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Original research paper

Mendeleev's discovery of the periodic table and the first European Academy of Sciences to honour him

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ABSTRACT

The chemical science community will commemorate the 155th anniversary of Mendeleev's groundbreaking discovery of the periodic table of elements in 2024. This paper aims to underscore the significance of Mendeleev's honorary membership in the Academy of Sciences in Zagreb, Croatia, which occurred in 1882, making it the first scientific academy in Europe to extend this recognition. Additionally, we seek to explore the contextual circumstances that contributed to this noteworthy event within the broader European context. To provide insight into the specificities and variations in the influence and reception of the periodic table of elements within the educational process of select European countries (Russia, Germany, Czech Lands, Serbia), we conducted a comprehensive review, drawing comparisons to Croatia. Notably, upon its initial publication in 1869, the discovery of the periodic table did not gain immediate acceptance in Croatia, largely attributed to the absence of a well-established presence of chemical science within the country. About fifteen years passed from Mendeleev's discovery of the periodic law to its reception and dissemination throughout Croatia. Despite an initial delay, Croatian chemical science followed the development of the periodic table through secondary and university education, while actively partaking it in.

Keywords: periodic table, Mendeleev, Croatian Academy of Sciences and Arts, Croatian chemistry textbooks

INTRODUCTION

The discovery of the periodic table of elements, which organized all known chemical elements based on their increasing atomic weight and periodic chemical properties, stands as a pivotal moment in the field of chemical science. In 1869, the Russian chemist Dmitri Ivanovich Mendeleev (1834–1907) published the initial version of the periodic table (1, 2), laying the foundation for the modern periodic table we recognize today.

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Even prior to Mendeleev's work, there were attempts to systematize and classify elements. German chemist J. W. Döbereiner (1780–1849) observed similarities among certain groups of elements and grouped them into triads (3). Other scientists, including J. P. Cooke, P. Kremers, J. H. Gladstone, L. Gmelin, E. Lenssen, M. J. Pettenkofer, and notably J. B. Dumas, made significant contributions toward organizing chemical elements based on the concept of periodicity (4). Chancourtois (1820–1886) took a unique three-dimensional approach that revealed a recurring pattern in the properties of chemical elements (5). J. Newlands (1837–1898) further expanded on this pattern, formulating the *law of octaves*, while W. Odling (1829–1921) discovered a similar periodicity (6). Although each of these chemists had their own ideas for arranging elements, a comprehensive and universally accepted arrangement remained unresolved (7, 8). Aside from Mendeleev, J. L. Meyer (1830–1895) played a significant role in the development of the periodic table. In 1868, Meyer constructed his periodic table based on atomic weights and chemical properties, deviating from a strict correlation with atomic weight. He anticipated the existence of modern main-group and transition-group elements and left vacant spaces for yet-to-be-discovered elements. Meyer published his findings in early 1870 (9). Meanwhile, Mendeleev published his table, rendering Meyer's work as a less influential contribution. In the history of science, Mendeleev is attributed with the discovery of the periodic table of elements. He was the first to propose the Law of Periodicity and incorporated gaps in the table to account for elements he predicted would be discovered, such as eka-aluminium, eka-boron, and eka-silicon. Mendeleev also described the properties of these predicted elements and actively worked to improve and expand knowledge about the periodic table (10). The discovery of eka-elements, namely gallium (1875), scandium (1879), and germanium (1886) further bolstered the acceptance of the periodic table in the realm of chemical science. Additionally, the discovery of noble gases in the early 20th century provided additional evidence of the enduring significance of the periodic table. Despite only half of Mendeleev's predictions proving accurate, this did not diminish the reception of the periodic table of elements. A significant contributing factor to its acceptance was the systematic arrangement of known elements (11–13).

One of the highest honors bestowed upon Mendeleev for his pioneering discovery was the Davy Medal awarded by the Royal Society of London in 1882 (14). In the same year, the Yugoslav (now Croatian) Academy of Sciences and Arts elected Mendeleev as an honorary member, becoming the first scientific academy in Europe to bestow such recognition upon him.

Reception of the periodic table of elements in Europe

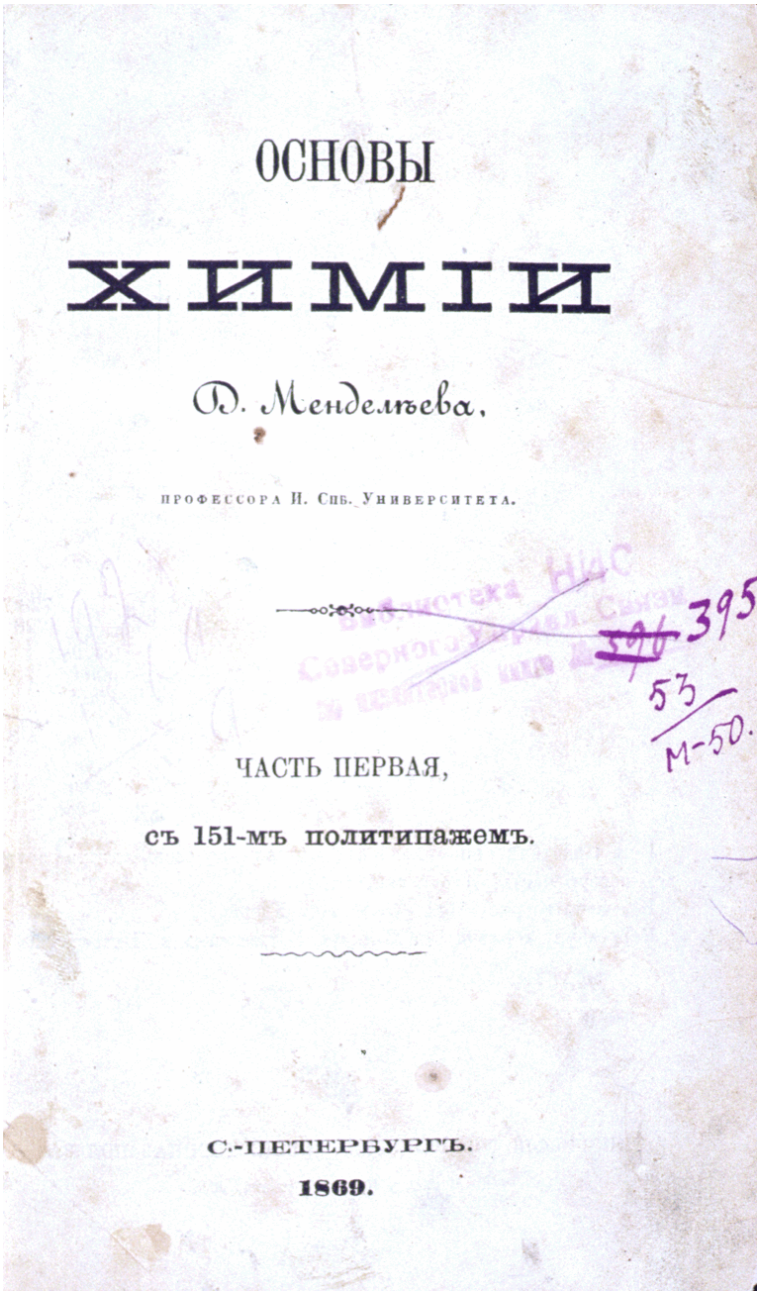
The reception and integration of the periodic table of elements varied among European countries, highlighting specificities and differences in how they accepted and incorporated this scientific tool (15). This paper explores the reception of the periodic table and its subsequent impact within the European and global chemical community, focusing on the period following Mendeleev's publication of a comprehensive article on the periodic table in *Annalen der Chemie und Pharmacie* in 1871 (16). At the time, Mendeleev was a professor of chemistry. While developing and improving the periodic table (Table I), he authored an influential textbook *Osnovy khimii* (The Principles of Chemistry) that used his innovative periodic table as a central organizing framework.

Table I. The publication of the first edition of Mendeleev's textbook The Principles of Chemistry and the discovery of the periodic table (17)

Date	Publication
May – June 1868	Textbook *Osnovy khimii* (*The Principles of Chemistry*), Volume 1 (part 1, chapters 1–11)
17 February 1869	A pamphlet with Mendeleev's first periodic table of elements. It was entitled *Opyt sistemy elementov, osnovannoi na ikh atomnom vese i khimicheskom skhodstve* (*An Attempted System of the Elements, based on their Atomic Weights and Chemical Analogies*).
6 March 1869	The first paper on the periodic law titled *Sootnoshenie svoistv s atomnym vesom elementov (On the Correlation of the Properties and Atomic Weights of the Elements*) was read at the meeting of the Russian Chemical Society by Nikolai Aleksandrovich Menshutkin (1842–1907). A paper was published in the first volume of the journal published by the Russian Chemical Society. Mendeleev's discovery of the periodic law and his periodic table of the elements was first announced to European scientists in a short publication in the German journal *Zeitschrift für Chemie (Journal of Chemistry)* in 1869 (2).
March 1869	*The Principles of Chemistry*, Volume 2 (part 1, chapters 12–22)
February – March 1870	*The Principles of Chemistry*, Volume 3 (part 2, chapters 1–8)
February 1871	*The Principles of Chemistry,* Volumes 4 and 5 (part 2, chapters 9–23)
July 1871	Mendeleev's article *Die periodische Gesetzmässigkeit der chemischen Elemente* (*The Periodic Law of the Chemical Elements*) published in *Annalen der Chemie und Pharmacie*

The Principles of Chemistry (1869), published in Russia, was the first textbook containing the periodic table of elements (Fig. 1).

The research conducted by M. Kaji suggests that Mendeleev was actively engaged in writing his textbook *The Principles of Chemistry* during the period in which he published the periodic table of elements for the first time and then continued to refine it. The correlation between the timing of the two publications supports this conclusion. Furthermore, the content of specific chapters, as well as the design of the textbook itself and the arrangement of its matter reinforces the notion that Mendeleev was concurrently working on both projects. Mendeleev started to write the textbook with the idea of valency as the basis for arranging elements. However, when he began to compare them in the chapter about alkaline metals and alkaline earth metals, it was clear that Mendeleev did so based on their atomic weight, which was finally confirmed by Mendeleev himself in his papers (17, 18). The influence of Mendeleev's textbook extended beyond Russia and played a significant role in the acceptance of the periodic table of elements in other countries as well. As a prominent figure in the Russian Chemical Society, which was established in 1868, Mendeleev was able to persuade fellow members of the society about the credibility and importance of the periodic table. Over time, the structure of future editions of Mendeleev's textbook changed, as did the periodic table of elements itself. The textbook went through a total of eight editions in Russian, with the final edition published in 1906, shortly before Mendeleev's


ОСНОВЫ

ХИМІИ

Д. Менделѣева,

ПРОФЕССОРА И. СПБ. УНИВЕРСИТЕТА.

ЧАСТЬ ПЕРВАЯ,

съ 151-мъ политипажемъ.

С.-ПЕТЕРБУРГЪ.

1869.

Fig. 1. The front page of the first edition of The Principles of Chemistry textbook written by Dmitri Ivanovich Mendeleev (Saint Petersburg 1869), by permission The Rare Book & Manuscript Library, University of Illinois at Urbana-Champaign.

death (19). Victor von Richter's *Textbook of Inorganic Chemistry According to Latest Views*, first published in 1874 (20), based on new findings, played a crucial role in spreading awareness of the periodic table in both Russia and Germany, where it was translated into German the following year (21). After Richter's passing, L. J. Jawein continued to work on the textbook, resulting in thirteen editions and translations into several languages, including German, English, Italian, and Dutch.

In Germany, particularly in German journals like *Berichte der Deutschen Chemischen Gesellschaft* (*Reports from the German Chemical Society*), there was an ongoing debate about who should be credited with the discovery of the periodic law: Meyer or Mendeleev. Prominent German scientists, including W. Ostwald, H. Landolt, C. Winkler, and V. Meyer, were involved in this debate. Although Meyer's paper on the periodic table was published in Germany and Mendeleev's ideas on the periodic table were very quickly translated into German and were known to the German scientific community, the periodic table was not immediately accepted and introduced to the chemistry education programme (22). The German Chemical Society, founded in 1867, published various reports in its journal *Berichte der Deutschen Chemischen Gesellschaft*. In late 1869, V. Richter wrote a report on the systematisation of elements proposed by Mendeleev (23). Thanks to V. Richter, Mendeleev's short publication for *Zeitschrift für Chemie* was also translated. In 1870, Meyer published an article entitled *Die Natur der chemischen Elemente als Funktion ihrer Atomgewichte* (*The Nature of the Chemical Elements as a Function of Their Atomic Weights*) (9). The first German textbook written in accordance with the periodic table is Richter's university textbook of inorganic chemistry, *Kurzes Lehrbuch der Anorganischen Chemie wesentlich für Studierende auf Universitäten und Polytechnischen Schulen sowie zum Selbstunterrichte* from 1875.

In Czech Lands, the reception of the periodic table was inextricably connected to chemist Bohuslav Brauner (1855–1935) (24). Brauner took interest in the periodic table of elements after 1875 and Boisbaudran's discovery of gallium, and after reading Meyer's textbook *Die modernen Theorien der Chemie* (*The Modern Theories of Chemistry*) (25) and the publication of Mendeleev's article in 1871. In 1877, even as a student, he wrote an article for the journal *Listy chemické* (*Chemical Letters*) published by the Czech Chemical Society in an attempt to better familiarize the Czech scientific community with the periodic table (26). A year later, Brauner's scientific paper on Mendeleev's periodic table was published in the German journal *Berichte der Deutschen Chemischen Gesellschaft* as his discussion on the atomic weight of beryllium (27). In his university lectures, he emphasised the significance and reception of Mendeleev's periodic table. His greatest contribution to the periodic table is the research of rare earth elements and their placement into a separate group within the periodic table of elements. This periodic table modification by Brauner was most widely used in contemporary tabular displays at the time. Throughout his career, he continued to research atomic weights and rare earth elements, as well as disseminate the periodic table (28). The first Czech textbook containing the periodic table was the *Rukověť chemie pro vysoké učení české. Díl I. Chemie anorganická* (*Chemistry Textbook for Czech Universities, Part I. Inorganic Chemistry*) from 1878, written by Vojtěch Šafařík (1829–1902) (29). The reception and dissemination of the periodic table in Czech Lands were closely tied to the development of Czech national chemistry terminology. During this period, the Czech chemical community began to distance itself from the German community and focused more on the Slavic community, with notable chemists such as Mendeleev, Butlerov, and Menshutkin playing important roles in this process (28).

In Serbia, the discovery and development of the periodic table were greatly influenced by Sima Lozanić (1847–1935). After completing a four-year scholarship in Zürich and Berlin, primarily intended for pedagogy, but later redirected towards chemistry by his own preference, Lozanić returned to Belgrade in 1872, where he became a professor of chemistry and chemical technology at the Great School, the highest educational institution in Serbia at that time. His arrival marked the beginning of rapid development in chemistry education in Belgrade. Lozanić introduced modern chemistry education methods, established well-equipped laboratories and a library, and incorporated contemporary knowledge that he acquired during his studies abroad. He introduced modern nomenclature, structural formulas, and atomic weights into his teachings. Lozanić's textbook, *Hemija sa gledišta moderne teorije. Prvi deo. Neorganska hemija* (*Chemistry from the Standpoint of Modern Theory. Part One. Inorganic Chemistry*) (1880), was the first textbook in Serbia to include Mendeleev's periodic table of elements (30). In addition to atomic weights, Lozanić's table also included atomic volumes of elements, following the model introduced by Meyer, who recognized that atomic volume is a property that changes with atomic weight (9). In later editions of his textbook (1883, 1893), Lozanić incorporated the developments in the periodic table and provided his own modifications to the table. He dedicated several of his papers to the development and significance of the periodic table (31). Sima Lozanić's contributions played a vital role in the establishment and dissemination of the periodic table in Serbia.

Why did Croatian chemical science accept the periodic table at a later time?

Russia, Germany, Czech Lands, and later Serbia were able to adopt the periodic table and incorporate new findings into their textbooks even before the discovery of new elements like gallium, scandium, and germanium due to having established universities, faculties, and chemistry education. The periodic table was quickly integrated into the educational process in these countries.

Croatia, which was part of the Austro-Hungarian Empire at the time, faced certain limitations compared to its neighbours Germany and Czech Lands where Mendeleev's periodic table was published almost at the same time as in Russia. At the time of Mendeleev's publication, there was no university study of chemistry in Croatia, and there were no professional or popular journals that would publish topics related to the periodic table. As a result, the Croatian scientific community had to wait for the development of chemistry education and the availability of publications before adopting the periodic table.

The University of Zagreb was established in 1669 but without university privileges. Therefore, the year of its foundation in the modern sense is considered to be 1874, when its foundation was ratified. Two years later, departments for natural sciences were established, where chemistry was taught in a manner modelled after European universities (32). Prior to university education, chemistry in Croatia was taught in regular and real-gymnasiums where it was a mandatory subject in the curriculum, comprising mostly of practical teaching. In the 19th century, Croatia was a part of the Habsburg monarchy that joined the Austro-Hungarian Empire in 1867. Consequently, the majority of school textbooks were in German, leading to the use of German chemistry textbooks in classes (33, 34). In the latter half of the 19th century, after the formal introduction of Croatian as a language for teaching and writing textbooks, efforts were made to develop a distinct scientific terminology

within the Croatian scientific community (35). From 1869, when Mendeleev published the Periodic Law and his first periodic table, until 1901 when the first tabular display of the periodic table of elements appeared in a Croatian chemistry textbook, Croatia had textbooks for secondary schools and universities that did not contain the periodic table of elements (Table II).

Table II. Chemistry textbooks written in Croatian, without the periodic table, published by 1901

Author	Year of publication	Title	Place of publication
P. Žulić	1877	*Uputa u kemiju za velike realke, dio I – Anorganička kemija* (*Chemistry Instructions for Great Real-Gymnasiums, Part I – Inorganic Chemistry*)	Zagreb
P. Žulić	1878	*Kemija* (*Chemistry*) (translation of a textbook written by H. Roscoe)	Zagreb
G. Fleischer	1882	*Naputak za metodično naučenje anorganske lučbe, Prvi dio (Instructions for Methodical Teaching of Inorganic Chemistry, Part One)* (translation of a German textbook written by F. Wilbrand)	Bjelovar
G. Janeček	1883	*Rukovodnik za praktičke vježbe u kvalitativnoj kemijskoj analysi neorganskih tjelesa* (*Handbook for Practical Exercises in Qualitative Chemical Analysis of Inorganic Substances*, university handbook)	Zagreb
I. Potočnjak and G. Pexidr	1884	*Fizika i kemija za ratarnice i druge niže škole* (*Physics and Chemistry for Agricultural Schools and Other Secondary Schools*)	Zagreb
F. Radić	1886	*Fizika i kemija: za više pučke i nalike im učione* (*Physics and Chemistry: For Higher Real Schools and Similar Institutions*) (translation of a textbook written by E. Netoliczka)	Zagreb
G. Pexidr	1887	*Kemija za niže razrede srednjih učilišta* (*Chemistry for Lower Grades of Secondary Schools*) (translation of a German textbook written by A. Kauer)	Zagreb
G. Janeček	1890	*Obća teoretička i fizikalna lučba, I. knjiga: Tvar i atomistički nazor o njezinu sastavu, I. polovica* (*General Theoretical and Physical Chemistry, Volume I: Substance and Atomistic Principles of its Composition, 1st Half*) (university handbook)	Zagreb
R. Gasperini	1896	*Analitička kemija* (*Analytical Chemistry)*	Split
A. Korlević and J. Beyer	1897	*Počela kemije i mineralogije: za niže razrede srednjih učilišta, ženske liceje i više djevojačke škole te više pučke škole realnoga smjera (Principles of Chemistry and Mineralogy: For Lower Grades of Secondary Schools, All-Girls Lyceums, All-Girls Secondary Schools and Higher Real-Schools)*	Zagreb

Reasons for the absence of the periodic table in the aforementioned textbooks vary. Some were not the authors' original works, but translations of foreign textbooks that were written and published before the introduction of the periodic table as a methodological aid to those textbooks. Another reason was the chemistry curriculum in real gymnasiums, which did not include the periodic table. Therefore, the authors did not include it in their textbooks. However, the fact remains that over 30 years went by from Mendeleev's publication of the periodic table in 1869 to its first physical appearance in Croatian chemistry textbooks in 1901.

First contribution to the development of the periodic table in Croatia

After the establishment of the modern University of Zagreb (1874) and its Natural Sciences departments (1876), the intense period of promotion and development of scientific chemistry in Croatia began. However, due to the lack of qualified teaching staff in the country, candidates for chemistry classes were selected through recruitment competitions or recommendations from prominent professors from other Central European universities such as Prague and Budapest. These professors shared their modern scientific knowledge and contributed to the development of chemistry at the University of Zagreb. The first professor of chemistry and the founder of the first modern university chemistry laboratory in Zagreb was Aleksandar Veljkov (Welkow) (1847–1878) who previuosly studied at universities in Budapest, Berlin, and Vienna (36, 37). Veljkov conducted significant research on the atomic weight of beryllium in 1873 and 1874 (38–41). His findings, published only two years after Mendeleev placed beryllium in the second group of the periodic table with an atomic weight of 9.4, validated Mendeleev's placement. Although Veljkov's scientific papers were published in one of the most respected journals of the time, *Berichte der Deutschen Chemischen Gesellschaft*, and represent one of the earliest validations of Mendeleev's placement of beryllium in the second group of the periodic table, these papers did not receive the proper attention of his colleagues and went unnoticed. It is known that only in 1881 did B. Brauner publish data confirming beryllium's place in the second group of the periodic table with its new atomic weight of 9.1 (42). Veljkov's successor, Gustav Janeček (1848–1929), who came from the University of Prague, is the founder of modern university chemistry teaching in Croatia and one of the founders of the study of pharmacy at the University of Zagreb (43, 44). He was credited for the establishment of two university chemical institutes in Zagreb (1884 and 1919) (45). He wrote the first university textbooks and handbooks of chemistry in Croatian (46, 47).

The election of Mendeleev as an honorary member of the Yugoslav (Croatian) Academy of Sciences and Arts

Although chemistry in Croatia had just begun to develop through university institutions (1876), the interest of the Croatian scientific community in the periodic table of elements was tremendeous, especially after the election of Dmitri Ivanovich Mendeleev as an honorary member of the former Yugoslav Academy of Sciences and Arts, in Croatian JAZU (today the Croatian Academy of Sciences and Arts, in Croatian HAZU), in Zagreb on 5 December 1882. The former Yugoslav Academy of Sciences and Arts (Fig. 2) was the first academy of sciences in Europe to elect Mendeleev as an honorary member, the same year he was awarded the Davy Medal by the Royal Society of London.

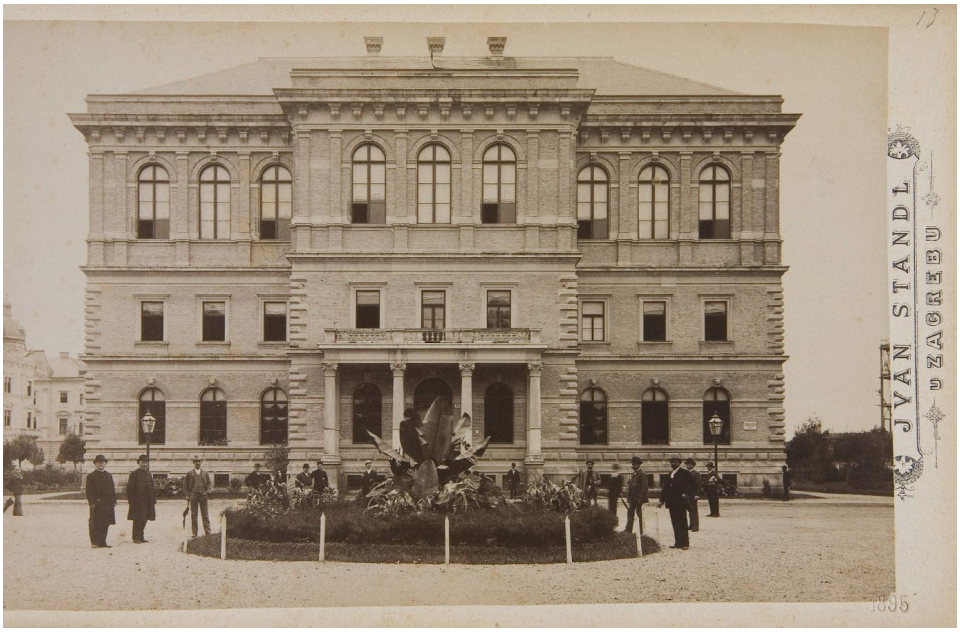
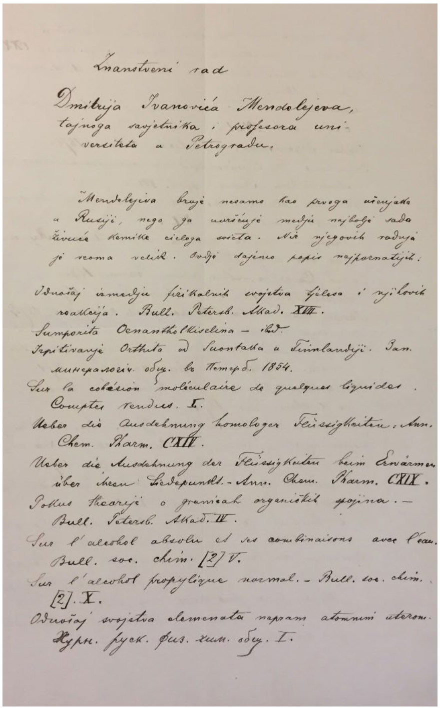


Fig. 2. Yugoslav Academy of Sciences and Arts, JAZU (today the Croatian Academy of Sciences and Arts, HAZU), the first scientific academy which elected Mendeleev an honorary member in Zagreb on December 5th, 1882. Photo of the Academy Palace from the end of the 19th century at today's Zrinski Square 11 in Zagreb. Retrived from https://sgallery.hazu.hr/izlozba/svecanost-otvorenja-1884/povijest-utemeljenja-galerije-i-gradenje-palace/#1-44&gid=1&pid=44

The Imperial Saint Petersburg Academy of Sciences elected him a corresponding member in 1876, but he was not elected a full member in the coming years (48–50). In the years 1871–1903, he was elected as a foreign member of several academies of sciences: Paris Academy of Sciences (1871), Royal Danish Academy of Sciences and Letters (1889), Czech Academy of Sciences (1891), Academy of Sciences in Rome (1893), National Academy of Sciences of the United States (1903) *etc*. (51). In 1889, he became a foreign honorary member of the American Academy of Sciences and Arts (52). The neighbouring Serbian Royal Academy elected him a corresponding member in 1904 (31). The details and facts about the manner in which Mendeleev was elected an honorary member of the Yugoslav Academy of Sciences and Arts are differently and incompletely provided in the literature where it is stated that Mendeleev was chosen at the suggestion of Gustav Janeček, university professor of chemistry (49, 53–55). At a meeting on 15 October 1882, the Department of Mathematics and Natural Sciences of the Academy, consisting of distinguished naturalists who started the development of science in Croatia and contributed to it through their work, accepted the proposal of Gjuro Pilar (1846–1893), a Croatian geologist and paleontologist, to appoint Mendeleev as an honorary member. Gjuro Pilar prepared a detailed hand-written list of Mendeleev's scientific papers for the meeting (Fig. 3) (56). It can be assumed that Janeček, as a chemist, knew and followed Mendeleev's work very well and that he wrote the report and explanation of the proposal for the meeting, which was then presented by Pilar as a



Znanstveni rad
Dmitrija Ivanovića Mendelejeva,
tajnoga savjetnika i profesora uni-
versiteta u Petrogradu.

Mendelejeva broji nesamo kao prvoga učenjaka u Rusiji, nego ga uvršćuje medju najbolje sada živuće kemike cieloga svieta. Na njegovih radnja ji veoma velik. Ovdje dajemo popis najznamenitijih.

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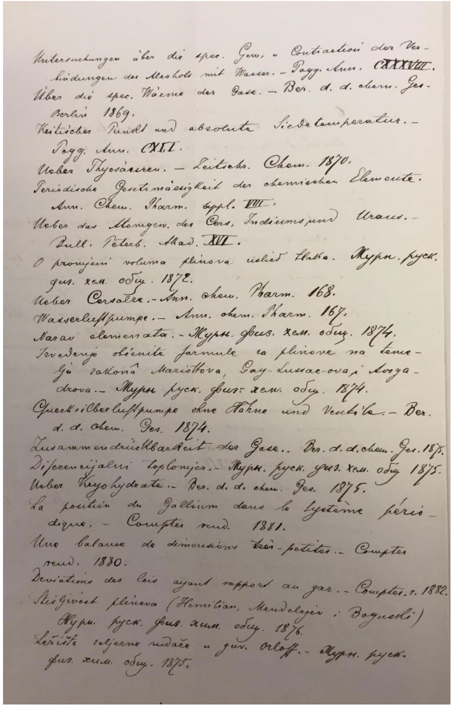

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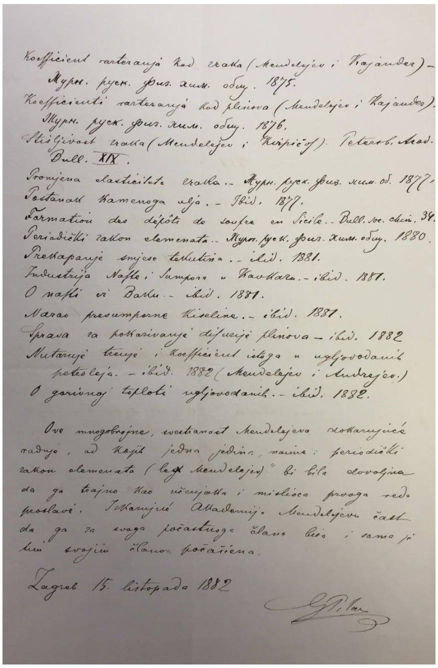

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Ove mnogobrojne, većinom ost Mendelejeva dokazujuće radnje, od kojih jedna jedina, naime: periodički zakon elemenata (lex Mendelejev) bi bila dovoljna da ga trajno kao učenjaka i mislioca prvoga reda proslavi. Pokanjuće Akademija Mendelejevu čast da ga za svoga počastnoga člana bira i samo ji time svojim članom počašćena.

Zagreb 15. listopada 1882

G. Pilar

Fig. 3. List of scientific papers and achievements of Dmitri Ivanovich Mendeleev, a professor of chemistry at the University of St. Petersburg at the time, which Gjuro Pilar prepared when he suggested Mendeleev become an honorary member of the Academy at the meeting of the Department of Mathematics and Natural Sciences on 15 October 1882, the Academy's Registry, courtesy of the Croatian Academy of Sciences and Arts Archives.

naturalist and a member of the Department of Mathematics and Natural Sciences of the Academy. Janeček was not a member of the Academy at the time. It was at the General Meeting on 5 December 1882 that he was elected as a corresponding member of JAZU.

Pilar's list of papers contains 43 Mendeleev's articles dating from 1854 to 1882. Among them are his first articles on the periodic table of elements such as *Sootnoshenie svoistv s atomnymvesom elementov* (*Ratio of Properties to the Atomic Weight of the Elements*) (1869) and *Die periodische Gesetzmässigkeit der chemischen Elemente* (*The Periodic Law of the Chemical Elements*) (1871), a paper through which we generally follow the impact of Mendeleev's discovery of the periodic law in European countries. Although at the time of Mendeleev's election as an honorary member of the Academy none of the members of the Department of Mathematics and Natural Sciences were chemists, it is clear that the Croatian scientific community was aware of and recognised the significance of this important discovery in chemistry. This is evidenced by the list of Mendeleev's papers and the explanation of the proponent, Gjuro Pilar: *Not only is Mendeleev regarded as the first scientist in Russia, but he is also considered one of the greatest chemists in the world at the moment... His versatility is demonstrated by his works, one of which, the periodic law of the elements (lex Mendeleev), would be sufficient to permanently celebrate him as a scientist and thinker of the first order. By electing Mendeleev as its honorary member, the Academy shows that it is flattered to have such a member* (56).

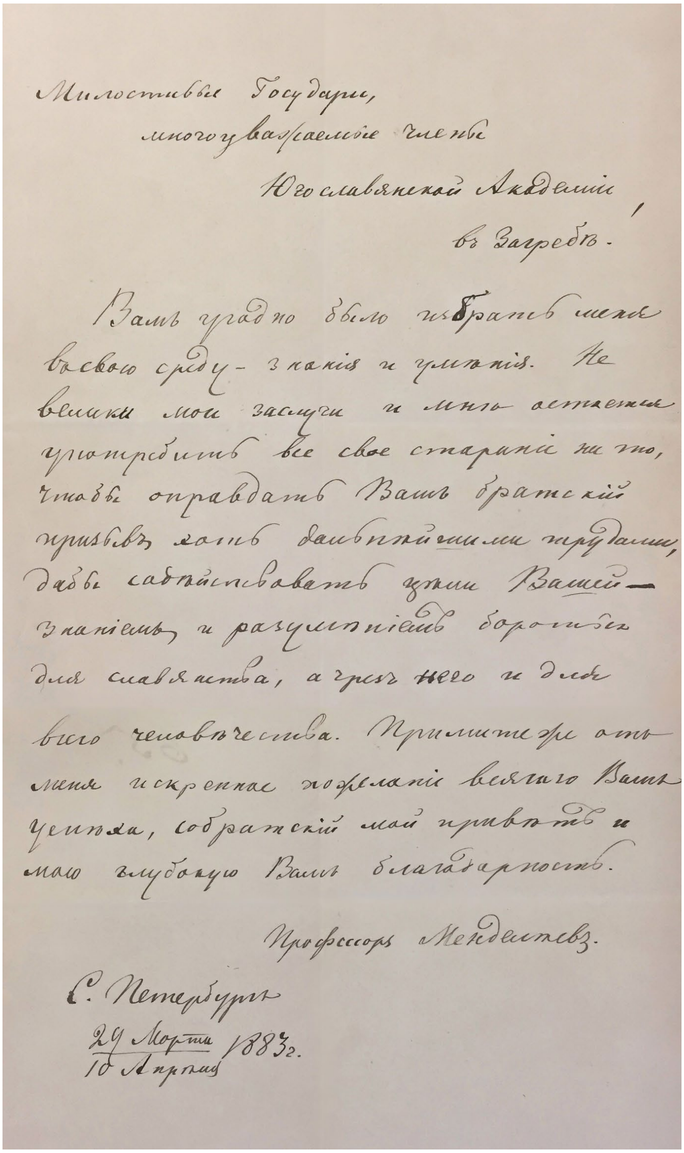
Mendeleev was formally elected as an honorary member of JAZU at the General Meeting on 5 December 1882 (57). After the *ban* of the former Kingdom of Croatia-Slavonia, Ladislav Pejačević (1824 –1901), confirmed his election, the Academy notified Mendeleev by letter of 20 March 1883: *At its Annual General Meeting held on 5 December 1882, the Yugoslav Academy of Sciences and Arts elected you as its honorary member, thus sending you a diploma enclosed. In order to get to know your rights and duties, please find the Academy's rules enclosed. The Academy respects your great contribution to science. The Yugoslav Academy of Sciences and Arts* (58). Mendeleev personally replied to the Academy's letter as early as March 29th (April 10th) 1883: *Dear Gentlemen, highly esteemed members of the Yugoslav Academy in Zagreb, you have elected me to your community of knowledge and skills. My merit is not great, and it remains for me to use all my efforts to at least justify, in my future research, your brotherly invitation to cooperate on your cause – to fight with knowledge and reason for the Slavic idea and thus for all humanity. Please accept my sincere wishes for your every success, my brotherly greetings and deep gratitude, Professor Mendeleev, S. Petersburg 29 March/10 April 1883* (Fig. 4) (59).

The specific recognition of Mendeleev as a Slavic scientist can be seen as having a political background, as it symbolized the resistance of the Croatian academic community against Hungary's efforts to "Hungarianize" Croatia, considering that Croatia was part of the Austro-Hungarian Empire and facing strong pressures in that regard.

First appearance of the periodic table in secondary and university education in Croatia

The first textbook in Croatia that mentioned the periodic table of elements, provided its tabular display, description, and detailed information about the discovery, was a textbook by Julije Domac, *Anorganska kemija za više razrede realnih gimnazija i realka* (*The Inorganic Chemistry for Upper Grades of Real-Gymnasiums*), published in 1901 in Zagreb (60). Domac (1853–1928), a chemist and a university professor of pharmacognosy (61), wrote his textbook according to the existing curriculum of real-gymnasiums, *i.e.* without using the

periodic table in teaching of chemistry. However, as an accomplished chemist, educated at universities in Vienna and Graz, he included a special chapter on the periodic table in his textbook because he understood the significance of this discovery (62) (Fig. 5).



Милостивые Государи,
многоуважаемые члены
Югославянской Академіи
въ Загребѣ.

Вамъ угодно было избрать меня
въ свою среду – знанія и умѣнія. Не
велики мои заслуги и мнѣ остается
употребить все свое стараніе на то,
чтобы оправдать Вашъ братскій
призывъ хотя дальнѣйшими трудами,
дабы содѣйствовать цѣли Вашей –
знаніемъ и разумѣніемъ бороться
для славянства, а чрезъ него и для
всего человѣчества. Примите же отъ
меня искреннія пожеланія всякаго Вамъ
успѣха, собратскій мой привѣтъ и
мою глубокую Вамъ благодарность.

Профессоръ Менделѣевъ.

С. Петербургъ
29 Марта / 10 Апрѣля 1883 г.

Fig. 4. Mendeleev's letter of thanks on 29 March (10 April) 1883 to the Yugoslav (today Croatian) Academy of Sciences and Arts for electing him an honorary member. The letter is kept in the Croatian Academy of Sciences and Arts Archives, the Academy's Registry.

Gustav Janeček, a university professor of chemistry, had dedicated a part of his lectures in general chemistry to Mendeleev and the periodic table of elements. Since 1888, he has been preparing his lectures in inorganic chemistry in compliance with this table (63),

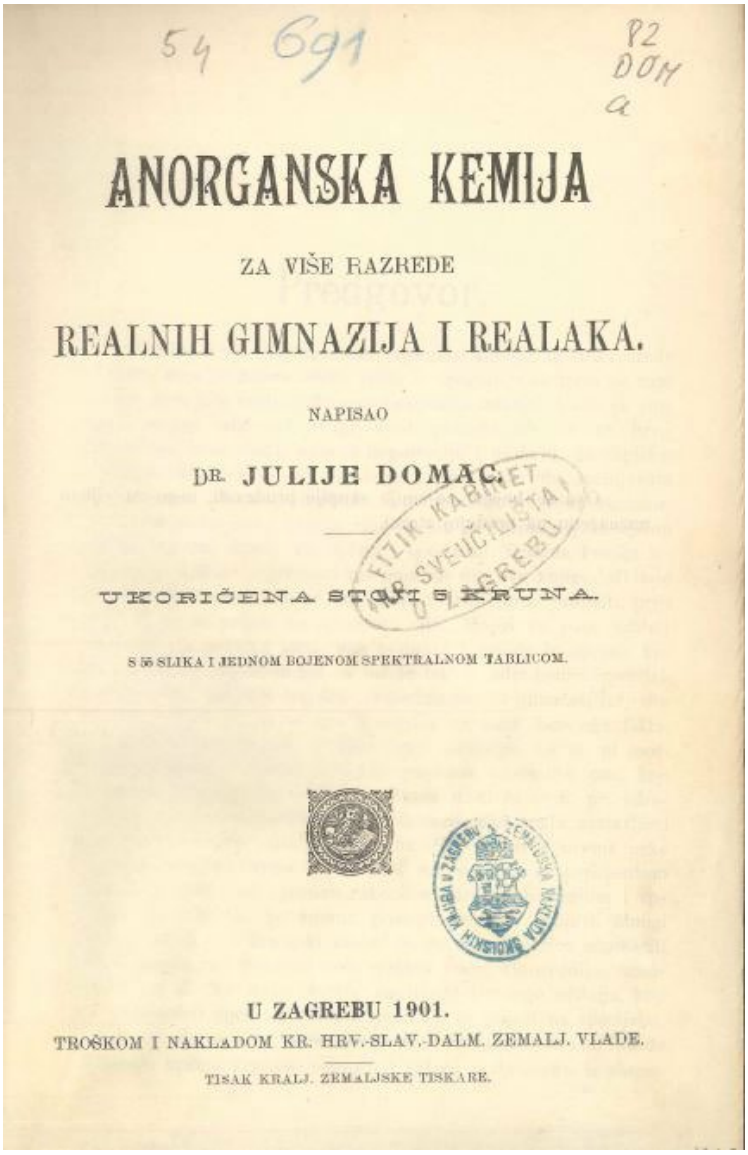
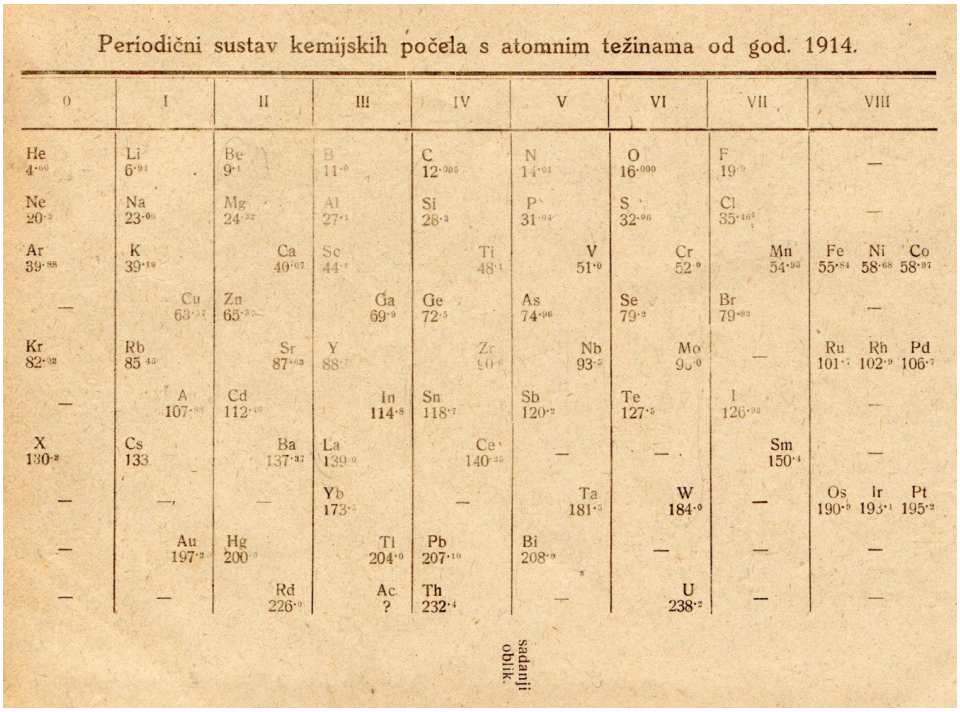


Fig. 5. The front page of the "Anorganska kemija" (Inorganic Chemistry) textbook by Julije Domac (1901) with a special chapter on the periodic table, pp. 394–397.

long before the publication of his chemistry textbook *Kemija I., opći dio* (*Chemistry I – General*, 1919) (64), the first university textbook in Croatian which included the periodic table of elements. In addition to Mendeleev's original table, the textbook contained a contemporary periodic table of elements in which the elements were arranged in groups from zero (noble gases) to eight. Blank spaces were left in the table for the elements that were predicted to be discovered, and it also included Mendeleev's eka-elements, gallium, germanium, and scandium. Beryllium was placed in the second group, while an atomic weight of 238 was determined for uranium. The table was still written using short-form periods (Fig. 6).


Periodični sustav kemijskih počela s atomnim težinama od god. 1914.

0	I	II	III	IV	V	VI	VII	VIII
He 4·00	Li 6·94	Be 9·1	B 11·0	C 12·005	N 14·01	O 16·000	F 19·0	—
Ne 20·2	Na 23·00	Mg 24·32	Al 27·1	Si 28·3	P 31·04	S 32·06	Cl 35·461	—
Ar 39·88	K 39·10	Ca 40·07	Sc 44·1	Ti 48·1	V 51·0	Cr 52·0	Mn 54·93	Fe 55·84 Ni 58·68 Co 58·97
—	Cu 63·57	Zn 65·37	Ga 69·9	Ge 72·5	As 74·96	Se 79·2	Br 79·92	—
Kr 82·92	Rb 85·45	Sr 87·63	Y 88·7	Zr 90·6	Nb 93·5	Mo 96·0	—	Ru 101·7 Rh 102·9 Pd 106·7
—	A 107·88	Cd 112·40	In 114·8	Sn 118·7	Sb 120·2	Te 127·5	I 126·92	—
X 130·2	Cs 133	Ba 137·37	La 139·0	Ce 140·25	—	—	Sm 150·4	—
—	—,	—	Yb 173·5	—	Ta 181·5	W 184·0	—	Os 190·9 Ir 193·1 Pt 195·2
—	Au 197·2	Hg 200·0	Tl 204·0	Pb 207·10	Bi 208·0	—	—	—
—	—	Rd 226·0	Ac ?	Th 232·4	—	U 238·2	—	—

sadanji oblik.

Fig. 6. The periodic table of elements published in the first university textbook in Croatian "Kemija I., opći dio" (Chemistry I – General) written by Gustav Janeček in 1919.

Fran Bubanović (1883–1956), a Croatian chemist who studied in Austria, the Netherlands, and Sweden with Nobel laureate Svante Arrhenius (1859–1927), spread knowledge about the periodic table in his popular paper *Slike iz kemije* (*Sketches from Chemistry*) (65) in which he first mentioned the periodic table of elements and included its tabular display. He is also the author of the first modern Croatian university textbook in chemistry, *Kemija* (*Chemistry*, 1930) (66), which contained a copy of Mendeleev's periodic table from the eighth edition of his *The Principles of Chemistry* textbook (1906). A coloured table, printed as an annex to the textbook, the author borrowed from Andreas von Antropoff (1878–1956). The special feature of Antropoff's table is its appearance which combines different colours to put together the periodic table with short-form and long-form periods (67). In Antropoff's

periodic table, the noble gases are found both as the initial and the final group of the periodic table.

With the publication of literature aimed at popularisation of science and the publication of specialised literature in Croatia, the impact of the publication of the periodic table of elements can be traced in the first journals, *Glasnik hrvatskoga naravoslovnoga društva* (*The Herald of Croatian Natural Society*) (68, 69) and *Farmaceutski vijesnik* (*The Pharmaceutical Herald*) (70, 71).

CONCLUSIONS

The impact and reception of the periodic table of elements in European countries varied. In Russia, Mendeleev's discovery and the introduction of the periodic table in a chemistry textbook occurred concurrently (1869). In Germany, the first information about the periodic table appeared in scientific journals (1869). However, its application in the teaching process occurred several years later (1875). The first paper on the periodic table appeared in Czech Lands in 1877, and a year later a textbook with the periodic table was published. In the southeast of Europe, in Serbia, the beginning of the development of chemistry and the application of the periodic table can be traced to 1880. In Croatia, there was no reception of the discovery of the periodic table of elements immediately after its publication because there was no university or higher education in chemistry at the time. Until the establishment of the modern University of Zagreb and the natural sciences departments (1876), chemistry in Croatia had been taught in real-gymnasiums. The first professors at the University of Zagreb were also members of the Yugoslav (now Croatian) Academy of Sciences and Arts, which in 1882 elected Mendeleev as their honorary member, being the first European Academy of Sciences to do so. Gustav Janeček, a university professor of chemistry, prepared his lectures in compliance with the periodic table of elements (1888). The first chemistry textbook in Croatian with the periodic table of elements was *The Inorganic Chemistry for Upper Grades of Real-Gymnasiums* by Julije Domac in 1901. The first university textbook of general chemistry in Croatian with the periodic table of elements was *Chemistry I – General*, published by Janeček in 1919, and the first comprehensive university textbook in compliance with the periodic table was published by Fran Bubanović (1930). The development of the periodic table of elements and the confirmation of its enduring validity, through the discovery of new elements and all noble gases, occurred simultaneously with the development of university chemistry teaching in Croatia. Although a bit later than other European countries, the Croatian academic community actively monitored the development of the periodic table and information on scientific findings related to the evolution of the periodic table.

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