

# Karel Zahradník (1848–1916)

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## IV. English summary

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## **IV. SUMMARY**

## ENGLISH SUMMARY

The main aim of this book is to inform the reader about the life of Karel Zahradník (1848–1916) and his work in mathematics as well as in some other fields that he created in the Czech lands and Croatia. It is mostly forgotten that Karel Zahradník was a distinguished Czech mathematician, teacher and organizer of education. In total he wrote down more than 100 publications (papers, textbooks, monographs, litographies and methodological works). They were published in Czech, German, Croatian and French.

This book is based on the documents about the Zahradník's life and work that are stored in the archives in Prague, Brno, Zámorsk, Litomyšl (Czech Republic) and Zagreb (Croatia). Some information was gathered from the family memoirs and memoirs of Zahradník's colleagues and friends.

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### Karel Zahradník's family and studies

Karel Zahradník was born on April 16, 1848 in Litomyšl (today Czech Republic). His father Karel Zahradník (1814–1898) was a citizen of Litomyšl too and a good shopkeeper there, his mother Anastázie Slámová (1824–1866) came from Chotěboř (a small city in the east of Bohemia), she was a daughter of a rich clothier. They had a nice house not far from the main square in Litomyšl. Karel Zahradník had one older sister Kateřina (1846 – after 1921) and six younger brothers: Otakar (1850–?), František (1852–?) (both died in childhood), Bedřich (1855–1915), Rudolf (1857–1914), Josef (1859–?) and Bohumil (1866–?).

At the age of six he entered the primary school in Litomyšl. From 1860 up to 1868 he attended the grammar school at his town where his remarkable talent for mathematics became evident. He passed his leaving examinations in 1868. After he had completed his secondary education, he studied at the Czech Technical University in Prague (1868–1870). He was interested in mathematics and geometry above all but he had no interest in technical studies. Over the years 1869–1872 he studied at the University in Prague, he was especially interested in mathematics. He attended the following courses: mathematics (H. J. K. Durège, W. Matzka), physics (E. Mach, H. Lippich), astronomy (K. Hornstein), history and philosophy. In 1874, he graduated from the University in Prague with a degree in mathematics (he became the Doctor of Philosophy).<sup>1</sup> Since he was interested in teaching at the secondary schools he passed the so-called “teacher examination” too.<sup>2</sup>

<sup>1</sup> According to the old rule he had to sit four examinations (1872 an examination in history, 1873 examinations in mathematics, physics, philosophy), no thesis was necessary.

<sup>2</sup> In 1874, he passed with the great success the so-called “teacher examination” (certificate n. 1115) and he became a teacher of mathematics and physics at the Czech secondary schools.

### First position

In 1872, still as a student of the University he was named as an assistant of mathematics at the Czech Technical University; he occupied this post four years. At this school he collaborated with professor Gabriel Blažek (1842–1910).<sup>3</sup> In 1874, he obtained the first appointment as a part-time teacher of mathematics and physics at the secondary school in Prague (*první české gymnasium realní*), he stayed there for two years. He taught mathematics, physics and philosophy, he had about 15 or 18 hours a week. He was also a custodian of physical laboratory and collection.

### Career in Croatia

Zahradník's real mathematical career started in 1876 when he was appointed as a full professor of mathematics at the newly established University in Zagreb, *the University of Franz Joseph I.*, in Croatia. He was only 28 years old! He instructed 23 years there; during this time he became twice the dean of the Philosophical Faculty (1883/1884 and 1892/1893). From 1876 up to 1899 he was the head of the *Mathematical Department* and from 1876 up to 1890 he was the only professor of mathematics; in 1891 D. Segen and in 1895 V. Varičák (Zahradník's students) started to teach geometry and mathematics at the university. In 1886, Karel Zahradník established the *Mathematical Seminar* which was attended by candidates of teaching and talented students. In 1893, he created the *Mathematical Collection* of mathematical models and textbooks. He used to work on several topics at the same time; his aim was to develop the Croatian university and Croatian scientific life. This period was the culmination of his pedagogical and scientific activities.

Since he was the only professor of mathematics at the university his work was very complicated. He had to teach algebra, differential and integral calculus, geometry as well as theory of numbers, probability, complex analysis. The spectrum of his lectures was much wider than the one of our professors at the university today. In the 70th he taught 4 or 5 hours a week because he had problems with Croatian language,<sup>4</sup> since the 80th he taught 7 or 9 hours a week. He was mainly interested in the preparation of new Croatian secondary school teachers but the level of his lectures was high and he was not a mild examiner.

After the arrival to Zagreb he started to change the educational system by preparing new curricula. He educated one of the first Croatian teachers of mathematics and mathematicians, he influenced the first Ph.D. students of mathematics in Croatia.

As a teacher of mathematics he wrote one of the first mathematical books and textbooks in Croatian language for his students and for students at the

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<sup>3</sup> More information about Zahradník's teaching at the Czech Technical University in Prague can be found in the archive of this school – the reports of professor's sessions.

<sup>4</sup> When he came to Zagreb he did not know Croatian at all and he had just started to study it. He prepared his lectures in German and then translated them into Czech language and with the help of his Croatian teacher he translated them into Croatian. After two years he was able to teach and write in Croatian without any problem.

secondary schools. For students of secondary schools he wrote *O determinantih drugoga i trećega stupnja. Za porabu viših srednjih učilišta* [Z42] (On Determinants of Second and Third Order. For Higher Classes of the Secondary Schools) (Zagreb, 1878, 39 pages)<sup>5</sup> and with D. Segen *Geometrijska vježbenica za više razrede srednjih učilišta* [Z75] (Collection of Geometrical Problems for Higher Classes of Secondary Schools) (I. volume, 1896, Zagreb, 105 pages, II. volume, 1899, Zagreb, 146 pages).<sup>6</sup> For his university students he prepared the lithographies *O determinantima. Predavanja u zimskom semestru godine 1897/8* [Z04] (On Determinants. Winter Semester 1897/8) (Zagreb, 112 pages) and *O plohama i o krivuljama u prostoru. Predavanja u ljetnom semestru godine 1898* [Z105] (On Surfaces and Curves in the Space. Summer Semester 1898) (Zagreb, 152 pages) which are in the National library in Zagreb now.

Karel Zahradník had a very difficult task because he wrote one of the first Croatian textbooks on the theory of determinants and analytical geometry. He had to create the Croatian terminology, he was opening the field for the future generations of Croatian teachers and students.

For Czech students he wrote two textbooks *Prvé počátky nauky o determinantech. Pro vyšší střední školy* [Z47] (The First Start of the Theory of Determinants. For Higher Classes of the Secondary Schools) (Prague, 1879, 48 pages)<sup>7</sup> and *Analytická geometrie v rovině. Pro školu* [Z56] (Analytical Geometry of the Plane. For Schools) (Prague, 1883, 144 pages).<sup>8</sup>

Thanks to him *Kapesní logaritmické tabulky F. J. Studničky* (Studnička's Pocket Logarithmic Tables) were published in Croatian. At the end of the 1870's he started to translate Studnička's textbook *Algebra pro vyšší třídy středních škol* (Algebra for Higher Classes of the Secondary Schools)<sup>9</sup> for the secondary schools, but the Croatian government did not allowed its publication. He organized the exams for candidates of teaching at the secondary schools and also the leaving exams at the secondary schools.<sup>10</sup>

He also created one of the first mathematical papers in Croatian language for which he had to create the terminology (especially in geometry). In that period he published more than 50 papers, almost all of them in Croatian,

<sup>5</sup> This book contains the modified text of lectures that Karel Zahradník had in the winter semester 1876/1877 at the university.

<sup>6</sup> The second edition is from 1905, the third edition is from 2003! It is very interesting that nearly one hundred years after author's death the book is used at the secondary school. In 1904, this book was translated by V. N. Ikononov into the Bulgarian language.

<sup>7</sup> This textbook is the Czech version of the Croatian textbook from 1878.

<sup>8</sup> The second edition of this book is from 1884. This textbook was not of a high level, it was old fashioned, written in the style of the end of the 18th century. It was very bad reviewed by A. Kostěnc. His reviews, Zahradník's reactions and Redaction's meaning can be found in the journal *Časopis pro pěstování matematiky a fyziky* 13(1884).

<sup>9</sup> Studnička's textbook was firstly published in 1877, for the second time in 1879. In 1878 and 1879 F. J. Studnička published German versions of his textbook.

<sup>10</sup> In this book, there are analysed and evaluated Zahradník's textbooks and lithographies. They are also compared with the best books written by Zahradník's Czech and Croatian contemporaries.

German and Czech journals. It is easy to see that Karel Zahradník was the very busy and energetic man. For example in 1892, he was named a member of the commission for the leaving exams at the secondary schools, in 1893, the Croatian government sent Karel Zahradník at the Mathematical congress in Munich and in 1894, it sent him at the Mathematical congress in Vienna.

Karel Zahradník laid the foundations of Croatian mathematics and contributed significantly to the development of the Croatian mathematical community. He participated in the mathematics and natural sciences section of the Croatian Academy of Sciences, where he gave professional and popularisation lectures and published his works. He influenced also the development of the mathematical section of the journal *Rad Jugoslavenske akademije znanosti i umjetnosti u Zagrebu* (Transactions of the Yugoslavian Academy of Science and Arts in Zagreb). While his work is still recognized and his name still well-known in Croatia, he is almost forgotten in Bohemia, though he cooperated with the *Jednota českých matematiků* (Union of Czech Mathematicians) until the end of his life.<sup>11</sup>

### First family

In Litomyšl on August 14, 1876 Karel Zahradník married *Anna Záleská* (1858–1888) who came from Litomyšl too (she was a daughter of a rich citizen but she was very ill from her childhood).<sup>12</sup> In their marriage, two children were born: *Ana Aloysia* (1878–1896) and *Karel* (1881–1899), both were born in Zagreb. The whole family returned to the Czech lands each summer, they visited their relatives in Litomyšl and Zahradník's friend in Prague.<sup>13</sup> Anna used to spend some time in Františkovy Lázně and Karlovy Vary (the famous Czech spas) to regain health. Ana Aloysia, in the family called Anita, studied at the secondary school for girls in Zagreb. She was very ill since her childhood as her mother and died of TBC on December 12, 1896. Karel studied at the secondary school in Zagreb too. He was a gifted student with an excellent talent for languages. After finishing his studies at the secondary school he became a student of law at the University of Zagreb. Since 1896 his health was not good; after the death of his sister he was sent to Crkvenica (the great climatic resort in Croatia). But he died of TBC on July 21, 1899. The whole family was buried in Zagreb on the cemetery *Gradska Groblja Miragoj*. Their graves exist up to this day and they are in a very good condition thanks to the Croatian state and the University in Zagreb.<sup>14</sup>

<sup>11</sup> Information about Zahradník's activities at the university was based on the documents deposited in the Archive of the University of Zagreb.

<sup>12</sup> She died of TBC in Zagreb on April 4, 1888.

<sup>13</sup> The very interesting information about Zahradník's family, his life, his position and work in Zagreb, political situation there etc. can be found in his letters which he wrote from 1874 to 1899 to his friend František Josef Studnička (1836–1903), a professor of mathematics at the University in Prague. More than 70 Zahradník's letters from 1874 to 1903 can be found in Prague in the *Literární archiv Památníku národního písemnictví v Praze* (Literary Archives of the Treasure of National Literature in Prague) (the collection of F. J. Studnička).

<sup>14</sup> Information about Zahradník's relatives was based on the documents that are deposited

### Career in the Czech lands

After his personal tragedies Karel Zahradník was very unhappy in Zagreb and wanted to return to the Czech lands. We can see that all his life he felt as the Czech and he was not so well-contented abroad although he was a recognized mathematician and an organizer of Croatian scientific life.

Since 1898 Czech deputies in Vienna tried to obtain emperor's agreement with the foundation of the second Czech polytechnic in Brno. On September 19, 1899 emperor Franz Joseph I. signed the creation of this school and on October 1, 1899 emperor named first four professors (K. Zahradník for mathematics, J. Sobotka for descriptive geometry, J. J. Jahn for mineralogy and H. Schwaiger for drawing). On November 3, 1899 the inaugural celebration of the foundation took part in Brno and the first class of 53 students was opened. The following day an excellent banquet for deputies and rich citizens from the Czech lands was held in Brno. It was in a big contrast with the very modest conditions of created school (for example rector's office and his flat were at the hotel "Slávia", the small teaching rooms were rented from "Vesna").

In 1899, Karel Zahradník returned to Moravia and became a full professor at the Czech polytechnic in Brno. From 1899 up to 1901 he was the first rector of the school, in 1910/1911 the dean of the Faculty "Cultural Engineering". From the first days he put his force to establish this new school. He prepared new textbooks, lectures and curricula for his students, he had to change completely his style of teaching because he now prepared engineers and neither mathematicians nor teachers of mathematics. He could see the great development of polytechnic during its first years (in 1899 the school had only 53 students, in 1916 more than 500 students studied there). For his students he wrote two textbooks *O determinantech* [Z92] (On Determinants) (Brno, J. Barvič, 1905, 50 pages), *Analytická geometrie, I. díl, Geometrie bodu, přímky a kuželoseček* [Z96] (Analytical Geometry. I. Volume. Geometry of Point, Straight Line and Conic Sections) (Brno, A. Píša, 1907, 184 pages) and four lithographies *Analytická geometrie v rovině. Přednášky z vyšší matematiky I. běh* [Z106] (Analytical Geometry in the Plane. Lectures on the Higher Mathematics. The First Part) (Brno, 1903–1904, 198 pages), *O determinantech. Přednášky z vyšší matematiky I. běh, část úvodní* [Z107] (On Determinants. Lectures on the Higher Mathematics. The First Part, the Introduction) (Brno, 1903–1904, 62 pages), *Přednášky o integraci diferenciálních rovnic obyčejných. Letní semestr, 1904* [Z108] (Lectures on the Differential Equations. Summer Semester 1904) (Brno, 1904, 174 pages) and *O plochách druhého stupně. Z přednášek v zimním pololetí 1910/1* [Z109] (On Surfaces of Second Order. Winter Semestr 1910/1) (Brno, 1911, 151 pages). He took a great care about the style of his textbooks.<sup>15</sup> In

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in the State archive of Zagreb (the register book of births and deaths of the parish Sv. Marko, Ana Aloysia was born on March 29, 1878 and Karel on May 14, 1881) and the register books from Gradska Groblja. The registration numbers of graves are part I, field 10, grave 68<sup>a-c</sup>.

<sup>15</sup> In this book, there are analysed and evaluated Zahradník's textbooks and lithographies. They are also compared with the best books written by Zahradník's Czech contemporaries.

that period he published more than 20 papers, almost all of them in Czech and German.

### Other activities

Karel Zahradník was a hardworking man who took part in many other activities that helped to the poor students. In 1900, he was named a honest member of the student's societies in Brno (*Akademický čtenářský spolek Zora, Podpůrný spolek Hlávka, Spolek Kaunicových studentských kolejí*). In 1909, he became a honest member of the student's society *Akademskoje udruženje Jugoslavija* in Brno which helped students from Croatia, Serbia, Slovenia and he was named *a honest citizen of Královo Pole* (today a part of Brno). At the beginning of the 20th century he was given a title "dvorní rada" (Hofrat) which was very famous in the Austro-Hungarian Monarchy. From 1900 up to 1907 he was a member of the *Moravian school executive council for secondary schools* and a president of the commission for the leaving exams at the secondary schools.

### Second family

On November 19, 1901 he got married for the second time. In Brno he married *Marie Prchalová* (1875–1955) from Třebíč (a daughter of František Prchal – a banking clerk – and Marie Klimentová); they had no children. He died of pneumonia on April 23, 1916. He was buried at the central cemetery in Brno on April 25, 1916; his grave does not exist now.

### Scientific activities

Since 1868 Karel Zahradník was a member of the *Spolek pro volné přednášky z matematiky a fyziky* (Society for Free Lectures from Mathematics and Physics).<sup>16</sup> In 1869, he became a full member of the *Jednota českých matematiků* (Union of Czech mathematicians). In 1870, he worked as a redactor of the *První zpráva Jednoty českých matematiků* (the First Report of the Union of Czech Mathematicians) [Z114].

In 1879, he was elected as a corresponding member and in 1882 a full member of the *Jugoslovanska akademija znanosti i umjetnosti* (Academy of Science and Arts in Zagreb), from 1891 up to 1899 he was the head of its part *Matematičko-přirodoslovnij razred* (Department of Mathematics and Nature Sciences). He was also a corresponding member of the *Královská česká společnost nauk* (Czech Royal Society of Science), the *Česká Akademie věd Františka Josefa I.* (Czech Academy of Science in Prague), the *Serbian Academy of Science in Belgrad*, the *Circolo matematico di Palermo* and the *Deutsche Mathematiker-Vereinigung*.

### Zahradník's publications

Karel Zahradník published more than 100 articles, books and monographs on various fields of mathematics. He worked on a large range of mathematical

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<sup>16</sup> He was one of the first technicians who became a member of that society.

topics – algebra (determinants, logarithms, equations), analysis (infinitesimal calculus, differential equations) and geometry. His publications can be divided into the following four groups:

- 12 mathematical textbooks, monographs and lithographies (in Czech and Croatian),
- 76 papers and memoirs (in German, Czech, Croatian, French),
- 27 papers for students and teachers (history of mathematics, short biography, didactics, in Czech, German and Croatian),
- 1 translation – G. Bellavitis: *Methoda equipollenci čili rovnic geometrických*, Praha, JČM, 1874 [Z110].

Karel Zahradník wrote in German, Czech, Croatian and French. The first article he prepared in 1872 was in Czech, the last paper he finished in 1912 was in Czech too. He was an “advanced” mathematician so he published the most important results of his research mainly in the German printed journals (*Zprávy ze zasedání Královské české společnosti nauk* (Minutes of Assemblies of the Royal Bohemian Society of Sciences), *Archiv der Mathematik und Physik* (Archive of Mathematics and Physics), *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien* (Proceedings of the Imperial Academie of Sciences in Vienna) and *Věstník Královské české společnosti nauk* (Proceedings of the Royal Bohemian Society of Sciences)) because he knew that the articles in Czech or Croatian are not readable in Europe. He published one article in French journal *Nouvelles annales de mathématiques* (News of Mathematics). The review articles on his research were written for the Croatian journal *Rad Jugoslovanske akademije znanosti i umjetnosti* (Transactions of the Yugoslavian Academy of Science and Arts in Zagreb) and sometimes for the Czech journals *Časopis pro pěstování matematiky a fysiky* (Journal for Cultivation of Mathematics and Physics) and *Archiv matematiky a fysiky* (Archive of Mathematics and Physics). The same articles were often published in both languages. Teacher- and student-oriented articles were published in Czech and Croatian in the journals *Časopis pro pěstování matematiky a fysiky* and *Nastavni vjestnik* (Reports).

It is possible to sum up these articles according to the languages thus: German 39 (from 1873 to 1911), Czech 36 (from 1872 to 1912), Croatian 20 (from 1877 to 1897) and French 1 (1899).

### Scientific works

Karel Zahradník was able to concentrate on solving several problems. He took care about the style of his articles above all. He obtained good results in geometry of algebraic curves and the theory of surfaces.<sup>17</sup>

He focused on the algebraic curves of the third or fourth degree. It is the first branch with which he was concerned. He used only analytical methods

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<sup>17</sup> In this book, there are carefully analysed and evaluated Zahradník’s mathematical articles and results.

based on choosing the special parametric equations. In the two-volume paper *O krivuljah u ravnini* [Z52] he gave a summary to his long-lasting researches. The first volume is based on the special parametric equations of plane curves in the “tangential” coordinates. Thus the curve can be looked as the envelope of straight lines determined by the distance from the origin of coordinates and the angle measure between the straight line and the  $x$ -axis. The second volume deals with the special kind of plane curves. Karel Zahradník showed their properties, equations, transformations, possibilities of their rectification and complanation. His lithography *O plohami i o krivuljama u prostoru* [Z105] solved the similar questions.

Properties of the so-called triplets of points were the second branch of his interest. He studied the triplets of points lying on the conic sections and special algebraic curves of the third or fourth degree. For the former he described points lying on the tangent to the curve passing through one fixed chosen point in the same plane. Then he described the triplets of points created by feet of the normals coming out from one fixed chosen point. At the end he described the triplets of points created by points of contact lying on the osculating circles passing through the points of that curve. He concentrated on computations of areas of triangles defined by these triplets of points, the radii of their inscribed circles or osculating circles. He studied some geometrical objects created by these points on conditions of constant area of triangle, radius of circle or radius of curvature etc. He also looked into the special curves (for example parabola, cissoid, strophoid, folium of Descartes, cardioid, lemniscate).

The geometrical constructions of cubic and biquadratic curves were the third domain of his interest. His special construction of the so-called cissoidal (i.e. the generalization of cissoid of Diocles) is still quoted under the name *cissoide of Zahradnic*. It is based on this idea: let us choose a conic section, one fixed point on it and one straight line as our directing elements. We put on every straight line passing through the fixed point a segment from this point congruent with the segment on the straight line between the conic section and the directing line. The endpoints of all segments of this kind distinct from the directing point form the cissoidal. In 1873 in the papers *Křivky cissoidalné* [Z4] and *Theorie der Cissoide auf Grundlage eines rationalen Parameters* [Z5], Karel Zahradník published his first idea that in this way it is possible to get each rational curve of the third degree but he did not publish any proof of his idea. In 1906 in the paper *Einheitliche Erzeugung der bekannten rationalen Kurven dritter Ordnung als Zissoidalen* [Z93], he came back to this idea again. He gave the detailed description of properties of 15 fundamental kinds of cubic curves. In the paper *Konstruktion der rationalen Kurven dritter und vierter Ordnung respektive Klasse vermittle der kollinear incidenten Elemente* [Z95] (1908) and in the paper *Einige Bemerkungen zu den zirkularen Zissoidalen als Fusspunktskurven* [Z97] (1909), he extended his results obtained in 1906.

The geometric transformations were the last Zahradník’s geometrical subject field. In his works *O jisté biracionální kubické transformaci a jejím upotřebení v theorii křivek* [Z89] and *Über eine birationale kubische Verwandtschaft und*

deren Anwendung [Z91], he analyzed a birational transformation of the third degree. It can be described in this way: we consider one point  $P$  through which are lead parallels with the axes of the rectangular system of coordinates. We obtain a rectangle. Then we drop the perpendicular through the origin of coordinate system on the diagonal of rectangle. We sign the intersection point by the letter  $P'$ . Then the transformation is  $P \rightarrow P'$ . Karel Zahradník studied this transformation by analytical methods, he looked for the inverse transformation and then he studied in detail the curves of the third and sixth degree springing from the transformation of straight line and conic section.

Further, Karel Zahradník concentrated on linear differential equations, differential equations of the second degree and their applications in the analytical geometry. He did not obtain any important results in this field. Only one of his results is interesting. He showed that the complete ordinary linear differential equation of the second degree has a common integral which presents the net of curves (i.e. two-parametric system). Karel Zahradník analyzed the geometrical loci of centres of osculating circles passing through a fixed chosen point. He recognized that these points create the curves of the third degree and fourth class which touch the straight line at the infinity. The theory of linear differential equations is also explained in his lithography *Přednášky o integraci diferenciálních rovnic obyčejných* [Z108], which was designated for Czech technical students. Besides several short papers on the integral calculus he wrote only one surveying abstract *O souvislosti kriterií konvergence nekonečných řad* [Z35] (in Croatian language [Z31]) explaining the criteria of convergence and divergence of the series.

Zahradník's works on cissoid and his construction are quoted in the famous book on curves of G. Loria: *Spezielle algebraische und transscendente ebene Kurven. Theorie und Geschichte*.<sup>18</sup> Zahradník's papers on the cubic algebraic curves are mentioned on p. 28, his works on cissoid on pp. 40, 41, 46, his results on cardioid on p. 142 and his contribution to lemniscate on p. 204.

W. Gaedecke quoted the last Zahradník's work on cissoid and his construction [Z97] in his paper *Über das Zentrum der mittleren Entfernungen gewisser Punktquadrupel auf den rationalen zirkularen Kurven 3. Ordnung mit Symmetrische*.<sup>19</sup>

Zahradník's contributions to the theory of algebraic curves are quoted by French mathematicians G. de Longchamps (the papers from 1887 and 1891) and P. Mainson (one paper from 1876), Czech mathematicians J. Pour (one paper 1899), Em. Weyr (the papers from the 70th and the 80th of the 19th century), J. Vojtěch (1917), M. Lerch (1917) and later by Czech geometers K. Pelz, J. Sobotka, M. Pelíšek.<sup>20</sup>

<sup>18</sup> Autorisierte, nach dem italienischen Manuskript bearbeitete deutsche Ausgabe von Fritz Schütte. Mit 174 Figuren auf 17 lithographierten Tafeln, B. G. Teubner, Leipzig, 1902.

<sup>19</sup> Sitzungsberichte der Berliner Mathematischen Gesellschaft 16(1917), pp. 3–9.

<sup>20</sup> We can find the fundamental information on the cissoid in the book written by Luciano Cresci: *Le curve celebri. Invito alla storia della matematica attraverso le curve piane più*

## Methodical and popularising papers

For teachers and gifted students Karel Zahradník wrote short papers on algebra, elementary and analytical geometry.

In the paper *O svístitosti Neperovih logaritama s naravskimi* [Z32], he described the relations between so-called Napier's logarithms and "natural" logarithms. He concentrated on the applications of so-called Gauss's logarithms too; he tried to use them to solve quadratic equations. In the paper *Prilog za riešitbu kvadratickih jednačaba pomou Gauss-ievih logaritama* [Z58] (Czech version [Z62]), he made a simple proof of the assertion that given logarithms of coefficients of quadratic equation one can calculate its roots.

The theory of determinants was another branch, which attracted his attention. He thought that determinants would play a very important role in the future mathematics, that is why he tried to explain them to his students. He wrote some short articles on their foundations. For students of secondary schools he published the following textbooks *O determinantih drugoga i trećega stupnja. Za porabu viših srednjih učilišta* [Z42] and *Prvé počátky nauky o determinantech. Pro vyšší střední školy* [Z47], for students of polytechnics and universities he wrote one textbook *O determinantech* [Z92], two lithographies *O determinantima* [Z104] and *O determinantech* [Z107]. To show the large applications of the determinants in the mechanics he translated French paper written by H. Durrande and published it under the title *O upotřebení determinantů v theorii momentů sil* [Z111].

Karel Zahradník also wrote about some elementary geometrical problems. He showed the simple proofs of elementary propositions (area of triangle, Pythagorean Theorem, Pappus's Theorem, some geometric and trigonometric formulas), he explained the problems by some transformations and the old Greek famous problems (quadrature and rectification of circle). In the paper *Izvodi iz Pitagorina poučka* [Z68] (German version [Z72] and Czech version [Z73]), he described some special applications of the Pythagorean Theorem. In the paper *Izvodi iz Pappusova poučka* [Z74] (Czech version [Z81] and German version [Z82]), he made the similar analogy for the Pappus's Theorem. In the first case he analyzed the relations between the rectangular triangle and the triangle with its vertices in the centres of the squares constructed under the sides of the rectangular triangle. In the second case he studied the relations between the oblique triangle and the triangle with vertices in the centres of parallelograms constructed under the side of the oblique triangle.

The analytical geometry for secondary schools is presented in his textbook *Analytická geometrie v rovině* [Z56] and exercises-collection *Geometrijska vježbenica za više razrede srednjih učilišta* [Z75], both were very popular in his time. In the lithography *Analytická geometrie v rovině* [Z106] and textbook *Analytická geometrie* [Z96], he explained in details the theory of straight

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*affascinanti*, Franco Muziio Editore, Padova, 1998, 194 pages (Diocle's cissoid is on the pages 85–86).

line and plane, fundamental transformations, symbolical calculus with points, theory of conic sections and elements of projective geometry.

According to the above mentioned information and with respect to the documents it can be said that Karel Zahradník worked very hard and that he essentially influenced Croatian and Czech culture and the development of mathematics and mathematical terminology.

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To show Zahradník's pedagogical activities as well as his scientific works and results four factographical appendices were added. Illustrations, photos and copies of some archival materials and documents can be found at the end of the book followed by the index of names.

### List of Zahradník's publications

The chronological list of Zahradník's publications given in the book was made thanks to the article<sup>21</sup> which includes the list of the most important Zahradník's publications. The quotations were carefully verified and corrected, the list was completed, a lot of information on Zahradník's lithographies, translations, reprints of his textbooks and other works were added. The titles of Zahradník's articles are given in italics and they are signed by letter Z, e.g. [Z14], in order to distinguish them from others.

### List of Zahradník's pedagogical activities

The chronological list of Zahradník's lecture courses at the University of Franz Joseph I. in Zagreb and at the Czech Technical University in Brno published in the book was prepared thanks to the school reports<sup>22</sup> and some archival materials which are deposited in Zagreb and Brno. The list shows the breadth of interests and duties of Zahradník's teaching activities.

### List of doctoral theses supervised or reviewed by Karel Zahradník

During his teaching at the University in Zagreb Karel Zahradník reviewed only ten doctoral theses (6 on mathematics, 4 on physics). He wrote his first review in the school year 1888/1889, the last one in the year 1898/1899.<sup>23</sup>

<sup>21</sup> J. Vojtěch: *Karel Zahradník. O životě a činnosti jeho*, Časopis pro pěstování matematiky a fyziky 46(1917), pp. 289–304. This article was written to commemorate the death of Karel Zahradník and to evaluate his scientific and pedagogical work.

<sup>22</sup> *Akademičke oblasti, osoblje i red predavanja na kr. sveučilištu Franje Josipa I u Zagrebu. U zimskom poljeću 1876/7, ..., U zimskom poljeću 1899/1900*, Zagreb, 1876, ..., 1899; *Čís. král. česká vysoká škola technická v Brně. Programm na studijní rok 1900–1901, ..., 1915–1916*, Brno, 1900, ..., 1915.

<sup>23</sup> At the University in Zagreb the first doctor's degree was awarded from philosophy in 1879. In 1881 M. Kišpatić was awarded a doctor's degree from geology, in 1881 F. Divić from physics, in 1886 V. Horvat from chemistry, in 1887 A. Heinz from biology, in 1889 D. Segen from mathematics and in 1895 M. Šenoa from geography.

The doctoral theses were evaluated according to the Austro-Hungarian law on the doctoral theses from 1872. It divided them into two groups – works containing original scientific results and compilation works. This law required besides doctoral works also major and minor exams. We can ascertain that the theses reviewed by Karel Zahradník belonged into the second group because they preserved till our times in the Archive of the University in Zagreb. According to the situation at the other universities in the Austro-Hungarian Monarchy we can presume that most of these theses belonged to the second group. They arose from the students' theses or students' homeworks written for so-called “teacher examination”.<sup>24</sup> Karel Zahradník was the head of both the department of mathematics and mathematical seminar and a member of the commission for teaching examinations, so he had the important influence on the choice of the themes of the doctoral theses.

We cannot ascertain whether the doctoral candidates were developing and elaborating Karel Zahradník's ideas or on the contrary Karel Zahradník made use of the results attained by the doctoral candidates.

The main source for the published list of theses was the book *Filosofski fakultet*<sup>25</sup> containing the list of doctoral candidates. This list was very carefully verified and corrected. New information was obtained thanks to the basic studies in the archive of the *Filosofski fakultet Sveučilišta u Zagrebu* and thanks to the book *120 godina nastavne prirodoslovlja i matematike na Sveučilištu u Zagrebu*.<sup>26</sup> There is the special register titled *Doktorati 1878–1933* containing interesting information about the doctoral examinations in the archive.

The published list of candidates gives their names, surnames, dates of birth and birthplaces, the titles of their theses together with the name of the second reviewer,<sup>27</sup> the branches and the dates of major and minor examinations. Some notes on reviews and examinations are added too.

### List of Zahradník's surviving correspondence

During the stay in Zagreb and teaching Karel Zahradník was in the contact with his family, friends, teachers and schoolmates in Czech lands. Only a few Zahradník's letters survived and they are scattered across the Czech Republic.

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<sup>24</sup> At the University in Zagreb from 1878 to 1899 only 75 students passed the “so-called teacher examinations” needed to become a teacher of mathematics at the Croatian secondary schools. The combinations were: mathematics, physics and philosophy (1 student), mathematics and physics (30), mathematics, physics and nature science (33), mathematics, physics and chemistry (5), mathematics, chemistry and nature science (2), mathematics and descriptive geometry (4).

<sup>25</sup> *Filosofski fakultet Sveučilišta u Zagrebu. Monografija*. Urednik Stjepan Damjanović. Zagreb, 1998. Especially pages 325–358 are devoted to the doctoral theses.

<sup>26</sup> Ž. Kučan (red.): *120 godina nastavne prirodoslovlja i matematiky na Sveučilištu u Zagrebu. 21. travnja 1876 – 21. travnja 1996. Spomenica PMF*, Sveučilište u Zagrebu, Prirodoslovno-Matematički Fakultet, Zagreb, 1996. On doctoral thesis see the pages 403–411.

<sup>27</sup> The second reviewer was Vincenc Dvořák (1848–1922), from 1875 professor of physics at the University in Zagreb.

After a long-lasting investigation only 88 letters written in Czech by Karel Zahradník from 1874 up to 1915 were found.

These letters give a rich stock of materials for the biographical part of this book. They were used for description of Zahradník's scientific and teaching activities, his family and social problems, his participation in broader social, political and cultural activities in Croatia in the second half of the 19th century etc. Many of them describe Zahradník's position at the University in Zagreb, his homesickness and his effort to return to Prague.

The list of surviving correspondence was elaborated in particular on the basis of study in many Czech archives and personal collections. The correspondence is given in the tablet in the alphabetical order according to the surname of addresser. Number of letters, the duration of correspondence and the abbreviations of signs from the archival funds are also added.

It is necessary to remark that this list is not complete since it is impossible to be sure that all Zahradník's letters were found. Some letters can be in the personal collections, probably privately owned. During the research in 2003 in Croatia there was no occasion to explore them. That is why the list of correspondence contains only letters deposited in the Czech Republic and Bulgaria.