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REVIEW ARTICLE

Aleksandr Porfiryevich Borodin (1833-1887) – eminent Russian chemist and outstanding composer

Aleksandr Porfiryevich Borodin (1833-1887) - químico ruso eminente y compositor destacado

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ABSTRACT

In this article, a literature concerning A.P. Borodin's life and his activity as the chemist and composer has been reviewed. Special attention has been paid to the references to his life and achievements in chemistry in 1881 – 2012 as well as his chemical work published between 1858 and 1886. Literature review was supplemented with: 1) description of the selected facts from Borodin's life; 2) acquaintance of the readers with the selected authors of his biography, and 3) description of the Borodin's premature death causes.

Keywords: A.P. Borodin; organic chemistry; Borodin's chemical achievements; music; Russia; XIX century

RESUMEN

En este artículo se ha hecho una revisión sobre la vida de A.P. Borodin y su actividad como químico y compositor. Se ha prestado especial atención a las referencias de su vida y logros en química entre 1881-2012, así como a su trabajo químico publicado entre 1858 y 1886. La revisión de la literatura se complementó con: 1) una descripción de los hechos seleccionados de la vida de Borodin; 2) un conocimiento de los lectores con los autores seleccionados de su biografía, y 3) una descripción de las causas de muerte prematura de Borodin.

Palabras clave: A.P. Borodin; química orgánica; logros químicos de Borodin; música; Rusia; siglo XIX

Borodin's biographies written in Russia and other countries

A.P. Borodin (Fig. 1) born October 31 (Old Style) [November 12, New Style] 1833 in St. Petersburg. In his adult life, he was both the chemist and composer. Therefore, both sides of his activity are mentioned in various proportions in his biographies or biographical notes published in Brazil, France, Holland, Mexico, Germany, New Zealand, Poland, Russia, Serbia, U.S.A., and Great Britain in the years 1895 –2017. The first as the chemist and the other connected with compose and music (Blokh, 1931, p. 75-76; Bulycheva, 2017; Chodkowski, 1954, p. 369-381; Davies, 1995, p. 207-217; Figurovskii & Solov'ev, 1950/1988; Habets, 1890/1893, p. 1-104; Halton, 2014, p. 41-47; Ilić, 2013, p. 233-236; Il'in & Segal, 1989; Lewis, 2012, p. 61-64; Lischke, 2004; "Medicine, molecules and, "2014; Podlech, 2010, p. 6490-6495; Ruiz, 2001, p. 190-192; Semisch, 1988, p. 14-24; Sokhor, 1965; Solod & Alekseev, 2013, p. 195-203; Stasov, 1887; Suvorin, 1889; Swolkień, 1979; Vijvers, 2007; White, 1987, p. 326-327;

Zakgeim, 2010, p. 90-95; Zorina, 1985).

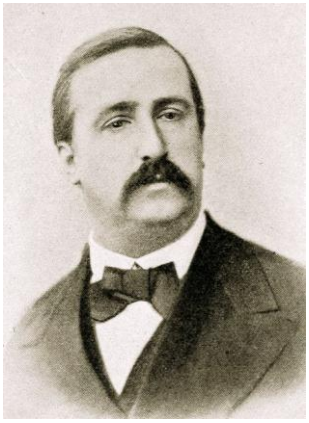

Figure 1. Aleksandr Porfiryevich Borodin (1833-1887) ("Aleksander Borodin, Photo" 1865).

Hundred years already past, when Pavel Ivanovich (Paul) Walden[1] (1863-1957) wrote that Borodin as a composer became known all over the world (Landenburg & Walden, 1917, p. 470). An interest in his musical creation did not decrease since then. One can confidently say that his compositions are admired by the consecutive generations. Borodin is also the author of both libretto and music of the opera "Prince Igor" (Borodin, 1915). Very popular is his piece "Polovtsian Dances" from this opera (Borodin, 1936; You Tube, 2010) and his Symphony No. 2[2] (Borodin, 1996).

Borodin is a subject of interest of the representatives of various disciplines of science. A clear image of such an interest is provided by the review of literature collected by Michael D. Gordin. Gordin in his essay entitled *The Weekly Chemist: The Training of Aleksandr Borodin* gave biographic data of 30 articles, in which the authors describe both Borodin's life and works. These articles were published between 1887 and 1998 in the following languages: English, Russian, German, Polish, and Danish, mainly in the medical, chemical, and music journals. It should be emphasized that the authors of these articles referred to Borodin as to "composer" and "chemist" most frequently. Moreover, they mentioned also that he was a physician. Titles of these articles contained also the following definitions: "medical educator", "surgeon", "musician", "Pedagogue", "scientist", and "man" (Gordin, 2012, pp. 138-139).

Borodin's biographies in the different languages may also find in the web. For instance, on the Internet side *Small science stories* his five-part biography in French is available. Selected facts of Borodin's life and activity both as composer and chemist is described there ("1869, Borodine à

[1] Pavel Ivanovich (Paul) Walden was Latvian, Russian, and German chemist. In 1984, he became professor of the analytic chemistry at the Polytechnic Institute in Riga. In 1916, he became a member of the Petersburg Academy of Sciences. In 1950, he received an honorary doctorate of the university in Tübingen (Morachevskii, 2003, p. 1186-1190).

[2] In 1980, Borodin's Museum was created in the Russian Davydovo Village. Eight hundred of various exhibits from Borodin's musical library and manuscripts of Sergei Aleksandrovich Dianin (1888-1968), who was the researcher of Borodin's works, were gathered in this Museum. Some of these manuscripts were not published, yet. Museum collection includes also memorial musical instruments ("Yedinstvennyi v mire, 2014"). Dianin's father "was Borodin's assistant, executor, and earliest biographer (1888), and his mother was one of Borodin's adopted daughters" (Krebs, 1965, p. 157). In the Russian National Museum of Music 267 exhibits related to Aleksandr P. Borodin are exposed. They are available on-line after entering his name, Christian name, and patronymic in the Russian language: <Бородин Александдр Порфирьевич>. These exhibits contained among other published materials, negatives with his portraits and scores, and also his photographs from 1870. ("Rossiiskii natsional'nyi muzei", n.d.).

Saint", 2018).

References to Borodin's life and activity in the literature in 1881-2012

Information about Borodin's life and activity as a chemist was scarce in the books on chemistry and its history in the books published in the eighties of XIX century to the half of the XX century. The most of such information the author of this article found in the Russian books. Below, information about Borodin in each of them is given below.

Russian chemist Nikolai Aleksandrovich Menshutkin (1842-1907) wrote in his book entitled *Essay on the development of chemical views* that Borodin was a student of Nikolai Nikolaievich Zinin (1812-1880). He wrote about Borodin's chemical works as follows:

> A.P. Borodin as one of the first chemists studied reaction of the aldehyde condensation reaction. He got the aldol [3-hydroxybutanal – CH_3-CH(OH)-CH_2-CHO] independently on A. Wurtz. Borodin's method of receiving the organic fluorine compounds (aromatic) proved to be of importance (Menshutkin, 1888, p. 199).

Russian chemist Alexander Erminingel'dovich Arbuzov (1877-1968) in his *Kratkii ocherk razvitiia organicheskoi khimii* (A short Essay of the Development of Organic Chemistry in Russia) also wrote about receiving aldol by Borodin, independent on the French chemist Charles Adolph Wurtz (1817-1884), adding that Borodin had given up further studies of these compounds (Arbuzov, 1948, p. 24).

Arbuzov in his note about Borodin submitted some facts from his life. He wrote, among others, that A.P. Borodin perfectly speaks French, German, and English. He was interested in the natural sciences since his youth, especially chemistry. In 1850, a 16-years old Borodin has begun studies in the Medical-Surgical Academy in St. Petersburg. He graduated with diploma *cum laude* in 1856. On graduation, he was appointed head of the ward in the military hospital. However, he abandoned medicine and seriously engaged in the work in Zinin's laboratory. In 1859, Borodin was sent abroad for 3 years[3]. First, he worked in Emil Erlenmeyer's (1825-1909) laboratory in Heidelberg and later in the laboratory of Sebastiano de Luca's (1820-1880) and Paolo Tassinari (1829-1909) in Pisa (Italy). In 1862, Borodin returned to Russia and took up the chair in chemistry at the Medical-Surgical Academy (Arbuzov, 1948, p. 23-24).

Paul Walden in his note about Borodin provided additional information on Borodin's life and his activity as a chemist:

> Borodin …taught chemistry at the Petersburg Forestry Academy since 1863, and in the School of Medicine for Women since 1872; …The most important chemical works is discovered by Borodin bromination of fatty acids by the reaction of bromine with silver salts of the following acids: acetic, butyric, and valeric acids in 1861, fluorination method by reaction of KHF_2 with benzoyl chloride in 1862, and also reactions of aldehyde condensation in 1870/3 (Landerburg & Walden, 1917, p. 470).

British chemist Thomas Percy Hilditch in his book entitled *Concise History of Chemistry* connected name Borodin with his new method of fluorination in the chapter entitled *Progress in the experimental methods.* He also mentioned the names of the chemists, who discovered other

[3] September 3-5, 1860, Borodin participated in the First International Congress of Chemists in Karlsruhe (Germany). In the Russian delegation was also i.a. Nikolai Nikolaievich Zinin and Dmitri Ivanovich Mendeleev (1834-1907) (Zorina, 1985, p. 7).

ways of organic compounds fluorination earlier than Borodin. These chemists are: Edgar Hugo Reinsch (1809-1884), who described his method in 1840, and French chemist Edmond Frémy (1814-1894), who suggested in 1854 (Hilditch, 1911, p. 200). In XXI century, fluorination of benzoyl chloride discovered by Borodin describes also David E. Lewis, professor of chemistry at the University of Wisconsin-Eau Claire (U.S.A.) in his book entitled *Early Russian Organic Chemists and Their Legacy*. In the chapter *Borodin's Chemistry,* Lewis, using structural formulas presented a scheme of benzoyl chloride (C_6H_5COCl) reaction with potassium hydrogen fluoride (KHF_2) into benzoyl fluoride (C_6H_5COF) (Lewis, 2012, p. 63).

In 1862, Borodin presented this reaction in the article published in *Comptes Rendus Hebdominaires des Sciences de L'Academie des Sciences* in the following way: $C^{14}H^5O^2Cl$ + FIK,FIH + $C^{14}H^5O^2FI$ + FIH + CIK (Borodin, 1862, p. 555). A year later, Borodin presented the same reaction in the form nearer to the contemporary ways: $C_{14}H_5O_2Cl$ + FIK, FIH = $C_{14}H_5O_2FI$ + FIH + CIK (Borodine, 1863a, p. 61).

In 1881, Dutch chemist Jacobus Henricus van't Hoff (1852-1911) in his book entitled *Ansichten über die organische Chemie* (Views on Organic Chemistry) mentioned Borodin's name, while discussing halomethane compounds such as bromoform ($HCBr_3$ – tribromomethane), chloroiodoform ($HCCl_2J$ – dichloro(iodo)methane), and bromoiodoform ($HCBrJ_2$ – bromodiiodomethane) (van't Hoff, 1881, p. 124-125). In 1911, E. Witte in his publication entitled *Aldehyde und Ketone der aromatischen Reihe* (Aldehydes and Ketones of the Aromatic Series) described properties of hydrocuminamide [$(C_3H_7.C_6H_4.C)_3N_2$] referred to Borodin's article entitled *On the Action of Ammonia on Cuminol* published in *Zhurnal Khimicheskogo I Fizicheskogo Obshchestva* (Borodin, 1873b, cited by Figurovskii & Solov'ev, 1950/1988, p. 124). It was abstracted by Victor von Richter in *Berichte der deutschen chemischen Gesellschaft* (Richter, 1873, p. 1253).

Borodin's chemical works

Two Russian chemists Nikolai Aleksandrovich Figurovskii (1901-1986) and Yurii Ivanovich Solov'ev (born 1924) in their book entitled *Aleksandr Porfir'evich Borodin: A Chemist's Biography* presented complete list of Borodin's chemical works published by him between 1858 and 1886. Altogether this list contained bibliographic entries of 42 his publications (Figurovskii & Solov'ev, 1950/1988. p. 121-126). The first Borodin's publication appeared in Russia in 1858 *in Bulletin de la classe physico-mathématique de l'Academie de Sciences de St. Pétersbourg* and was entitled *Recherchers sur la constitution chimique de l'hydrobenzamide et l'amarine* (Researches on the Constitution of Hydrobenzamide and Amarine[4]) (Figurovskii & Solov'ev, 1950/1988, p.121).

The same article was published one year later in the German journal *Justus Liebings Annalen der Chemie* (Borodine, 1859a). In 1858, was also published Borodin's Dissertation for degree of the Doctor of Medicine entitled *Ob' analogii mysh'iakovoi kisloty s fosfornoiu v khimicheskom i toksikologicheskom otnosheniiakh* (On the Analogy between Arsenic Acid and Phosphoric Acid in Chemical and Toxicological Behavior) (Figurovskii & Solov'ev, 1950/1988, p.121). Work entitled *Ueber die Entwirklung des Jodathyis auf Benzoylanilid* (On the Action of Ethyl Iodide on Benzoylanilide) was first published in St. Petersburg in 1859 and later in *Justus Liebig der Chemie* (Borodine, 1859b).

[4] Hydroxybenzamide [$(C_6H_3CH)_3N_2$] "synthetized for the first time in 1836, gives by heating at 130° C the amarine [4,5-dihydro-2,4,5-triphenyl-imidazole – $C_{21}H_{18}N_2$]. Each of these compounds reacts differently when ethyl iodide … giving two salts that can be identified. Borodin will publish its final results … only in 1873". ("1869, Borodine à Saint," 2018).

In 1861, Borodin's work concerning recognition of both bromovaleric and bromobutyric acids was published (Borodine, 1861). Two years later, three his works were published in the *Justus Liebigs Annalen der Chemie*. The first was entitled *Zur Geschichte der Fluorverbindungen und über das Fluorbenzoyl* (The history of fluorine compounds and the fluorobenzoyl) (Borodine, 1863a). The second entitled *Ueber die Einwirkung des Zinkäthyls auf das Chlorojodoform* (On the Action of Zinc Ethyl on Chloroiodoform) (Borodine, 1863b). The third published work, was entitled *Ueber die Einwirkung des Benzils auf Natrium Amylat* (On the Action of Benzyl on Sodium) (Borodine, 1863c). In 1864, Borodin's work entitled *Ueber die Einwirkung des Natriums auf Valeraldehyd* (On the Action of Sodium on Valeraldehyde [pentanal: $CH_3(CH_2)_3CHO$] was published in the German journal *Journal für Praktsche Chemie* (Borodin, 1864). This article was abstracted in 1873 by the German chemist Carl Schorlemmer (1834-1892) in *Journal of the Chemical Society* and entitled *Condensation-products of Aldehydes* ("Organic Chemistry", 1873, p. 58).

In 1872, Borodin published his work entitled *O poluchenii produkta uplotneniia obyknovennogo al'degida* (On Condensation Products of Common Aldehyde) in the *Zhurnal Russkogo khimiczeskogo obshchestva* (Journal of the Russian Chemical Society) (Borodin, 1872, cited by Figurovskii & Solov'ev, 1950/1988, p. 124). This article was abstracted by the German chemist Victor von Richter (1841-1891) in the *Berichte der deutschen chemischen Gesellschaft* in 1872 (Richter, 1872, p. 481-482). Schorlemmer in the abstract published a year later in the *Journal of the Chemical Society* wrote: "By acting with hydrochloric acid on acetaldehyde a condensation product was obtained resembling that described by Wurtz. But whilst the latter is resolved by distillation into water and crotonic aldehyde, that prepared by the author yielded principally acetaldehyde" ("Organic chemistry", 1873, p. 58).

Reaction of receiving aldol from the acetic aldehyde and later its dehydration to crotonic aldehyde goes as follows: $CH_3CHO + CH_3CHO \rightarrow CH_3\text{-}CHOH\text{-}CH_2\text{-}CHO \rightarrow CH_3\text{-}CH{=}CH\text{-}CHO$ (Musabekov, 1963, p. 40). In 1873, Borodin published an article entitled *Ueber einen nauen Abkömmling des Valerals* (On a new derivative of valeral) in the journal *Berichte der deutschen chemischen Gesellschaft* (Borodin, 1873a). Two years later, his work entitled *Ueber Nitrosoamarine* (On Nitrosoamarine) was published in the same journal (Borodin, 1875).

Other chemical works published by Borodin in 1875-1886, concerned i.a. a New Method for the Determination of Nitrogen in Urine (1875), a New Method for the Quantitative Determination of Urea (1876)[5], Disinfection and Disinfecting Agents (1878), the Relationship of Hydrogen Peroxide toward Lower Organisms and the Importance of Ozonized Oils for Disinfection (1884), A Simplification of an Azotometric of the Metamorphosis of Nitrogeneous Substances in an Organism from a Contemporary Point of View (1886), (Figurovskii & Solov'ev, 1950/1988, p. 124-126).

Review of the chemical literature provides a knowledge of the authors from 1931-2014, who discussed in their publications some Borodin's works, using not only empirical but also structural formulas to describe chemical reactions discovered by Borodin (Getman, 1931; Halton, 2014; Li, 2009, p. 298-299; Lewis, 2012, p. 63-64; Rae, 1989; Semisch, 1988). Below, a brief discussion about Borodin's chemical works, cited by some of the listed authors. Frederic H. Getman in his article entitled *Alexander Borodin – Chemist and Musician* discussed several experimental Borodin's works, i.a. his studies on the reaction diethylzinc with dichloro(iodo)methane. This reaction describes the following equation: $3(C_2H_5)_2Zn + 2CHCl_2I$

[5] Part of this method was the reaction of urea decomposition. The following reaction described this process: $CO(NH_2)_2 + 3\ NaBrO \rightarrow N_2 + CO_2 + 2H_2O + 3NaBr$ (Solod and Alekssev, 2013, s. 197).

$\rightarrow 2ZnCl_2 + ZnI_2 + 7C_2H_4 + 2H_2$ (Getman, 1931, p. 1768). Getman wrote about the results of the course of metallic sodium with valeralaldehyde, studied by Borodin what follows:

> sodium was found to displace hydrogen in the aldehyde, and the resulting product resembled a mixture rather than a single substitution product. On treatment with water it was found to decompose, yielding, along with sodium hydroxide, amyl alcohol and valeric acid, two other substances which, on analysis, were found to correspond to the empirical formulas, $C_{10}H_{22}O$ and $C_{10}H_{18}O$. The former compound proved to be a monatomic alcohol corresponding to capric acid, $C_{16}H_{22}O_2$ (Getman, 1931, p.1768).

Brian Halton in the article entitled *Some Unremembered Chemists: Alexander Porfirevich Borodin (1834-1887),* published in *Chemistry in New Zealand* presented reaction of benzoyl chloride with potassium hydrogen difluoride with abbreviated designation of the fenyl group (C_6H_5-Ph) in the following form: $PhCOCl + KHF_2 \rightarrow PhCOF + KCl + HF$ (Halton, 2014, p. 44). Jie Jack Li in his book entitled *Name Reactions: A Collection of Detailed Mechanisms and Synthetic Applications* wrote about Borodin's the receipt of methyl bromide in reaction with silver acetate with bromine (Li, 2009, p. 298). He also mentioned that German chemists, couple Heinz (1904-1981) and Cläre (1903-1995) Hundsdiecker generalized Borodin's method in 1942. It illustrates the following equation: $RCOOMe + Br_2(Cl_2) = RBr(Cl) + CO_2 + MeBr(Cl)$ (Hundsdiecker & Hundsdiecker, 1942, p. 291). "Conversion of silver carboxylate to halide by treatment with halogen" was named in chemistry "Hundsdiecker-Borodin reaction" (Li, 2009, p. 298).

Causes of the Borodin's premature death in the literature

One day prior to his unexpected death, February 14, 1887, Aleksandr Borodin wrote a letter to his sick wife, Ekaterina Sergeevna Borodina (Protopopova) (1832-1887)[6] , who stayed in Moscow.

> To-morrow we have a musical party here, it will be very grand – '*il y aura de la bougie,'* (there will be candle) as Murger would say in his *'Vie de Bohéme'* (Bohemian life); to-day we have engaged the pianist. There will be a masked ball, but I will not unveil the mysteries, and I leave the description of the entertainment to the more skillful pens of your other corresponders (Habets, 1880/1895, p. 89).

Aleksandr Profiryevich Borodin suddenly died on February 15 (Old Style), February 27 (New Style), 1887. Alfred Habets (1839-1908) briefly described last moments of Borodin's life. His death happened during masked ball, organized during musical party, he mentioned in the letter to his wife. Aneurysm rupture was a cause of his death.

> Borodin was dressed in national costume with red shit and high boots; he was talking, full of animation, with his guests, when he was seen stagger forward. Without a cry, and without suffering, he succumbed in a few second to a ruptured aneurism, in the presence of his guests, who were thrown into consternation (Habets, 1880/1895, p. 89).

Detailed description of the probable cause of Borodin's death was published soon after his

[6] Aleksandr P. Borodin and Ekaterina Sergeevna Protopopova (born January, 3 1832) were married on 17th April 1863 in St. Petersburg (Figurovskii & Solov'ev, 1950/1988, p.51). „Throughout her marriage with Borodin she was plagued with severe asthma attacks, hypochondria, and insomnia, and she often lived in Moscow, while he resided in St. Petersburg. Because of her ill health she did not sleep until 3 or 4 A.M., and Borodin could not get to sleep before that time. She arose about 3 or 4 P.M. next day. As a result of this peculiar way of life Borodin suffered from lack of sleep, and his unusual routine may have hastened the heart disease which led to his premature death" (Figurovskii & Solov'ev, 1950/1988, p. 45).

death in the journal *The Lancet* on March 19, 1887. "On Feb. 28th, Dr. Alexander Porphyryevich Borodin, Professor of Organic Chemistry in the Military Medical Academy in St. Petersburg, died quite suddenly from cardiac paralysis, probably from embolism of highly diseased coronary arteries" ("Obituary. Professor Borodin", 1887, p. 601). David E. Lewis gave cardiac aneurysm as Borodin's cause of death (Lewis, 2012, p. 63), while Jim Leavesly indicated arteries rupture.

> An autopsy was performed and the cause of death was established as being due to a rupture of a coronary aneuirysm, leading to blood gushing into the pericardium tissue surrounding the heart to cause a fatal squeezing, or tamponade, of the heart (Leavesley, 2010, p. 137).

Borodin's Funeral

Russian music critic Vladimir Vasilievich Stasov (1824-1906) wrote about Borodin's funeral:

> Borodin was buried in The Alexander Nevsky Lavra, next to his friend Modest Petrovich Mussorgsky (1839-1881). He was said goodbye by his admirers, very numerous, whole Medical Academy, all female physicians of ten vintages, who were present in Moscow. The young carried his coffin on their hands to the grave, men and women; the whole forest of wreaths accompanied his body. One of them, silver, had an inscription "To the founder, guardian, master of the medical courses for women, supporter and friend of the students – women-physicians of 10 vintages, 1872-1887". Another, with ribbons of the heavy golden brocade, with an inscription made with black velvet letters and golden gold tassels was saying: "To the great Russian musician – from friends and admirers" (Stasov, 1985, p. 40).

CONCLUSIONS

Aleksandr Porfiryevich Borodin was the eminent chemist. This proves the results of his works in chemistry. His discoveries of new experimental methods contributed to development of the organic chemistry. Borodin represented the group of the eminent Russian chemists of the 60th of the XIX century. Their scientific achievements placed Russian organic chemistry on the high position in the world. Here, one should have mentioned his teacher N.N. Zinin (1812-1880), also Aleksandr Mikhailovich Butlerov[7] (1828-1886), N. A. Menshutkin (1842-1907), Friedrich Konrad Beilstein (1838-1906), Vladimir Vasil'evich Makarovnikov (1842-1904), and Aleksandr Mikhailovich Zaitsev (1841-1910).

Borodin was also the exceptional composer of the second half of the XIX century. His creation in 1843-1887 includes various musical compositions, such as operas, symphony, chamber pieces for two or more instruments, piano music and vocal compositions (Figurovskii & Solov'ev, 1988, p. 127-131). He became known in Russia and the world due to these compositions. On his death, several his works, including stage ones[8] were published in Russian, English, German, and French.

In 1883, V.V. Stasov wrote about Borodin's musical works and his talent:

> Borodin composed not many pieces in the quantitative category, much less than his

[7] In 1880, Borodin and Butlerov wrote an article entitled *Nikolai Nikolaevich Zinin. Vospominaniia o nem i biograficheskii ocherk* (N.N. Zinin. Reminiscences of him and a biographical sketch) (Zinin, 1982, p. 181-209).

[8] The opera *Prince Igor* was completed after Borodin's death by the Russian composers Nikolai Andreevich Rimsky-Korsakov (1844-1908) and Aleksandr Konstantinovich Glazunov (1865-1936) (Borodin, 1915).

> colleagues but his compositions, nearly all without exception, bear the mark of the full development and deep excellency. There is no weak track among them. Weaker might be string quartets, chamber pieces, but here some of the parts are composed with the great talent. Borodin's talent is equally powerful and amazing both in symphony and opera and romance. His main features include enormous power and width, enormous momentum, energy, and impetuosity connected with incredible passion, tenderness, and beauty (Stasov, 1883, cited by Stasov, 1985, p. 40).

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Alexander Borodin. Photo. (1865). Public Domain. Retrieved from Wikimedia Commons website: https://commons.wikimedia.org/wiki/Alexander_Borodin#/media/File:Borodin.jpg

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