EARLY WOMEN CHEMISTS IN RUSSIA: ANNA VOLKOVA, IULIIA LERMONTOVA, AND NADEZHDA ZIBER-SHUMOVA

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About eighty-five percent of the nineteenth-century publications by women in the chemical sciences came from three national groups, Russian, American, and British, other Continental Europeans contributing the remainder (1).

Over the period from 1870 (the year when the earliest chemistry papers by a woman appeared) until the end of the century (2) American output increased steadily, while British women, who started only in the 1880s, were the most productive in the last decade of the century (3). The Russians, a group of about twenty, are especially notable in that they are the most prominent of the early workers, making a strong start in the 1870s and 1880s, although their output declined somewhat in the following decade (see Fig. 1 and 2). Several produced a remarkable amount of very creditable research. Interestingly, a list of their mentors and associates would read like a who's who of turn-of-the-century chemists; among them were Mendeleev, Markovnikov, Favorskii, Menshutkin, Butlerov, and L'vov (4).

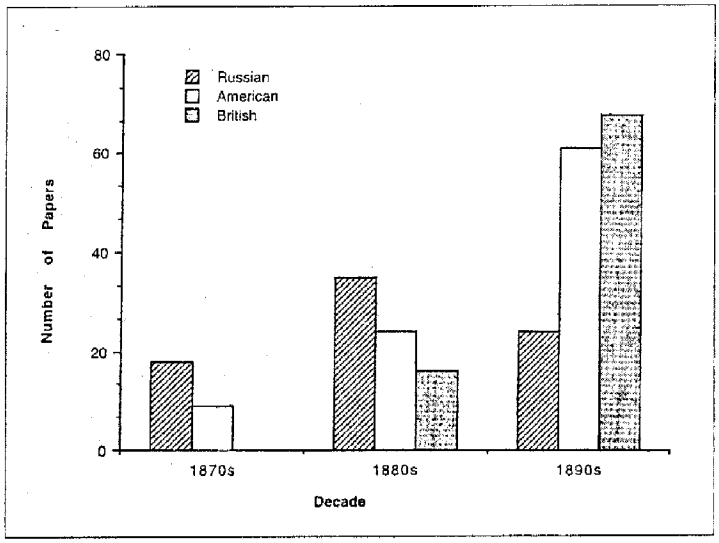

Figure 1. Number of papers authored or co-authored by Russian, American, and British women chemists and biochemists, 1870-1900, by decade. The count includes only full papers; preliminary notes and second-language duplicate papers are excluded. The Russian count does not include 10 papers constituting the combined pre-1901 contribution of Polish women chemists. Data from the London Royal Society *Catalogue of Scientific Papers, 1800-1900.*

Sketches of three of the earliest of the Russian women chemists are offered below: Anna Volkova, the first to publish; Iuliia Lermontova, the first Russian and the second European woman to receive a doctorate in chemistry (5); and Nadezhda Ziber-Shumova, one of the most productive women chemists/biochemists of the late nineteenth-early twentieth century (6)

Anna Fedorovna Volkova (d. 1876) acquired her basic education in chemistry at the systematic public lectures given in the late 1860s by St. Petersburgh university faculty members. Her first research experience was at the St. Petersburg Institute of Agriculture and Forestry, where she worked with chemist and agronomist Aleksandr Engel'gardt, one of the founders of the first Russian-language chemical journal. Engel'gardt and his co-workers were then engaged in investigations on the structure and properties of arylsulfonic acids and their derivatives (7). From 1870, when she moved to the St. Petersburgh Technological Insti-

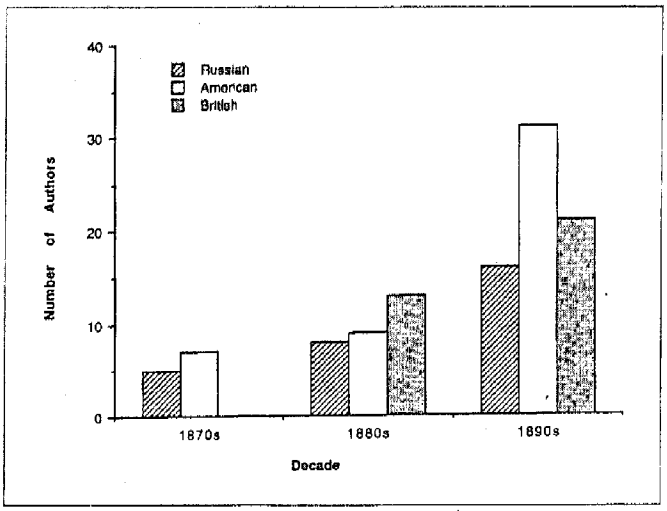

Figure 2. Number of Russian, American, and British women authors or co-authors of chemistry and biochemistry papers, 1870-1900, by decade. Since several women were active throughout the whole period, the 3-decade author total for a given nationality cannot be accurately estimated by adding the counts for the individual decades. Polish women are not included in the Russian count. Data from the London Royal Society *Catalogue of Scientific Papers, 1800-1900.*

tute, Volkova extended studies in this area with encouragement and direction from Dmitrii Mendeleev (8). Her two papers on toluenesulfonic acids and their amides in *Zeitschrift für Chemie* in 1870 were probably the first reporting chemical research by a woman from a modern chemical laboratory (9). Following their publication she was invited to join the recently founded Russian Chemical Society as its first woman member (10); about the same time Nikolai Menshutkin enlisted her help in editing and abstracting work for the society's journal.

Despite a very short career, ended by poverty-related illness and premature death in 1876, Volkova carried out a remarkable amount of synthetic work on aromatic amides, particularly the sulfonic acid amides. The contribution for which she is remembered (9, 11) is her 1870 preparation of the amide of *o*-toluenesulfonic acid, which was to become a key intermediate in the manufacture of saccharine. However, over the period 1870-73, she investigated a number of reactions of both the *o*- and *p*-toluenesulfonic acids or their chlorides, and prepared and studied the properties of several new acid amides (12). She was well regarded by her colleagues and well integrated into the chemical community; not only did she present two papers at the Third Congress of Russian Naturalists at Kiev in 1871, but she was elected chair of one of the chemistry sessions there. Compounds she synthesized were among the new materials prepared by Russian chemists which were exhibited at the World Industrial Exhibition in London in 1876.

Iuliia Vsevolodovna Lermontova (1846-1919), most likely the first Russian woman to receive a doctoral degree in chemistry (13), is better remembered than Volkova. Born in St. Petersburg, December 21, 1846, she was the daughter of the director of the First Cadet Corps in Moscow, a government-supported military school for future army officers and military specialists. She received a good basic education from private tutors but, even though she had the benefit of an acquaintance with Mendeleev, failed to gain admittance as an auditor (the most she could hope for) at the Institute of Agriculture and Forestry in St. Petersburg.

In 1869, therefore, along with her friend the future mathematician Sof'ia Kovalevskaia, she went to the University of Heidelberg. After persistent effort, mainly on the part of the more confident Kovalevskaia, she was allowed to audit lectures by Robert Bunsen, Gustav Kirchoff, and Herman Kopp. She also obtained a place

Iuliia Lermontova (from D. H. Kennedy, *Little Sparrow: a Portrait of Sophia Kovalevsky*, 1983; the author thanks Christopher Kennedy for permission to reproduce the photo.)

in Bunsen's laboratory; urged by Mendeleev, with whom she kept up a regular correspondence during her years in Germany, she learned Bunsen's methods of ore analysis and joined in his then ongoing research on the separation of metals of the platinum group. Subsequently she was given a place, again as a private student, in August Hofmann's laboratory at the University of Berlin. Although most of his studies concerned coal-tar derivatives, he also worked on several aliphatic series in ongoing efforts to establish structural principles (14). Under his guidance Lermontova carried out her dissertation research, preparing a number of halogen derivatives of short-chain aliphatic hydrocarbons and investigating their properties. Her first paper, however, published in *Berichte* in 1872, described her study of an aromatic compound (4,4′-diamino-azobenzene) (15).

Since neither the University of Berlin nor the University of Heidelberg would consider granting a degree to a woman at the time, an approach was made by Hofmann to the University of Göttingen. A smaller institution of a generally more liberal outlook, it accepted Lermontova as a doctoral candidate, the requirement being that she take an oral examination. On the occasion of her passing, *cum magna laude*, Friedrich Wöhler, one of the two chemists on her examining committee (the other was Hans Hübner), presented her with a memento—a small cut stone of the mineral in which he had first discovered titanium. Her dissertation, "Zur Kenntnis der Methylenverbindungen," was published in Göttingen in 1874.

On her return to Moscow she stopped in St. Petersburg and was given a warm welcome by the chemical community. At a celebration at Mendeleev's home in her honor, speeches were made and toasts drunk. Aleksandr Butlerov, one of the most distinguished of Russia's organic chemists and a strong supporter of higher education for women, suggested she join his research group.

She returned to Moscow, however, and obtained a position there in Vladimir Markovnikov's laboratory where she continued research on aliphatic hydrocarbons. The preparation of 1,3-dibromopropane, reported under her name only in 1876 (16), led to the synthesis, via the corresponding dicyano-compound, of glutaric acid. Moving to St. Petersburgh in 1878, she took up Butlerov's earlier invitation and joined him and Mikhail L'vov. One of the leading developers of modern structural theories of organic chemistry, Butlerov carried out extensive experimental work on both saturated and unsaturated series. Lermontova joined in ongoing studies on branched olefins. Much of her work was published under Butlerov's name (with acknowledgments), although her synthesis of 2,4,4-trimethyl-2-pentene appeared under her own name in 1879 (17).

Going back to Moscow for family reasons and to be near Sof'ia Kovalevskaia, she rejoined Markovnikov, this time assisting with his investigations into the composition of Caucasian petroleum. She was probably the first woman ever to work in petroleum chemistry, a field of applied research in which there was then considerable interest in Russia and elsewhere (18). At Markovnikov's suggestion she investigated high-temperature fractionation processes and metal-catalyzed "cracking," presenting her results at meetings of the Moscow Section of the Russian Technical Society; for a time she was an especially active member of the latter's chemical technology division. She joined the Russian Chemical Society in 1875, elected on Mendeleev's recommendation.

About 1886 she put aside her chemical work and turned her attention to agricultural projects on her estate outside Moscow. Following modern methods for improving soil fertility, she increased yields considerably; she took up cheese-making, also using modern technology, and had moderate success, producing French cheeses for sale in Moscow. She lived through the First World War and the early phases of the social revolution that followed, dying at the age of seventy-three in December, 1919.

Nadezhda Olimpievna Ziber-Shumova (fl. 1870s-1914), from St. Petersburg, the third in this group of early Russian women chemists, probably authored or coauthored more pre-1901 papers in the chemical sciences than any other woman. Both she and her sister Ekaterina studied in Switzerland in the early 1870s. Nadezhda, already married to Nikolai Ziber from Kiev, one of Russia's first Marxist economists, was in Zürich with Ziber in 1872-73, although not formally enrolled at the university. Subsequently, she and Ekaterina, a medical student, continued their studies at Bern University, one of the institutions to which the Russian women students at Zürich scattered after being ordered by their government to leave Zürich in 1873. (With its then large Russian student community, Zürich was considered a hotbed of dangerous revolutionary activity by the tsarist government.)

By 1877 she had joined the research group led by Polish-born Marceli Nencki (1847-1901), head of the biochemical department at Bern and a pioneer in the chemical approach to the study of microorganisms. Their collaboration lasted until Nencki's death twenty-three

years later. Between the late 1870s and the turn of the century, she authored or co-authored more than thirty papers on a variety of biochemical topics, including *in vivo* oxidation, bacterial fermentation and decomposition processes, enzyme studies, and sugar hydrolysis, as well as basic chemical studies, such as the zinc choride-catalyzed acylation of phenols known as the "Nencki reaction(19)". Her most important early contribution, however, was probably her joint work with Nencki on the constitution of the blood pigment hemin, part of a long series of systematic investigations on the degredation products of hemin, carried out by Nencki and his co-workers over many years. When integrated with the work of Leon Marchlewski on chlorophyll, these studies led Nencki to his hypothesis concerning the chemical relationship between the plant and animal kingdoms (20). The joint Nencki-Ziber papers were among the earliest on hemin (21).

Nencki left Bern in 1891 to assist in organizing the new Imperial Institute of Experimental Medicine in St. Petersburg, where he became head of the department of chemistry and biochemistry. Ziber-Shumova, a widow from 1888, joined the institute staff, along with Szymon Dzierzgowski and Martin Hahn, as one of Nencki's three senior co-workers.

During the recurrent and very widespread famines and epidemics which ravaged the country throughout the 1890s, considerable effort was made by Russian professionals in the fields of public health and sanitation to provide assistance and bring about improvement. Measures taken included the organization of clinics and observational units in the countryside. Nencki, Ziber-Shumova, and Dzierzgowski joined in this work, their contributions including extensive field observations carried out during a cholera epidemic of 1892. Their search for a source of readily accessible antiseptics led to a detailed investigation of the chemical composition of pine pitch and an examination of its disinfecting properties (22). Later in the decade they published a considerable amount of bacteriological work on the problem of cattle plague, Nencki having been commissioned to carry out immunization field trials in the Caucasus and Siberia (23).

Ziber-Shumova rose to a senior position in the institute's biochemical department and continued to publish at least until the outbreak of World War I. Her later work included investigations of the lipids present in lung tissue and a number of enzyme studies, many of which appeared in *Zeitschrift für Physiologische Chemie*.

Volkova, Lermontova, and Ziber-Shumova form a remarkable group in the history of women chemists, publishing the first research (Volkova, 1870), taking the second doctoral degree awarded to a European woman (Lermontova, 1874), and creating an early record in publications (Ziber-Shumova, during the 1880s). Indeed among women whose careers in chemical research began before 1900, Ziber-Shumova is perhaps *the* dominant figure; she is also one of the most notable in the half century before World War I (24).

REFERENCES AND NOTES

1. Data from a count of papers by women authors in the nineteen-volume London Royal Society *Catalogue of Scientific Papers, 1800-1900*, University Press, Cambridge, 1867-1925. I have not reclaimed Marie Curie from physics, and so the ten papers she published in the 1890s are not included in the present comparison.
2. One or two pre-1870 publications by nineteenth-century women recording observations on chemical topics are known (see, for instance, D. A. Davenport and K. M. Ireland, "The Ingenius, Lively and Celebrated Mrs Fulhame, and a Dyer's Hand," *Bull. Hist. Chem.*, **1989**, 5, 37-42). The present paper, however, focuses on work carried out in modern chemical laboratories, from which women were virtually excluded until the late 1860s.
3. Accounts of the American and British groups, along with further comparisons and numerical data, will appear in the forthcoming book, M.R.S. Creese, *Ladies in the Laboratory? American and British Women in Science, 1800-1900: A Survey of their Contributions to Research*, Scarecrow Press, Lanham, MD, in press. For an earlier discussion of the British group see M.R.S. Creese, "British Women . . . Research in the Chemical Sciences," *Br. J. Hist. Sci.*, **1991**, *24*, 275-305.
4. The long struggle, against powerful government opposition, of Russian women from about 1860 for access to higher education generated much sympathy for their cause in the academic community; further, this sympathy was backed by concrete practical help. For a discussion of the unique alliance between faculty members at Russian universities and women students at this period see, for instance, C. Johanson, *Women's Struggle for Higher Education in Russia, 1855-1900*, McGill-Queen's University Press, Kingston and Montreal, 1987; and R. A. Dudgeon, "The Forgotten Minority: Women Students in Imperial Russia 1872-1917," *Russ. Hist.*, **1982**, *9*, 1-26.
5. Lermontova's degree was awarded in the autumn of 1874. Six months previously (April 1874) Lidiia Zesemann from Finland (admittedly then part of imperial Russia) had her inaugural dissertation on dibenzylacetic acid accepted by Zürich University [J. A. Meijer, *Knowledge and Revolution. The Russian Colony in Zürich (1870-1873)*, International Instituut voor Sociale Geschiednis, Assen, 1955, p. 204, n. 71]. Zesemann worked in the physical chemistry laboratory

at the University of Leipzig for several years in the 1870s and 1880s, later moving to Firenze (*Ber. Dtsch. Chem. Ges.*, 1877-1914, German Chemical Society membership lists).

6. Information about Volkova and Lermontova came mainly from I. S. Musabekov, *Iuliia Vsevolodovna Lermontova, 1846-1919*, Nauka, Moscow, 1967; the discussion of Volkova appears in Chapter 1, "The First Women Chemists," 7-10. Previously published English-language notes on Lermontova include C. Steinberg's, "Yulia Vsevolodovna Lermontova (1846-1919)," *J. Chem. Educ.*, **1983**, *60*, 757, and J. Miller, "Women in Chemistry," in G. Kass-Simon and P. Farnes, Ed., *Women of Science: Righting the Record*, Indiana University Press, Bloomington, IN, 1990, pp. 310-311. Ziber-Shumova is mentioned in a number of scattered sources, including A. Szwejcerowa, *Marceli Nencki*, Wydawnictwo Interpress, Warsaw, 1977; V.A. Bazanov and G.A. Vladimirova, "'Russkaia koloniia' b Tsiurikhe," ["'Russian colony' in Zürich"], *Sovetskoe Zdravookhranenie*, **1969**, *25*, 71-76; and Meijer, reference 4. [In Russian sources, dates before the calendar change from Julian to Gregorian (made on February 14, 1918) are traditionally given in the Julian (Old Style) calendar; thereafter they are given in the Gregorian. This article follows that pattern. At the beginning of the twentieth century, the Julian calendar was thirteen days behind the Gregorian.]
7. See, for example, A. Engelhardt and P. Latschinoff, "Über die Benzoylsulfanilidsäure," *Z. Chem.*, **1868**, *4*, 266-270; "Über die Phenoldisulfosäure und die Isäthiosulfosäure," *ibid.*, **1868**, *4*, 270-271; "Über isomere Kresole und ihre Derivate," *ibid.*, **1869**, *5*, 615-623.
8. Although remembered especially for his formulation of the Periodic Law of the elements, Mendeleev was a man of exceptionally broad scientific, technological, and general educational interests. His *Organic Chemistry* (1861) was the first systematic textbook in that field written by a Russian, and his three-volume *Principles of Chemistry* (1868-69) was considered a classic. He taught organic chemistry at the St. Petersburg Institute of Agriculture and Forestry from 1861 (A. Vucinich, *Science in Russian Culture 1861-1917*, Stanford University Press, Stanford, CA, 1970, pp. 147-165).
9. A. Th. Wolkow, "Ueber die isomeren Toluosulfosäuren," *Z. Chem.*, **1870**, *6*, 321-327 and *J. Russ. Chem. Soc.*, **1870**, *2*, 161-175; "Ueber die Säuren, welche durch Vertretung des Wasserstoffs in den Amiden der Toluosulfosäuren durch saure Radicale entstehen," *Z. Chem.*, **1870**, *6*, 577-581 and *J. Russ. Chem. Soc.*, **1870**, *2*, 243-252.
10. The russian Chemical Society, founded in 1878 with the Russian Physical Society (founded in 1872), becoming the Russian Physical and Chemical Society (Vucinich, Ref. 8, 82, 137).
11. J. Turkevich, *Chemistry in the Soviet Union*, Van Nostrand, Princeton, NJ, 1965, p. 51.
12. See A. Th. Wolkow, "Ueber die Einwirkung des β-Toluosulfosäure-chlorides auf Säure-amide," *Z. Chem.*, **1871**, *7*, 421-422 and *J. Russ. Chem. Soc.*, **1871**, *3*, 239-242; "Ueber neue Amidsäuren," *Z. Chem.*, **1871**, *7*, 422-423, *J. Russ. Chem. Soc.*, **1871**, *3*, 242-245 and **1872**, *4*, 7-15; "Ueber die Einwirkung von Phosphorpentachlorid auf einige Aciamide," *Ber. Dtsch. Chem. Ges.*, **1872**, *5*, 137-143. Volkova's last paper ("*Iso*- Crotylether," *ibid.*, **1873**, *6*, 196) suggests that she was then moving to a new area.
13. Ref. 5.
14. J. R. Partington, *A History of Chemistry*, Macmillan, London, 1964, Vol. 4, pp. 432-444 and many other entries.
15. J. Lermontoff, "Ueber die Zusammensetzung des Diphenins," *Ber. Dtsch. Chem. Ges.*, **1872**, *5*, 230-236.
16. "Ueber die Darstellung von Trimethylenbromid," *Justus Liebigs Ann. Chem.*, **1876**, *182*, 358-362.
17. "Sur l'action de l'iodure de butyle tertiare sur l'isobutylène en présence d'oxydes métalliques," *St. Pétersb. Ac. Sci. Bull.*, **1879**, *25*, col. 203-209, and *Justus Liebigs Ann. Chem.*, **1879**, *196*, 116-122.
18. For a note on the first American woman to work in petroleum chemistry, see M.R.S. Creese and T. M. Creese, "Laura Alberta Linton (1853-1915): an American Chemist," *Bull. Hist. Chem.*, **1990**, *8*, 15-18.
19. M. Nencki and N. Sieber, "Ueber die Verbindungen der ein- und zweibasichen Fettsäuren mit Phenolen," *J. Prakt. Chem.*, **1881**, *23*, 147-156, 537-546. See also L. F. Fieser and M. Fieser, *Reagents for Organic Synthesis*, Wiley, New York, 1967, p. 1291.
20. Wlodzimierz Niemierko, in *Dictionary of Scientific Biography*, Scribner's, New York, 1974, Vol. 10, pp. 22-23; N.-O. Sieber, "Note sur les travaux scientifiques du prof. M. W. Nencki," *Arch. Sci. Biol. Instit. Expt. Méd.*, St. Petersburg, **1904**, *11*, 167-195.
21. See "Untersuchungen über den Blutfarbstoff," *Arch. Exp. Pathol. Pharmakol.*, **1884**, *18*, 401-422; *Ber. Dtsch. Chem. Ges.*, **1884**, *17*, 2267-2276; **1885**, *18*, 392-399; "Ueber das Hämin," *Arch. Exp. Pathol. Pharmakol.*, **1886**, *20*, 325-332; "Venöse Hämoglobinkrystalle," *Ber. Dtsch. Chem. Ges.*, **1886**, *19*, 128-130, 410; "Ueber das Hämatoporphyrin," *Monatsh. Chem.*, **1888**, 115-132.
22. M. Nencki and N. O. Ziber-Shumova, "Sur la composition chimique du goudron de pin et sur ses propriétés désinfectantes," *Arch. Sci. Biol. Instit. Expt. Méd.*, St. Petersburg, **1893**, *2*, 358-419.
23. See, for instance, M. Nencki, N. O. Ziber-Shumova, and W. Wyzhnikiewicz, "Recherches sur la peste bovine," *Zentral. Bakt.* (Abt. 1), **1898**, *23*, 529-538; and *Arch. Sci. Biol. Instit. Expt. Méd.*, St. Petersburg, **1898**, *6*, 374-396; **1899**, *7*, 303-336; "Die Immunisation gegen die Rinderpest nach den im Institute für experimentelle Medizin in St. Petersburg auf der Station `Iknewi' im

Gouvernment Tiflis gesammelten Erfahrungen," *Arch. Int. Pharmacodyn. Ther.*, **1899**, *5*, 475-508.

24. The decline in numbers of publications by Russian women chemists in the 1890s from the early peak in the 1880s (Fig. 1) can be correlated in large measure with the diversion of Ziber-Shumova's energies to bacteriology during much of the nineties (her sixteen bacteriological papers published during the nineties are not included in the data in Fig. 1). It is also the case that political events of the time were again influencing Russian women's access to higher education; as part of the counter-reforms instituted after the assassination of Tsar Aleksandr II (1881), most of the university-level Higher Courses for Women, established in several cities in the late 1870s, were discontinued (see both Johanson and Dudgeon, Ref. 4). This made conditions more difficult for aspiring women chemists, a great many having benefited from these programs. However, as is shown in Fig. 2, the number of Russian women participating in research increased in the 1890s (many of those active then took their training in Switzerland); and so it would not seem to be an exaggeration to say that Ziber-Shumova's activities are the controlling factor in the Russian women's publication profile for the 1880s and 1890s.

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