BEGINNINGS OF THE TEACHING OF CHEMISTRY AT THE UNIVERSITY OF ZAGREB*

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The Hungarian-Croatian scientific collaboration established in the 18th century through the activity of some Croatian experts in the exact sciences at the University and at the astronomical observatory of Budapest continued also in the 19th century when in Zagreb at the "Regia scientiarum academia" (Royal Academy of Science) a Hungarian, J. Mikussay, taught physics from 1836 to 1844 [1].

This collaboration was of particular importance for introducing the teaching of chemistry and chemical research work in Croatia at the reorganized University of Zagreb. The Zagreb University was founded in 1669, and modernized in 1874. In the same year they decided to establish Natural Science Departments at the Faculty of Philosophy, so that applications were invited for the posts of teachers of physics, chemistry, zoology, botany, geology and mineralogy [3]. The candidates had to meet some requirements: they had to be Academic Doctors of the corresponding science, and authors of some scientific works, they had to know Croatian or some other Slavic language, etc.

Five candidates had applied for the post of chemistry teacher but the teaching staff at the Faculty of Philosophy took only three applications into consideration: those submitted by M. Barač, Ph. D. Aleksandr Veljkov-Welkow and Ph. D. M. Nevole. The teaching staff proposed Ph. D. A. Veljkov-Welkow, an assistant chemistry professor at the Technical University of Budapest for the post of first chemistry professor at the University of Zagreb. He was appointed associate professor by a decision of November 13, 1875.

In the archives of the Philosophical Faculty of Zagreb and in the Archives of Croatia the following data were found about A. Veljkov-Welkow: born in Pest, 28 years old, had studied in Pest and Berlin; he occupied himself with natural science in Pest, his special field was chemistry. He became Ph. D. of chemistry in Vienna in 1869. After this he was appointed chemistry assistant and later assistant professor at the Technical University of Pest. According to the reports of his teachers he spoke Croatian, Hungarian and German.

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Professor Aleksander Veljkov-Welkow (1847—1878)

The biography of A. Veljkov-Welkow — first professor of chemistry at the University of Zagreb

Aleksandr Veljkov-Welkow was born in Budapest to father Dimitrije and mother Jelena Veljkov, born Dimšić, on May 6, 1847. Recent researches have proved that the Veljkov family originated from Irig is Srijem, on the territory of today's SFR Yugoslavia, and that Dimitrije Veljkov had been born there [8]. In the register of baptism Aleksandr's name was spelt Veljkov, but other spellings like Welkow and Veljkov also occurred quite often. His mother-tongue was Serbian, he had a first-rate knowledge of Hungarian, German and French, and was quite fluent in Italian and English.

Aleksandr Veljkov-Welkow attended school in Budapest, and after six grades in secondary school he had four years of pharmaceutical practice. He graduated from high school as a private student and took his A-level in 1866. As a full-time student at the University of Budapest he took up the following subjects: physics, mineralogy, geology, botany and chemistry: the latter interested him most of all. Professor K. Than was in charge of the Institute of Chemistry at that time; he had brought to the University of Pest

the ideas and knowledge of his teachers Bunsen, Redtenbacher and others. During appr. fifty years of active work professor Than was the central figure in the development of chemistry in Hungary. He had brought contemporary chemistry into his country. During the first ten years of his activity (from 1860) professor Than himself taught chemistry to students of philosophy, pharmaceutics and medicine, and these were the very years when Veljkov-Welkow studied here.

According to professor Than himself, the Chemical Institute consisted at the time of a lecture-room with 90 seats, a small laboratory, and some 15 desks along the corridors. The number of students had been constantly increasing and reached 300 of whom 50 did the exercises. Than's lectures were very clear and lucid and his constant interest in the new achievements in chemistry offered a good basis for his pupils so that they acquired knowledge which enabled them to occupy the leading positions at various institutes of chemistry [5]. After four terms at the University of Pest Veljkov-Welkow passed the exam for dispensing chemist with top marks, and in 1868 he received his Master's Degree in pharmacy. He continued his studies at the University of Berlin, and there, in the laboratory of Professor A. W. Hofmann, he practised organic chemistry. Professor Hofmann, a well-known authority in chemistry and founder of the German Chemical Society, had a very favourable opinion of his work and knowledge: "Hr. Welkow hat sich bereits recht schöne Kenntnisse erworben und noch in der letzten Sitzung der Deutschen Chemischen Gesellschaft zu Berlin einige Ergebnisse seiner chemischen Studien mitgeteilt." (Hofmann's recommendation).

In 1870 Veljkov-Welkow became member of "The German Chemical Society" and preserved his membership throughout his life.

In 1869 A. Veljkov-Welkow obtained his Doctor's Degree with very good marks at the University of Vienna. He improved his knowledge in inorganic chemistry working in the laboratory of Professor E. Ludwig in Vienna for two years. Professor Ludwig wrote in his testimonial that he learned to know dr Welkow in the course of several years as a chemist of extremely professional and sound scientific and philosophical knowledge, and pointed out that any high school where he would go as a teacher could deem itself fortunate.

In 1870 Veljkov-Welkow was invited to Hungary, and was first appointed assistant lecturer (1871) and later assistant professor of chemistry at the Technical University Budapest.

Ph. D. Veljkov-Welkow worked at the Technical University from 1870 to 1875. These were the years when professor K. Nendtwich was lecturer in chemistry; he had been leader of the Chemical Department at the Technical University as early as 1847 when lectures in general and technical chemistry had been organized.

The existing archive materials found recently in Budapest describe in detail Veljkov-Welkow's activity at the Technical University.* Some documents concerning the transfer and appointment of Ph. D. A. Veljkov-Welkow to the post of associate professor at the University of Zagreb have also been preserved in Budapest. (In all documents the name is spelt Welkow.)

In 1875 A. Veljkov-Welkow was elected associate professor of chemistry at the University of Zagreb. He entered that office by the end of the same year [6].

In order to introduce modern chemistry teaching at the University of Zagreb (and modern teaching methods meant both lectures and research laboratories for students to experiment in) it was absolutely necessary to establish a chemical institute where teaching and research could be combined. Therefore Professor Veljkov-Welkow was charged with founding a chemical laboratory immediately after his arrival in Zagreb. He knew university institutions in Europe quite well, he himself had spent some time working in several of them, and had visited many more while travelling in Italy, Germany and Switzerland. In 1875 he had already submitted his reports on the "foundation of the chemical laboratory", and on the basis of these reports the National Government issued the decree to constitute a committee of experts in charge of supervising the building of the chemical institute.

After visiting laboratories in Graz and Vienna, professor Veljkov-Welkow, himself a member of the committee, prepared together with Mr. Srećko Jakomini, the surveyor, some designs for the construction and interior arrangement of the chemical institute. It was decided on May 17, 1876, to erect the building on the plot which is today on Strossmayer's square. Although the site had been obtained, the blueprints were ready, and the decision to start building had been adopted, owing to some unknown reasons actual building work never got started. However, the chemical institute was built some eight years later on the same site.

The problem of accommodation was temporarily solved when in 1876 they hired the building at Nova Ves 1, and professor Veljkov-Welkow established the first chemical institute of the Zagreb University there.

The arrangement of the laboratory can be seen on the drawings found in the files of the Zagreb University Archives. The largest room (37.5 sqm according to contemporary measurements) was the lecture room. The professor's study was adjacent to this room; it contained fine instruments. Other rooms were equipped with laboratory tables, gas supplies and taps, and "hearts".

* I got the archive materials from Budapest thanks to the kindness of É. Vámos and F. Némethy; I wish to express my sincere gratitude.

University courses in chemistry commenced in Croatia in the spring of 1876. Professor Veljkov-Welkow lectured on chemistry at the Faculty of Philosophy during four terms. His first course of lectures was entitled "History of Chemical Theories"; later he lectured on "General Experimental Chemistry", "Analytical Chemistry", "General Chemistry and Chemistry of Carbon Compounds", and he was also in charge of practical laboratory experiments for three terms [7].

As early as 1876 the staff of the Faculty of Philosophy had suggested to the National Government to nominate A. Veljkov-Welkow professor ordinarius (i.e. full-time professor), but this appointment was postponed with the explanation that hardly a year had passed since his election to associate professor. Next year the staff repeatedly asked for Veljkov-Welkow's nomination to professor ordinarius explaining that professor Veljkov-Welkow has been holding lectures as prescribed by law for two years now, and that he had arranged and equipped the chemical institute so that fulfilled all requirements of contemporary science, as stated by experts. Professor Veljkov-Welkow stayed in Zagreb until the end of February 1878. His sudden death put an abrupt end to his teaching activities and research work. He died in Budapest on April 29, 1878, in the heart of his family.

Professor K. Vojnović, Rector of the Zagreb University wrote at the time that professor Veljkov-Welkow had won the respect and affection of both teachers and students with his extensive knowledge, enthusiasm and kindness.

Zagreb newspapers "Obzor" and "Agramer Zeitung" published the news about the death of the first Professor of Chemistry at the University of Zagreb on May 3, 1878. The newspaper "Narodne novine" of the same day published a longer article saying that "the deceased was barely 30 years of age. Although one of the youngest, he was nevertheless one of the worthiest representatives of the Croatian University, true minister of science, an expert with such profound and wide knowledge that every university, the largest and oldest, could have equally been proud of him. Deeply inspired by his calling, he worked day and night, trying to reach into the depth of its secrets. In spite of his scientific seriousness Veljkov-Welkow was so modest and calm, so kind that he simply had to be admired and loved equally by student, friend and acquaintance". The Novi Sad paper "Orao kalendar" published a brief biography of professor Veljkov-Welkow with the following comment: "Many words of praise have been said after his demise, that he had organized the chemical laboratory of the Zagreb University with competence, and that he had been an excellent teacher." A portrait of Professor Veljkov-Welkow, the only one known so far [6] accompanied the article.

The research works of A. Veljkov-Welkow

A. Veljkov-Welkow published altogether seven papers; six were printed in the journal "Berichte der Deutschen Chemischen Gesellschaft zu Berlin" in German, and a more voluminous work was published in Hungarian under the title "Beryllium és alumínium kettős sók" by the Academy in Budapest [9].

The first scientific work of A. Veljkov-Welkow published in 1869 had been completed at the University Laboratory in Berlin; it represented the continuation of the work of his professor, A. W. Hofmann. It deals with the process of preparing the compound "Nitro- und Amidoderivate des Cyannaphtyls" with the following formula according to the author's opinion:

$$C_{11}H_8N_2 = C_{10}H_6(CN)(H_2N)$$

Veljkov-Welkow did other research work in the laboratory of professor E. Ludwig in Vienna: the results were published in 1873 and 1874. He prepared a new beryllium salt: "Beryllium-Platinchlorid" by mixing the concentrated solutions of beryllium-chloride and platinum-chloride. He described the method with which he had analyzed the prepared compounds; on the basis of these results he defined the formula:

$BePtCl_6 + 8\ H_2O$ where the atomic weight of beryllium is 9.4.

Veljkov-Welkow prepared another beryllium-salt: "Beryllium-Palladiumchloride" and found that it was isomorphic with the platinum-compound which he had prepared before.

It is a characteristic of aluminium to form dichloride according to the formula $Al_2Cl_6 + 2\ MCl$, and this encouraged Veljkov-Welkow to study the possibility of the synthesis: "Aluminium-Platinchloride." He suggested two formulas for the obtained compounds:

$$AlPtCl_7 + 15\ H_2O \text{ and } Al_2Cl_6 + 2\ PtCl_4 + 30\ H_2O.$$

Veljkov-Welkow described the synthesis of the compounds "Aluminium-Palladiumchloride" and "Beryllium-Palladiumchloride" in two papers. He deduced two formulas from the results obtained by analysis: $AlPdCl_5 + 10\ H_2O$ or $Al_2Cl_6 + 2\ PdCl_2 + 20\ H_2O$ (for the first compound) and for the second compound he suggested the following formula: $BeCl_2 + PdCl_2 + 6\ H_2O$, also on the basis of his analysis.

Discussion

Veljkov-Welkow in his works in 1883 and 1884 tried to prove by applying the law of isomorphics that beryllium belonged to the IInd and not to the IIIrd group of the periodic system. He believed that his experimental data

provided a basis for the determination of atomic weight, and considered that 9.4 was the atomic weight of beryllium, the definition of this atomic weight was not precise at the time. Until 1843 beryllium which resembles aluminium was believed tervalent. Avdeyev, who showed that beryllium did not form alum, suggested that beryllium oxide BeO was like MgO. In 1871 Mendeleyev put beryllium into group II and suggested 9.4 as the atomic weight of this element. Two years later Veljkov-Welkow announced the results of his experiments with which he had determined that the atomic weight of beryllium was as suggested by Mendeleyev. He had come to the conclusion about the almost exact weight of beryllium already in 1873, much before the general acceptance of Mendeleyev's suggestion. Brauner collected data about beryllium belonging to the IInd group only in 1881, when he supported the suggestion to put beryllium into group II.

Veljkov-Welkow's works had been published a long time before Nilson and Pettersson (in 1884) found out that the vapour density of beryllium chloride at 686—812° agreed with $BeCl_2$, and Humpidge stated in 1885 and 1886 that the atomic heat of beryllium was abnormally low and that at higher temperatures it approached a value corresponding to Be = 9.4 [4].

Although Veljkov-Welkow's works appeared in one of the most prominent journals of the time, his results did not arouse adequate attention. The Yugoslav chemistry historians have recently directed attention to the significance of Veljkov-Welkow's work.

We do not know whether Welkow continued his experiments with beryllium compounds after his return to Budapest. Some documents mention that he did such experiments in Vienna but it leaves no doubt that he published his results exactly at the time when he was Nentwich's assistant at the Technical University. So it is quite possible that ideas derived from his new environment influenced his interpretation of experimental results.

Welkow's most important contributions to chemistry were his works on beryllium compounds. However, at this time it was not known that this metal caused serious injuries in a human body. No certain proofs about the causes of the death of Veljkov-Welkow have been found so far. A friend and his biographer S. V. Popović mentioned that the traces of tuberculosis were apparent on Veljkov-Welkow's face. Some decades later it was found that the symptoms of tuberculosis were the same as those of the decease berylliosis caused by contact with beryllium. In chronic cases the symptoms appeared even ten years after the actual beryllium poisoning. The supposition that experiments with beryllium were responsible for the early death of A. Veljkov-Welkow may be justifiable.

Veljkov-Welkow's contemporaries evaluated his works very positively. On the occasion of his appointment as professor of chemistry at the University of Zagreb Ph. D. Gjuro Pilar, professor of mineralogy and geology at the

same University pointed out that Veljkov-Welkow had done research about "the double salts and salts of beryllium, aluminium, palladium and platinum", had described the synthesis of these salts, and had defined their essential physical and chemical characteristics. With the help of chemical analysis he had established the formulas of compounds "which he thus introduced for the first time into science". His activities "guarantee serious work and scientific precision, and provide the basic conditions for success" — concluded Pilar.

Academician D. Grdenić, professor of the History of Chemistry at the Faculty of Science in Zagreb, expressed his appreciation of Professor Veljkov's research work and teaching, based on the latest data and published papers, in consideration of the present development stage of chemical science: "The teaching work of Veljkov was certainly good, for it was up-to-date. Veljkov has had a good academical education at great universities under the guidance and tutorship of outstanding chemists, and what is most important, he himself as a researcher took active part in the development of chemistry; this is obvious from his published papers. The chances for Veljkov to transfer and transplant European chemistry to the new Zagreb University were indeed excellent. Unfortunately he died after three years of devoted work, respected and honoured as a professor, scientist and citizen of Zagreb" [2].

In 1976 they celebrated the centenary of the first lessons of chemistry at the University of Zagreb. On that occasion the eminent work of professor Veljkov-Welkow, his contribution to establishing the first chemical institute and his merits as the first teacher of chemistry at the Zagreb University, were highly appreciated.

The connection between chemistry teaching in Budapest and Zagreb continued also after the end of A. Veljkov-Welkow's activity. It is a point of interest that his successor, Prof. Gustav Janaček managed to realize the plans of his predecessor; namely the building of the Institute of Chemistry in Zagreb.

Than's Institute in Budapest built in 1872 served as a model for the construction and interior arrangement of the first Institute of Chemistry at the University of Croatia. Just before the construction started in 1882, professor Janaček had been to Budapest to examine the interior arrangement of the Institute of Chemistry. The detailed blueprint of the new building, completed and put into operation in 1883, followed Janaček's instructions [7].

Summary

The Hungarian-Croatian scientific relations established in the 18th, continued also in the 19th century. This collaboration was of particular importance for introducing the teaching of chemistry, and for doing research in the field of chemistry in Croatia at the University of Zagreb. Professor Aleksandr Veljkov-Welkow, born and educated in Budapest, established the first Department of Chemistry at the University of Zagreb where he lectured on modern chemistry and supervised the laboratory exercises of students. He was appointed associate professor of Chemistry at the Faculty of Philosophy in Zagreb in 1875.

References

1. DADIĆ, Ž.: The Development of Exact Sciences in Croatia (Razvoj egzaktnih znanosti u Hrvata) part II. chapt. 1.1.
2. GRDENIĆ, D.: Croatica Chemica Acta **50,** 5 (1977).
3. Spomenica Prirodoslovno-matematičkog fakulteta 1874—1974 (Memorial of the Faculty for Natural and Mathematical Sciences 1874—1974, University of Zagreb), Sveučilište u Zagrebu, Zagreb, 1974, 222 p.
4. PARTINGTON, J. R.: A History of Chemistry, Vol. IV, London, McMillan, 1964, 896.
5. SZABADVÁRY, F.—SZŐKEFALVI-NAGY, Z.: A kémia története Magyarországon (History of Chemistry in Hungary), Budapest, 1972, 196—204.
6. SENČAR-ČUPOVIĆ, I.: Croatica Chemica Acta **50,** 45 (1977).
7. SENČAR-ČUPOVIĆ, I.: Croatica Chemica Acta **50,** 59 (1977).
8. SENČAR-ČUPOVIĆ, I.: Aleksandr Veljkov osnivač prvog sveučilišnog kemijskog zavoda i prvi profesor kemije na Svenčilištu u Zagrebu — bio je porijeklom iz Iriga u Srijemu (Aleksander Veljkov — the Founder of the First Institute of Chemistry and First Professor of Chemistry at the University of Zagreb — Born in Irig in Srijem, Collection of papers of the Learned Society for the History of Health Culture in Yugoslavia, Novi Sad.
9. WELKOW, A.: Ueber Nitro und Amidoderivate des Cyannaphtyls, Ber. Deutsch. Chem. Ges. **2,** 407 (1869); Beryllium—Platinchlorid, ibid. **6,** 1228 (1873); Beryllium—Palladiumchlorid, ibid. **7,** 38 (1874); Aluminium—Platinchlorid, ibid. **7,** 304 (1874); Aluminium—Palladiumchlorür, ibid. **7,** 802 (1874); Beryllium—Palladiumchlorür, ibid. **7,** 803 (1874): Beryllium és alumínium kettős sók, Budapest 1874 (Eggenberger-féle Akad. Könyvkereskedés).

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