



Alexander P. Borodin (1833–1887) – great composer, army physician and distinguished scientist-chemist

Aleksandar P. Borodin (1833–1887) – veliki kompozitor, vojni lekar i priznati naučnik-hemičar

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Introduction

Alexander Porfiryevich Borodin (Figure 1) was born on November 12, 1833, in the capital of the Imperial Russia St. Petersburg, as a rejected and illegitimate son of 62-year-old Georgian prince Luka Gedevanishvili (according to one historical source) or prince Luka Stepanovich Gedeonov (second historical source) and a 37 years younger Russian peasant Evdokia Konstantinovna Antonovna. The father forgot Borodin's name and enrolled him in the birth registry as the



Fig. 1 – Portrait of Alexander P. Borodin

son of a room made, Jevdokia, and an indoor servant, Borodin Porfiryevich. On his deathbed in 1843 Luka Gedeonov admitted Alexander Borodin as his son and released him of obligations as servant¹.

Interest in music

The father's aristocratic position allowed Borodin to gain good education in his childhood, including instructions on how to play the piano and cello. Later on Borodin surmounted the technique of playing the flute oboe. By the way, he was also occupied with literature. This talent for music was noticed at the age of nine when his first compositions appeared². Although being skinny and in poor health he successfully attended the lessons of foreign languages in adolescent years delivered by his energetic and wise mother, although she had a very modest education.

Shortly after his father's death, Borodin's mother married a military doctor Kleinek. Later on, he helped Borodin to enroll the study of medicine³. In the years to come, Borodin acquired culture and fine manners of aristocratic society where he belonged to⁴. At that time, Borodin was dreaming and planning about the study of chemistry due to his interest in the chemistry of fireworks. Passion and commitment to chemistry obscured his musical skills and creativity when for a time he neglected composing and performing.

As his mother was dissuading him from chemistry at his puberty age, she persuaded her husband, Borodin's stepfather, to help her. Finally, Borodin enrolled medicine study in 1850⁵. Another reason to give his assent for the medicine study was as follows: receiving university diploma in chemistry was a condition to obtain diploma in any biomedicine study. Upon the next five years of successful studies in Peters-

burg at the Military Academy of Medicine and Surgery (Military Academy of Surgery or Military Medical Academy as stated by various literature data) Borodin graduated in 1855⁵.

Employment

After graduation, in the 1856 Borodin worked as family doctor at a military hospital. At the same time, he became more and more engaged in experimental medical chemistry at the Academy. This well-equipped institution was the Russian center of natural sciences allowing him a wide field of work and open up his mind to researching and achievements that followed up⁵.

Borodin spent some time as an intern at the Academy in the rank of physician-surgeon. There he met a young guard officer, lieutenant Modest Mussorgsky, made friends with him and worked on musical cooperation forming a famous circle of musicians, the so-called "Mighty Five"⁶.

There was a lot of work in the crowded Russian military hospitals with sick soldiers and wounded in those years after big losses during the Russo-Turkish war in Crimea (1853–1856). It was noted that Borodin had selfless kindness, compassion and tenderness for patients at ambulance work in the next three years. He was often on duty as a volunteer due to the large influx of warriors from the Crimean front. However, at that internship time Borodin got a "coordinator" role at military hospital. Once Borodin almost fainted during examination and treatment of serious wounds of Crimean wounded. From then on, he realized that medical practice was too hard and emotional work for him (Borodin always felt a slight dizziness when in contact with blood or bloody interventions)². Borodin began more and more to move away from clinical practice of medicine and in time moved to the Department of Anatomy and Pathology to work as a preparator. At the same time, he began to care for medical chemistry from laboratory and scientific aspects of biochemical research that would later bring him a great fame⁵.

A career in science – chemistry

As renowned expert in four languages, Borodin attended International Congress of Ophthalmology and Optics (1857) as the Russian government delegate. During those months, he intensively conducted research in the pharmaceutical laboratory and received advanced training, studied and travelled to professional meetings.

After specialization in medical chemistry at the "Institute for Youth doctors" in 1858, he attended practical courses in organic chemistry (biochemistry). Next year (1859), he published an article in the field of balneology and balneomedicine⁷.

Borodin conferred a doctorate in the field of toxicology ("Analogy in the action of arsenic and phosphoric acid in the chemical and toxicological sense") on May 15th 1858. It was the first written and defended PhD in Russian language in former Russia at the "Military Medical Academy", while all previous ones were in Latin. St. Petersburg Academy of that time was a glorious institution where the famous Nobel

Prize winner, Ivan Pavlov, one of the founders of modern human physiology, soon began to work.

Shortly after that, Borodin began specialization in medical (physiological) chemistry. He rearranged the apartment in a small laboratory and focused researching on toxicology and organic chemistry. Besides, he used to teach at the University School of Medicine that made him more exhausted. Many historians recorded that his excessive experimentation in the laboratory placed within the house produced heavy mist of chemicals threatening with fire all the time.

After diploma promotion at the end of 1859 Borodin went to the Western Europe as a state scholarship and gained further education. This was to thank to his teacher, Nikolai Nikolayevich Zinin, who paid much respect to Borodin. Zinin enabled him postdoctoral scholarship in Prussia because at that time Russian medical profession was the youngest in Europe with modern medicine still in its infancy compared with the Western European one⁸. Zinin used to chide him many times in a friendly way for his excessive dedication to music instead to laboratory research for which he was believed to possess a great talent especially in the field of applied chemistry in medicine. Since then, Borodin used to compose and perform music "in the underground".

Filled with energy and enthusiasm, Borodin went to the Prussian Heidelberg in autumn 1859 to do his postdoctoral studies in the laboratory of a famous Emil Erlenmeyer up to the 1862. Here he also collaborated with the renowned chemist Bunsen⁸ and compatriots Mendeleev and Sechenoff, the scientists already recognized at the time¹.

The scholarship was extended to him for two years due to the prolific scientific work. Borodin moved to Italy because of his fiancé illness (tuberculosis). Actually, pianist Ekaterina Protopopova, his "dear Katyusha" was advised by doctors for hot climate treating. Beloved Ekaterina will be taken as wife in 1863 in Petersburg. Leisure time Borodin spent in Viareggio, the village near Pisa, where used to work in the chemical research laboratory "Lucca and Tasiperi", the property of Sebastian di Lucca, where studied mostly organohalogenes. During that period Borodin composed little in rare spare time spent at home nurturing the sick wife.

Mastery of the English, French, German and Italian allowed him to travel in the next few years to professional meetings and for medical research projects across Europe (Pisa, Paris, Berlin, Karlsruhe, Frankfurt, Jena, Belgium, Switzerland etc).

Returning to Russia in the autumn of 1862, the famous Borodin became associate professor of organic chemistry at the Military Medical Academy in St. Petersburg where kept on hard scientific research¹. At that time he established "Medical school for women". This was a very important event for Russian medicine since it was the first time in Russia (St. Petersburg) that women were allowed to be educated for the health care profession and physicians¹. This type of training Borodin would repeated in the period from 1872 to 1887 organizing the multiple "courses of medicine for women"³.

Due to the dedicated work at the Academy and the scientific achievements, Borodin was announced in 1864 as full professor. Then he met a famous composer Mily A.

Balakirev and his music colleagues, and made friends with him. Hence, he became the member of the so-called "Big Five" ("Mighty Handful"), later on the famous independent group of composers. Modest Musorgsky who left military service for the sake of love or music joined the "Mighty Five" and got down to hard work to create and express "Russian" versus "German" art music. They wanted to prevent the enormous impact of the West, mainly German, composers and create independent Russian art music folk songs and folklore of the big Russia. Doing so, they were gradually very successful in years to come^{3,9}.

Borodin created the first symphony under the Balakirev's influence but written in four years because torn up by family and professional responsibilities. He experienced its successful performance not until 1869.

Researches in the field of biochemistry, toxicology and organic chemistry

At the same time Borodin realized many organic analytic and synthetic reactions in the field of biochemistry applied to laboratory tests, medical and pharmaceutical industry. Much effort Borodin invested in organohalogen synthesis (up to that time the first synthetic organic compounds of fluorine). He published a paper on fluorine compounds (fluorbenzen) in the German magazine "Chemical annals" from Liebig. His notable studies on amides as well as those related to polymerization, addition and condensation of aldehydes were presented in 21 scientific articles. The fundamental discovery was his aldol-addition achieved in 1872 that soon led to the synthesis of the first sedatives. His successfully published work "The effect of ethyl iodide to hydrobenzamide and amarine" was notable. Having early realized the harmfulness of adverse effects of opioids (in the middle of the 19th century it came from Afghanistan), Borodin conducted the tests on the medicinal properties of Bukhara opium with high content of morphine that he announced in the article in 1876. By the way he examined the synthesis of fatty acids and the effect of antiseptic means (1878) and tea (1883) in human medicine and published it too². Borodin was competing for superiority in the field of substitution and the addition of halogen elements in cyclic hydrocarbons to the famous chemist Kekulé. He also worked on the organohalogen synthesis important for medical industry of that time: methyl chloride (kryoanesthetic, degreasing mean), chloroform (inhalation drug, penicillin extractor, an organic solvent), ethyl chloride (inhalation anesthetic), iodine (antiseptic), war poisons (mustard gas, vesicants, phosgene), vinylbromide (component of rubber for dental prosthesis) and many other substances^{10,11}. He did and described the aldol synthesis at the same time as Wurtz did (1872) although this reaction was named only by the German author ("Wurtz's synthesis"). It is explained by the strong influence of German lobby in the European Chemists' Association, as well as the first previously published statement issued by the author Wurtz.

Due to excessive effort in the field of medicinal chemistry in 1874, Borodin was appointed the head of chemical laboratories at the Military Medical Academy.

The last completed Borodin study was to investigate the amount of urea in urine. Specifically, in 1876 for a purpose Borodin invented a nitrogenous method and apparatus for quantitative determination of urea by measuring the quantity of elemental nitrogen extracted from urine. He published detailed article about this method in the same year. This easy and precise method soon became widely accepted in biochemical and clinical laboratories¹. Borodin also continued to investigate the toxicological aspects of phosphoric and arsenic acid started as early as during his PhD researches.

Overall, Borodin presented on life over forty and published around 20 papers of high quality in Russian and foreign journals. Actually, on that way Borodin fought for supremacy in many fields of toxicology, biochemistry and organic chemistry with German and French researchers.

Because of dedicated work, the Academy promoted him to title of academician in 1877.

Borodin did not reach the old age but died of massive heart attack in 1887 at his own admission, the masked ball in the lobby of the Academy. Historical sources indicate different causes of death: ..."rupture of blood vessels of the heart"¹², ..."congestive heart disease"⁹ or ..."aortic aneurysm"¹³.

Thousands of people were in the parade to pay a final tribute to him, when the young ones carried the coffin on their hands to the grave drenched with the most sincere tears of all those who loved him and knew his creativity, endless kindness, spirituality and goodness³. He was buried with great honour next to Modest Mussorgsky in the St. Petersburg laura of the Alexander Nevsky Monastery.

Instead of conclusion – in praise of great composer and scientist

Borodin became famous in music for life attained the fame noticed by a musical genius of that time, Franz Liszt, whom he met once in 1877. Liszt organized for him with great compliment the performance of the First Symphony in 1880 in Germany with the advice ..."not to change anything in so original style of composing..." Belgian Countess Mercy-Argento propagated his music across France and Belgium, what consequently quickly spread Borodin's glory and across the Atlantic.

It is known that the Borodin's music influenced French composers Debussy and Ravel. The latter one paid homage to him in 1913 in the piano piece.

Evoking memories to Borodin, Robert Wright and George Forest created the work "Kismet" ("Fate"), an adaptation of his compositions in 1953, most pronounced in the song "Stranger in Paradise". Realizing the size of Borodin music through the presentation of this compilation, he was posthumously awarded by the "Tony Award" recognition in 1954^{12,13}.

It can be said that the popular arias from "Polovetian dances", the unfinished opera "Prince Igor", which he used to make intermittently over 17 years, represent the pearl of evergreen music that popularizes the best authentic Russian

music arose from an open soul and the heart of Russian peasants.

However, due to many duties at the Academy, mentoring and nurturing a seriously ill spouse, lack of continuous spare time necessary for the serious business of music and weak concentration unfavorable for composing, Borodin failed to create a large opus of work. Besides, he was ill himself often. He barely attained to compose something meaningful on Sundays he called hence himself "a weekend composer"¹³.

However, for a few compositions of the small opus he created (about 20), one can say to be the unrepeatable masterpieces of art music of a specific and unique expression of full flavor and taste of great Russia with nuances of oriental music. Borodin wove in a specific way lyricism and harmony derived from Russian folk songs.

How deeply ambivalent figure Borodin was the next quotation could explain ... "I am ashamed of own musical activities because I believe that music just relaxes me. I feel the passion to my main profession as research in the field of medical chemistry and biochemistry"...^{1,11}.

This quote from a letter confirms Borodin's agonizing in many fields: ... "I compose during the winter when my illness does not allow lectures and work in the lab. Then I am forced to stay at home until my head bursting with pain and tears filled my eyes. That is why my music fans do not want me to be healthy but ill..."^{14,15}.

In his best creative years Borodin left great works unfinished (opera "Prince Igor" and scientific publications), completed by his students and his colleagues (Alexander Glazunov and Rimsky-Korsakov). The successor of Borodin's chemical laboratory research was his brother in law, young A. P. Dianin.

Homage to this great researcher of medical chemistry presents the chemical reaction of halogen substitution in cyclic hydrocarbons that is well-known as "Hunsdicker's reaction". This reaction was published in Western Europe not until 1939, but performed as early as 1862 by Borodin. The Chemists' Association of Russia demonstratively but with full right named the substitution reaction as "Borodin's reaction". "Borodin's silver-decarboxylation reaction" was also named after him¹⁴.

Although under-reported in the areas dealt with, overexerted by family obligations and professional activities, Borodin left an indelible stamp on art music of the national romanticism of the 19th century.

Borodin's researches in toxicology, biochemistry, organic and physiological chemistry altogether used as basic achievements led to the synthesis of important pharmacological substances that are being applied in modern medicine. In this manner, Borodin gave great impetus to the development not only of Russian but also of European medicine in the second half of the 19th century, otherwise some branches of up-to-date medicine could not exist.

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