways. It could, for example, have been triggered by the discovery of the three not-yet-discovered elements whose properties Mendeleev predicted: gallium (Mendeleev's eka-aluminum) in 1875, scandium (eka-boron) in 1879, and germanium (eka-silicon) in 1886. Or chemists might have focused on Meyer's curve of atomic volumes, and encouraged a range of graphical presentations of the relationships between the elements. But those alternative histories also did not come to pass. Instead, we see Mendeleev and Meyer sparring with each other about credit largely as self-defined "Russian" and "German" chemists. The history suggests very strongly that this particular nationalist inflection, not altogether rare in this period, was accentuated by the faulty translation in the first German-language article Mendeleev published on his system in 1869. It was, in short, a reflection of debates over scientific languages, concentrated in a single word: periodic.

[72] Draft of Erlenmeyer to Beilstein, May 19, 1872, reproduced in Krätz. Beilstein-Erlenmeyer. Pp. 33-34.

The emphasis on language was, to some extent, derived from the nationalist ideologies then sweeping across European culture, from which science was hardly exempt. This was the age of the unification of Germany, the creation of the French Third Republic, the Risorgimento in Italy, the Great Reforms in Russia, and many other smaller-scale clashes stemming from the entrenchment of the nation-state as the primary mode of the European political order (at least in Western Europe). But one does not need to look at such dramatic developments to find the roots of the Mendeleev–Meyer conflict. There was, rather, a simple conjuncture of events in the late 1860s as Russian chemistry was beginning to transition from being a subsidiary of German chemistry into an established feature of the tsarist polity. Emblematic of this transition was the few years of overlap when Russians published *simultaneously* in the *Journal of the Russian Chemical Society* and the *Zeitschrift für Chemie*. Russian science was not yet prominent enough to command attention when published in the Russian language, and so Mendeleev felt compelled to print his findings in German as well; the disconnect between the Russian and German versions motivated the subsequent hostility with Meyer.

That hostility was never really resolved on a personal level. Mendeleev began to keep an exhaustive archive of his correspondence starting with the development of the periodic system, and yet one finds only two substantial items there filed under Lothar Meyer's name. The second of these was a note from Meyer's widow informing Mendeleev of her husband's death in 1895 – an indication that the Petersburger was on the list of people who were expected to be personally informed of the sad event.[73] In the earlier communication, a letter from 1893, which is the only personal correspondence between the two in the archive, Meyer informs Mendeleev that the distinguished Leipzig chemist Wilhelm Ostwald had commissioned two issues of his *Klassiker* – pamphlets of primary sources on monumental discoveries in chemistry – on the development of the periodic system. Meyer edited the first, on the "precursors" who had noticed smaller patterns among the elements before the 1860s.[74] Since he was uncomfortable calling himself a "classic," Meyer delegated the second volume on himself and Mendeleev to his student Karl Seubert. Meyer now asked Mendeleev

[73] Johanna Meyer (née Volkmann) and her children, Tübingen, April 12, 1895 // Museum-Archive of D. I. Mendeleev at St. Petersburg State University. I-V-27-1-26.

[74] Lothar Meyer (Ed.). Die Anfänge des Systems der chemischen Elemente: Abhandlungen von J. W. Doebereiner 1829 und Max Pettenkofer 1850 nebst einer geschichtlichen Uebersicht der Weiterentwicklung der Lehre von den Triaden der Elemente. Leipzig, 1895.

to send some copies of articles, especially "your article in the first volume of the Russ. Society, from which I had quickly received an actual translation through Beilstein's mediation"[75] – translated into German, of course. One can detect a subtle friction in Meyer's careful phrasing. We have no record of Mendeleev's response, but Seubert's volume was published with the relevant pieces in 1895.[76]

By that point, the controversy between the two had reached a semi-stable equilibrium. After the heated exchange in the *Berichte* of the German Chemical Society in 1880, Meyer and Mendeleev never again crossed swords directly. The tension was, however, palpable, and an outside group decided to step in and resolve it by fiat. In 1882, the Royal Society of London, Britain's premier scholarly association, jointly awarded the two men the coveted Davy Medal "[f]or their discovery of the periodic relations of the atomic weights."[77] This award was later dubbed by Seubert in his 1895 volume "a most just and beautiful decision," and it seemed to have calmed matters considerably.[78] A nonpartisan national organization opting for a middle path seemed to codify a consensus developing even among nationally committed observers. For example, when Butlerov gave lectures (in Russian) on the history of recent chemistry in 1879–80, he also divided the credit between the two, and Nikolai Menshutkin continued this pattern in 1895 when he announced Meyer's death at a meeting of the Russian Chemical Society – with Mendeleev himself presiding.[79] Interactions between the men now dubbed "co-discoverers" remained officially correct on the few occasions when they interacted, as in one contemporary description of the two men on the dais at the 1887 Manchester meeting of the British Association. Here too, language played its role, when "there

[75] Lothar Meyer to Mendeleev, August 16, 1893, Tübingen // Museum-Archive of D. I. Mendeleev at St. Petersburg State University. I-V-63-1-70.

[76] Karl Seubert (Ed.). Das natürliche System der chemischen Elemente: Abhandlungen von Lothar Meyer 1864–1869 und D. Mendelejeff 1869–1871. Leipzig, 1895.

[77] http://royalsociety.org/Content.aspx?id=3277 (last accessed August 20, 2012).

[78] Editorial comments in Seubert (Ed.). Das natürliche System der chemischen Elemente. Pp. 122-123. See also Nikolai A. Menshutkin. Ocherk razvitiia khimicheskikh vozzrenii. St. Petersburg, 1888. P. 319.

[79] Menshutkin in minutes of Russian Chemical Society meeting of April 13, 1895 // Zhurnal Russkogo fiziko-khimicheskogo obshchestva. 1895. No. 27. P. 197; and Butlerov. Istoricheskii ocherk razvitiia khimii v poslednie 40 let // Idem. Sochineniia. Vol. 3. Moscow, 1958. P. 280. See also American chemist Ira Remsen's Solomonic dividing of credit in his review of Newlands's claims to priority in American Chemical Journal. 1884–1885. Vol. 6. P. 144.

was a call for a speech from Mendeléef, he declined to make an attempt to address the section in English." He knew that this was beyond his linguistic capacities, so the Russian just stood up and bowed. But then Meyer, seated next to Mendeleev, rose, and – to avoid misunderstanding – declared: "I am not Mendeléef." But a moment later, "speaking faultless English, asked permission to address the section in German, and then proceeded, on behalf of Mendeléeff and other foreign chemists present, to express the pleasure they had derived from listening to the Presidential address."[80] At that time, as in 1880, Meyer got the last word. But after his death in 1895, Mendeleev was left to shape the history, at which point he relented on his exclusion of Meyer from any credit and included him within his narratives of the system – but only as a "strengthener" (*ukrepitel'*) of the system, not as a full-fledged co-discoverer.[81] And it is Mendeleev's post-Meyer allocation of credit that is dominant today.

Perhaps the real victory was not in terms of who discovered the periodic system, but in terms of which languages were seen to "count" among the scientists of Europe. In no small part due to Mendeleev's emphasis on the importance of reading his original writings in Russian to adjudicate priority – and no doubt the impressive quality of those works themselves – Western European scientists began to take notice of the Russian-language works published in the journal. Foreign correspondents would report, in translation, on the major activities discussed at meetings of the Russian Chemical Society. The Belgians, for example, began publishing the journal's table of contents in their own journal, in French, in 1875.[82] At the twenty-fifth anniversary celebration of the Russian Chemical Society, president of the Chemical Society of London Henry E. Armstrong sent a congratulatory letter: "Notwithstanding the great difficulties which your language imposes, your english [*sic*] colleagues learn from time to time of your labours, the name of your Society and a record of its work regularly appearing in our volume of abstracts of chemical papers."[83] At the same meeting where this letter was read out, again under Mendeleev's presiding eye, Menshutkin lauded his writings on the periodic system: "These works, printed in Russian, now

[80] P. Phillips Bedson. Lothar Meyer Memorial Lecture // Journal of the Chemical Society. 1896. Vol. 69. P. 1409.

[81] See, for example, F. P. Venable. The Development of the Periodic Law. Easton, PA, 1896. P. 95.

[82] Minutes of Russian Chemical Society meeting of April 3, 1875 // Zhurnal Russkogo fiziko-khimicheskogo obshchestva. 1875. No. 7. P. 177.

[83] Russkoe khimicheskoe obshchestvo. P. 4.

become an achievement of universal science, thanks to abstracts about them in foreign scholarly societies."[84] To be sure, Western Europeans were not signing up to learn Russian in droves, but a few did indeed try to master the Slavic tongue, and many of the others at least now came to understand that they could not simply dismiss writings in the language, as Lothar Meyer had, as not registering in the scientific literature.

This was surely no small part of Mendeleev's reasoning, in 1899, when he wrote – in French – that "as a Russian, I am proud of having participated in the establishment of the periodic law."[85] For something had indeed happened in the previous fifty years that marked the distance the Russian chemical community, and the scientific community in general, had traveled since the abortive efforts at founding a chemical periodical in 1859. In 1890, Russian historian Vasilii I. Modestov wrote about what he could now call "Russian science": "We know that during these past twenty-five years *Russian science was created*, a science that begins to garner to itself both in this and that area a recognition that before did not exist."[86] For this recognition to happen, Russian science had actually to be written *in Russian*, and that process began in earnest in the 1860s.

SUMMARY

In the late 1860s, chemistry was rocked by a priority dispute over who discovered the periodic system of chemical elements: St. Petersburg chemist Dmitrii I. Mendeleev (1834–1907) or southern German chemist Lothar Meyer (1830–1895)? The dispute hinged upon whether publications in the Russian language "counted" within the credit system of European chemistry. This article excavates this dispute and places it in the context of the limited publishing opportunities in both Russian and German for chemists within the Russian Empire, and argues for the role of this particular argument in establishing the status of Russian as a viable international chemical language.

[84] Russkoe khimicheskoe obshchestvo. P. 2.

[85] D. Mendeléeff. Comment j'ai trouvé le système périodique des éléments // Revue générale de chemie pure et appliquée. 1901. Vol. 4. P. 546.

[86] V. Modestov. Russkaia nauka v poslednie dvadtsat' piat' let // Russkaia mysl'. 1890. No. 5. P. 78. Emphasis in original.

Резюме

В конце 1860-х гг. химическое сообщество сотрясал спор о том, кому принадлежит приоритет открытия периодической системы химических элементов: санкт-петербургскому химику Д. И. Менделееву (1834–1907) или южно-немецкому химику Юлиусу Лотару Мейеру (1830–1895). В основе спора лежали разногласия по поводу того, "засчитываются" ли публикации на русском языке в системе европейской химической науки. В статье реконструируется история этой полемики, рассматриваемой в контексте проблемы ограниченных возможностей научных публикаций для российских химиков как на русском, так и на немецком языках. Как доказывается в статье, именно спор между Менделеевым и Мейером привел к утверждению статуса русского как полноценного международного языка химической науки.