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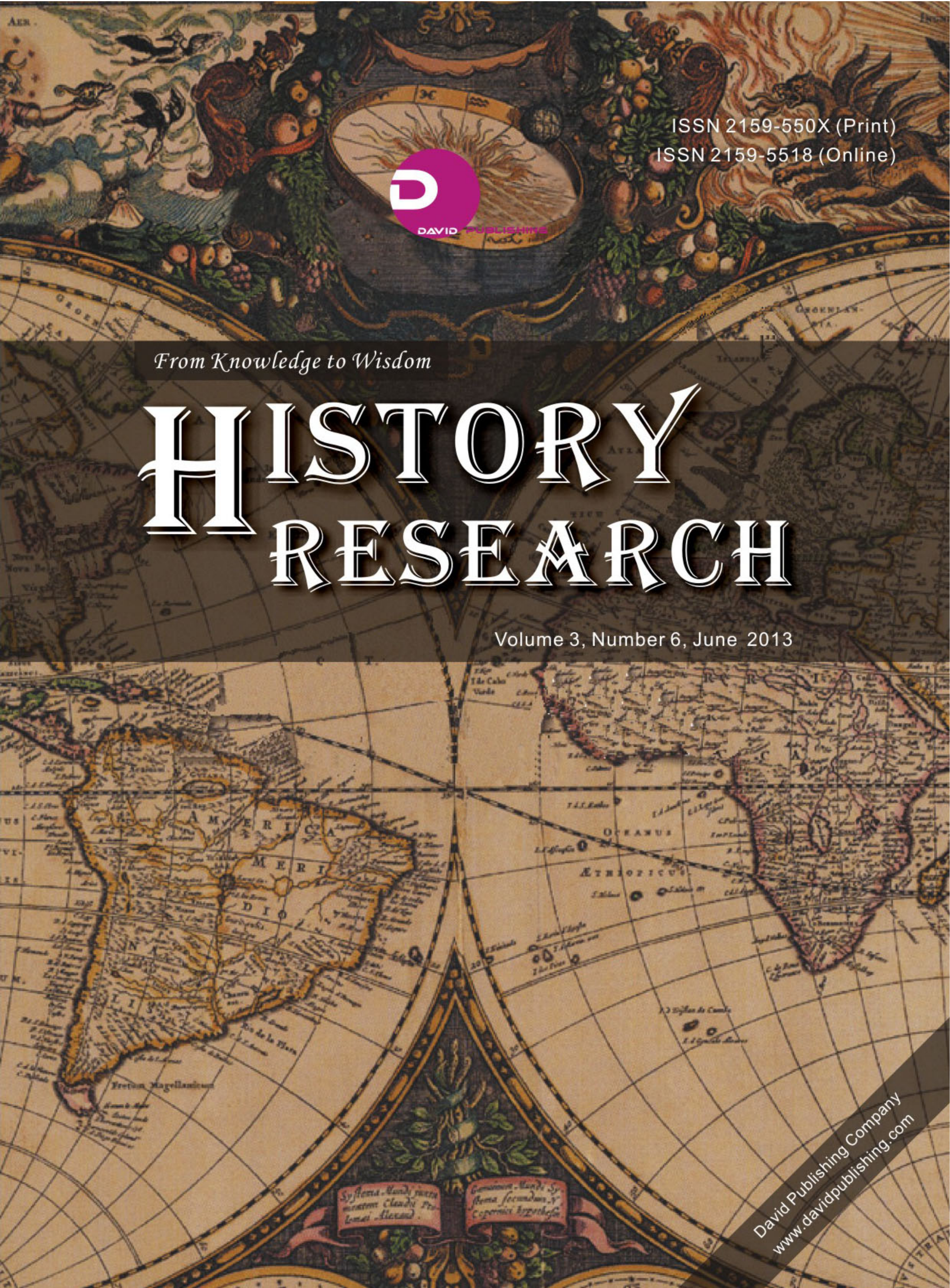

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Exiled Chemists of the Spanish Civil War's Footprint in Mexico

History on five renowned Spanish-Mexican chemists

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The focus of this article will be centered on five Spanish chemists who were refugees in Mexico after the Civil War and provided a strong drive in developing Mexican chemistry. Their names are: Antonio Madinaveitia Tabuyo, José Giral Pereira, Modesto Bargalló Ardévol, Francisco Giral González, and José Ignacio Bolívar Goyanes. This article starts with the panorama of science in Europe (mainly Spain) and in Mexico from the end of the 19th Century to the beginning of the 20th century. It is also included the development of chemistry in Germany in the 19th century. The paper includes a short out line of these scientists' work in Europe, as well as focusing on their contributions to the development of Chemistry in Mexico, in the areas of Organic, Inorganic, Physical and Pharmacy. A conclusion is the importance of their contribution to Mexican chemistry through two institutions: the National University and the National Polytechnic Institute.

Keywords: Spanish science, exiled chemists, Mexico's chemistry improvement

> We, the (Spaniard) chemists have found in México, besides a large amount of raw materials to study, a very interesting tradition whether in the ancient indigenous civilization or in the history of its cultural centers. The scientific medium is very similar to ours and we have been able to collaborate in it without difficulty. Antonio Madinaveitia (Giral-González, 1994)

Introduction

Through history we advance through time between oblivion and memory. We start by assuming general ideas at the beginning of the 20th century on the professional activities of chemists within the Spanish and Mexican contexts.

Science in Latin America during the 20th century can be divided into five periods (Vessuri, 1996):

(1) Order and progress: the positive science of the beginning of the 20th century

(2) Developing institutionalization of the experimental sciences (1918-1940)

(3) The development decades (1940-1960)

(4) The era of the scientific policy (1960-1980)

(5) A new audience for the science: the industrial entrepreneurs (1980-2000)

With its particular differences, the presence of European academics in the first three phases had been important for Latin America, particularly for Argentina, Brazil, and Mexico.

The incorporation of the Spanish chemists after the Civil War corresponds to the development phase. So, after the great depression and during the Second World War, Latin America underwent a great deal of industrial growth at the expense of agriculture, with the expansion of the urban nuclei and the improvement of basic education. Local manufacturing of finished products was given priority, substituting the imports, but without a parallel investment in research and national development. In a general and concise way, it may be said that the ascent of a new nationalist middle class enhanced the professionalization and autonomy of the intellectual activities, which materialized with the expansion of the editorial industry. Besides these general features shared by the countries of the region, Mexico also had the incorporation of the Spanish exiles and the creation of new institutions.

The Spanish Civil War was lost for the Republic and thousands of exiles had to leave Spain for political reasons. The Second World War was also taking shape and several countries including Mexico welcomed the refugees. Spanish academics and professionals left a scientific world nourished by the latest advances in their fields and arrived to countries with a lesser advancement. Instead of being paralyzed, or complain of this contrast and apparent backward movement, they devoted themselves to work, whenever and wherever they were useful. This modesty honored even more their solid training and background.

The activities developed by some of the most significant Spanish exiled chemists in Mexico after the Spanish civil war (1936-1939) are presented: Antonio Madinaveitia, José Giral Pereira, Modesto Bargalló Ardévol, Francisco Giral González, and José Ignacio Bolívar Goyanes.

Resilience seems to be a common denominator to this extraordinary group of exiles. They all had the capability to face life's adversities, to overcome them and to be positively transformed by them (Grotberg, 1997). The factors which are considered as the resilience pillars (Melillo, 2004) may be tracked along their lives: self-esteem, introspection, independence, ability to relate with others, initiative, sense of humor, creativity, morality, and critical thinking capability.

Chemistry in Spain during the First Third of the 20th Century

In April 14, 1931, the Second Spanish Republic was proclaimed in a peaceful way as the result of exemplary elections. It substituted the strangled monarchic regime which had been struggling for years to solve the severe economic and social problems of a country politically and scientifically 'peripheral', which relied more on its past glories than on its present achievements.

It wasn't until 1903 when the Spanish Society of Physics and Chemistry was founded. Shortly after, it started the publication of the *Anales* as the means of communication among the Society members. Just for the sake of comparison, the British Royal Society was established in 1841.

To counterbalance this handicap, in 1907 the Ministry of Public Instruction created the "Junta para la Ampliación de Estudios e Investigaciones Científicas" (JAE) [Committee for the Expansion of Scientific Studies and Research] conceived by F. Giner de los Ríos. Its objective was to send young Spaniards to study in other European countries with the purpose of learning how science was conducted in those countries and afterwards return to Spain to start original research at premises created and guaranteed by the Junta. The creation of JAE was decisive for the awakening of the physical-chemical sciences in Spain. The foreign scholarship policy allowed the establishment of the first reliable contacts with international scientific centers.

The regenerationist consciousness is the one that settled the basis for the JAE creation. The colonial crisis in 1898 produced a regenerationist impulse at every Spanish scope.

The boost given by the JAE to Spanish science and the quality of the scientific research was such that around 1930 the project for the "Instituto Nacional de Física y Química" [National Institute of Physics and Chemistry] was developed and the Institute was founded in 1932. The similarities between Spain and Latin-America are obvious.

As a consequence of the military defeat of the Spanish Republic and the renewal of Franco's dictatorship in 1939, an emigration of Spaniards occurred that "[…] entailed the departure towards exile of a substantial part of the Spanish intellectuals and scientists, which constituted an irreparable blow for the expectative of […] establishing a scientific system capable of integrating Spain into the science scene" (Otero-Carvajal, 2001). A great number of these scientists immigrated to Mexico, where public institutions, private industries and universities received them. The Spanish scientists and academics that had to abandon their country brought with them the renovating and creative impetus of Spain.

The Mexican government created "la Casa de España" [the House of Spain], with the purpose of locating the Spanish exiled scientists, to transport them, and to find them a place to carry out their working life in Mexico.

Chemistry in Mexico during the First Third of the 20th Century

Due to its natural resources-silver at one time, petroleum nowadays and always the diversity of its flora-Mexico has a rich history of topics related to chemistry, but not only as a raw materials provider. By the end of the 18th and the beginning of the 19th, awareness of the knowledge being produced existed among Mexican scientists that science was feasible thanks to an institution such as the "Real Seminario de Minería" [the Royal Mining Institute] created in 1792, and presided by Fausto De Elhúyar, the discoverer of Wolframium (today Tungsten) in Spain. There, Andrés Manuel del Río discovered another chemical element (today called vanadium) in 1801. During the 19th century, pharmacology appears as a subject at the 'Establecimiento de Ciencias Médicas' [Medical Sciences Establishment]. In 1843 the syllabus for studying pharmacy was developed, which allowed the formation of a scientific figure as Leopoldo Río de la Loza. He wrote in 1848, when he was only 37 years old, the book *Introducción al estudio de la química* [Introduction to the study of chemistry]. As far as we know, it was the first chemistry book written by a Mexican. Years later he collaborated in the foundation of the "Sociedad Farmacéutica" [Pharmaceutical Society], in charge of editing the Mexican Pharmacopea, which recounts the enormous variety of substances and healing preparations used in the country.

The turbulent 19th century leaded Mexico to begin the 20th with few chemists at university level, a scarce and incipient industry and almost no higher chemical education and research institutions. One of those few chemists and chemical engineers was Juan Salvador Agraz who achieved by 1916 the creation of the "Escuela Nacional de Química Industrial" [National School of Industrial Chemistry]. Soon after was incorporated in 1917 to the National University as "Facultad de Ciencias Quimicas" [School of Chemical Sciences], where the academics and students of pharmacy were also incorporated since 1918. Here, was the beginning of the profession "industrial chemist", later known as "technical chemist" and finally in 1927 "chemical engineer". Estanislao Ramírez, formed at the Sorbone, was at the peak of his career that brought the modernity of the unit operations to the teaching of this discipline in Mexico. He later founded the "Escuela Superior de Ingenierìa Química e Industrias Extractivas" [Chemical Engineering and Extractive Industries Higher School] at the "Instituto Politécnico Nacional" (IPN) [National Polytechnic Institute]. That synthesis of chemistry with two of its most outstanding applications, pharmacy and engineering, has characterized many of the Mexican universities ever since. It was renamed as "Escuela Nacional de Ciencias Químicas" [National School of Chemical Sciences] in the 1930s. In 1965 this school became "Facultad de Quimica" [Faculty of Chemistry] of the National University of Mexico (UNAM).

José Vasconcelos, as UNAM President and afterwards as Public Education Minister, led a project to educate personnel in foreign countries to be later employed to work in Mexico. In 1924 there were 22 recipients of scholarships sent to study chemistry in Europe. Among them was Fernando Orozco, in Germany, who was later to become the Director of the School (between 1935 and 1942) and who opened the doors of the School to the exiled Spanish chemists.

In 1939 Mexico was at a historical, cultural and politically pivotal time. President Cárdenas had founded the National Polytechnic Institute in 1936 and decreed the petroleum expropriation in 1938. The paintings, the music and the films of the time reflect the spirits prevailing in the country. Shortly after, with the beginning of the Second World War, a rapid industrialization process started with the challenge for Mexican professionals and technicians to operate and manage industries, which had been controlled by foreigners up to that time. It was evident that there was a need to create locally relevant research and techniques in order to have the essential tools for the development of the country. There were new buildings and more institutions, however, as ever, insufficient budgets.

The Chemists of the Spanish Exile

The exact number of Spanish chemists that arrived to Mexico is uncertain. Fresco (2001, pp. 57-58) suggests there were about 60, including chemists with a Ph.D. degree, pharmacists, engineers and chemical experts. Some of them were university professors and chemistry researchers that had contributed to the growth of Chemistry in Spain.

It is easy to imagine the feelings of confusion and uncertainty of the exiled Spaniards when they arrived to Mexico. Undoubtedly it was not simple, and the initial employment for the majority of them was decided on the basis of their needs and opportunities. However, in a short time, some of the newly arrived scientists created or collaborated in the creation of several important laboratories. Others found jobs at academic institutions such as UNAM, IPN, El Colegio de Mexico, and other State universities. Some worked for Mexican State industries such as Petróleos Mexicanos [Mexican petroleum industry], Guanos y Fertilizantes de México [Mexican fertilizers], and in other public or private laboratories already existing before their arrival.

These chemists dedicated themselves to scientific and technological research, as well as the creation of companies. All of the activities were orientated from the beginning to the study and resolution of matters necessary and important for Mexico.

Antonio Madinaveitia Tabuyo

His Collaboration with the Mexican Science Community

Antonio San Quintín Madinaveitia Tabuyo was born in Madrid in 1890. Amongst the postulates of the formation of Madinaveitia we must mention the primary influences from the 'Instituto Libre de Enseñanza' [Free Education Institute], an institution created by Francisco Giner de los Ríos and a group of colleagues that was born as a response to the decline of the academic freedom. The education that the students received in these classrooms was liberal, scientific, and critical, as Giner's generation intended to modernize Spain, in the sense of overcoming the scientific backwardness in relation to other European countries. These efforts promoted the creation of diverse academic sites and it was the origin of the development of Spanish education. One of them was the creation in 1900 of scientific research laboratories.

Years later, the first generations that graduated from the Institute were responsible for the impetus of the scientific research in Spain by creating governmental initiatives that promoted academic exchanges as well as scientific production in Spain.

Spanish science began to be disseminated. To promote the publication of studies and research done in Spain, in 1903 the Physics and Chemistry Spanish Society was founded and via the printing of the journal *Anales*, started the configuration of a consolidated scene.

At just 16 years old Antonio, with the support of JAE travelled to the Zurich Polytechnic in Germany.

To understand the nature of the scientific school to which Antonio Madinaveitia belonged, some considerations have to be made:

The philosophical foundations of the epistemology conceived by Hegel;

The origins of the research and instrumentation of the chemical practices among the 19th century German chemists;

Their most representative theme sand study techniques;

The education Madinaveitia received from his advisor Richard Willstätter at the Zurich Polytechnic;

The nature of the research he developed before his arrival to Mexico.

In sum, two main concepts can be discussed as the "pillars" of his school:

The 19th Century German research tradition;

The regeneracionist attitude of the 98 generation had important impact for the development paradigm of the Iberian-American countries.

German Chemistry on the 19th Century

Scientific activity in Germany concerning chemistry during the 19th Century focused on the knowledge and reproduction of the *absolute spirit* of the principles and properties of diverse chemical substances from its natural origin. This will be referred to as 'German scientific school'. As early as 1830, Justus von Liebig received the necessary support to develop a laboratory specialized in chemistry where he was able to devote himself to the analysis of different chemical products, many of them from animal and vegetal origins and with social or economic applications. It is important to highlight the fact that von Liebig, besides having discovered and synthesized substances that are indispensable to the development of the western world (chloral, chloroform, formaldehyde, benzoic acid), developed the basis for practical research in chemistry.

His work resulted in him being considered as the 'father' of organic chemistry. Devoted to form young chemists that arrived from many places, even from foreign countries, and to make them authentic researchers, therefore founding the real scientific teaching of chemistry (Lockemann, 1955). There, with von Liebig, studied Vicente Ortigosa from 1839 to 1842, the first Mexican that got a Ph.D. in Europe (Estrada-Ocampo, 1984), in which he determined the formula of nicotine, the tobacco alkaloid (Chamizo, 1999).

Among the relevant chemists belonging to the same school as von Liebig, we must mention Robert Wilhelm Bunsen, discoverer of cesium (in 1860) and rubidium (in 1861) with Gustav Kirchhoff. Bunsen developed several gas-analytical methods, was a pioneer in photochemistry, and he did early work in the field of organo-arsenic chemistry. Also, Friedrich Wöhler, who accidentally synthesized urea from ammonium cyanatein 1828—synthesis that was a landmark in the history of science which disproved and undermined the Vital Force Theory defended by Berzelius, believed for centuries, by showing that organic compounds could be synthesized from inorganic materials.

There is a direct relationship between von Liebig's school and Madinaveitia; not only through the affinity of their research, but also through his substitutes. Adolf von Bayer, von Liebig's successor in the organic chemistry chair at Munich University, was teacher and precursor of Richard Willstätter whose studies of the structure of plant pigments, including chlorophyll, won him the 1915 Nobel Prize for Chemistry. The latter was Madinavetia's teacher at the Zurich Polytechnic and a very close colleague ever since. Madinaveitia obtained his Ph.D. degree in 1912 and, once back in Spain, got the degree validation by the Spanish academy.

Thus, Madinaveitia was formed within the modern German philosophical and ideological system developed during the first half of the 19th century. On the other hand, also to the framework of the ideological restructuring that occurred in Spain through the so-called 98 Generation.

Impulse to the Spanish Science in the 19th-20th Centuries

The second pillar of Madinaveitia's scientific school is directly related to the regeneration is attitude from the 98 Generation.

Chemistry teaching at the Spanish universities during the 19th century was not as an important priority as it was at French, German or British universities, even though it was included in the curricula of some Spanish scientific centers, at schools such as pharmacy and medicine. During the time of the expansion of the Napoleonic army, chemistry as a subject appeared in some degree courses at the Universities of Madrid and Barcelona (1805).

In 1827 chemistry was considered a subject in courses at the "Real Conservatorio de Artes de Madrid" [Madrid's Royal Conservatory of Arts]. Since 1847, the Central University of Madrid created the field so Natural Sciences and Physical-Mathematics, Ph.D. degrees including chemistry. Almost 25 years after Liebig's laboratory was established, in 1857, the Science Department of the Central University of Madrid in the fields of Physics, Mathematics and Chemistry was formed. At this University the subject of chemical analysis was changed from the doctoral degree to the undergraduate level. It was not until 1922 that the chemistry field of the Science Department became a specialized teaching area.

The political and social situation was an important factor that determined the slow development of the scientific production in Spain. Before the 1868 revolution and, afterwards, during the Monarchy restoration, the Spanish crown hardened its rancid censorship. Nevertheless, during polarization periods, such as the First Republic and the Monarchy restoration, the Spanish university academics were not in different to the social dichotomy. In 1868, academic freedom was obtained, and as a consequence the academics were persecuted after the restoration in 1875. Likewise, during the reign of Alfonso XII a decree was emitted that ordered the university professors to present their syllabus to the Public Instruction Council for its revision and approval. The advancement of Spanish science was constantly threatened by censorship and criticism from the most traditionalists groups that restricted academic freedom. Science in Spain depended on foreign countries, since every technical or theoretical advance was produced outside the country.

By that time, Germany was the nation that had paid the greatest attention to the development of the teaching, communication and application of chemistry.

A great part of the scientific influence that Spain had at the end of the 19th century mainly came from Germany. This influence increased during the restoration time. It explains why Madinaveitia received the influence of the German scientific school from his father, and had a German governess since early childhood. In particular, the "krausism" was a dominant ideology in the modern development to Spain, not because of its specific premises, but because it released the Spanish philosophical thinking from its litany. It meant a complex humanistic movement that reviewed the ideas in every field: social, political, pedagogical, artistic, etc.

The registration through JAE by Antonio Madinaveitia has been documented by Bosch-Giral, 2010 (see illustration 1).


Madinaveitia y Tabuyo
RELACIONES CON ESTA JUNTA
Madinaveitia y Tabuyo
RELACIONES CON ESTA JUNTA

Figure 1. JAE papers of Medinaveitiay Tabuyo (taken from Bosh, 2001).

His Chemistry Work in Spain

In Table 1, Medinaveitia's list of publications on organic chemistry, published before he arrived to Mexico, is shown. The themes clearly illustrate the influence of the two pillars of his scientific school mentioned at the beginning.

Madinaveitia was Doctor Carracido's assistant and got the Organic Chemistry 'cátedra' [Chair] at the Universidad Central de Madrid in 1925, which he held until his exile in 1939. He was the Director of the Organic Chemistry section of the "Instituto Nacional de Física y Química" [National Institute of Physics and Chemistry] of Madrid, where outstanding national and international figures from the scientific field participated. He also developed research projects together with Ernst Fourneau at the Pasteur Institute of Paris.

Antonio Madinaveitia and his Arrival to Mexico

Madinaveitia arrived to Mexico in 1939 and was fostered by "La Casa de España" (The House of Spain), created by Alfonso Reyes and Daniel Cosío Villegas.

Just after his arrival in July he gave several lectures during August and September the same year, among others in the Universities of San Luis Potosí, Jalisco and Michoacán. From this program we can appreciate the themes that Madinaveitia considered important for Mexico's social, biological and economic reality, and on the other hand, those he was very familiar with, belonged to the intellectual German elite previously defined as the 'German scientific school'. Also, he taught courses and gave lectures at the IPN as well as the radio talks called 'Voices from Spain'. He also gave three lectures at the 'Escuela Nacional de Ciencias Químicas' [National

Chemical Sciences School] under the names: Pharmaco-chemistry, Moisturizers and Detergents, and Chain Reactions.

Table 1

Studies Published by Antonio Madinaveitia in Spain (1912-1936)

Title in Spanish	[Translation]	Coauthors (Year)
"Contribución al análisis de las grasas"	[Contribution to the analysis of fatty acids]	(1912)
"Los fermentos oxidantes" Tesis Doctoral	[The oxidizing ferments] Doctoral Thesis	(1913)
"Sobre la acción peroxidante de la cianhematina"	[On the peroxidazing effect of cianhematine]	(1914)
"Sobre la oxidación del nopineno de la esencia de la trementina española"	[On the oxidation of nipinene in the Spanish trementine essence]	(1914)
"Sobre la alcohólisis de los ésteres"	[On the alcoholysis of esters]	(1914)
"Síntesis de una alcalina benzoilada del grupo del canfano"	[Synthesis of a benzoiled alcaline of the group of canfane]	(1914)
"Productos de adición del ácidooxálico"	[Addition products of oxalic acid]	José Sorolla (1916)
"Sobre la separación de la colesterina y la isocolesterina"	[On the separation of cholesterine and isocholesterine]	Ángel González (1916)
"Nota sobrenaftiletilaminas"	[Note on naftilethylamines]	(1918)
"Síntesis con derivadosorganosodiados"	[Synthesis with organo-sodium derivatives]	José Renedo (1918)
"La bromación en α de los aldehídos de la seriegrasa"	[The α-bromation of aldehides on the fatty series]	José Puyal (1918)
	"Derivatives of naphtyl-β-ethylamine"	(1919)
"Síntesis en el núcleo del naftaleno"	[Synthesis in naphtalene kernel]	José Puyal (1919)
"Contribución al estudio de las aminas simpatomiméticas. I. Aminas derivadas del Naftaleno"	[Contribution to the study of sympatomimetic amines I. Amines derived from naphthalene]	(1920)
"Estudio farmacológico de la salicaria"	[Pharmacological study of purple loosestrife]	(1921)
"Sobre oxi-dimetil-bencil-aminas"	[On oxi-dimethyl-bencyl-amines]	(1921)
Síntesis de medicamentos orgánicos. 449 p.	[Synthesis of organic drugs] 449 p.	(1921)
"Sobre el ácido abietínico"	[On abietinic acid]	(1922)
"Estudio de la miera del pino"	[Study of pine oleoresins]	(1922)
"Estudio del pineno del aguarrás español"	[Study of Spanish pinene of turpentine]	(1922)
"La isomería de los ácidos difenil-succínicos"	[Isomery in difenil-succinic acids]	Ignacio Ribas (1925)
"Estudio de la plumbagina"	[A study on plumbagine]	M. Gallego (1928)
"Estudio de algunos derivados de las metal-naftalinas"	[Study on some derivatives of metal-naftalines]	Jesús Sáenz de Buruaga (1929)
"Una lección de espectrografía aplicada a la farmacología"	[One lesson of spectroscopy applied to pharmacology]	(1931)
"Programa de Química Orgánica aplicada a la Farmacia"	[Syllabus of Organic Chemistry applied to Pharmacy]	(1931)
"Desmotropía en el grupo de los fenoles"	[Desmothropy in the phenols group]	(1932)
"Estudio del ácido cinamilideno-malónico decolorado"	[A study on decoloured cinamiliden-malonic acid]	Juan Madinaveitia (1932)
"Separación de dos formas desmótropas en algunos polifenoles derivados de la naftalina"	[Separation of two desmothropycal forms in some polyphenols obtained from naphtaline]	Eladio Olay (1933)
"Investigaciones sobre la química del corcho"	[Research on the chemistry of cork]	Eladio Olay & Tomás Catalán (1935)
"La tautomería de los fenoles en química farmacéutica"	[Tautomery of phenols in pharmaceutical chemistry]	(1935)
"La síntesis química y la defensa nacional"	[Chemical synthesis and national defense]	(1936)

He enrolled to the National School of Chemistry in 1939, and joined with Fernando Orozco, the Director of the School, to ask the Rockefeller Foundation for funding to create the Institute of Chemistry of UNAM, in the same area of the School. The Institute was inaugurated in 1941. Among the studies conducted there by Madinaveitia the most important were those on the composition of the brackish lakes of central Mexico, the catalytic hydrogenation of quinones, the polymerization of anthracene, the wild legumes, pulque [Mexican traditional beberage], the Organo-mercury compounds and Mexican turpentine. Notably, Dr. Madinaveitia became interested in the study and industrial application of natural products of the country that received him. There he tutored outstanding Mexicans that became luminaries in the field of chemistry around the middle of the 20th Century: Octavio Mancera, Jesús Romo Armería, Humberto Estrada, José Iriarte, Alfonso Sandoval and José F. Herrán; almost all of them members of the UNAM Institute of Chemistry.

He also designed processes for the caustic soda industry that used the brackish water of Texcoco Lake:

Sosa Texcoco is one of the most relevant and important activities that the Spanish refugees took part in, and Antonio Madinaveitia played a notorious role there. A Mexican engineer named Hermion Larios had the idea that the salts produced by efflorescence from the soil cleansing of Texcoco Lake could be recuperated. Based on this idea, Madinaveitia, who was a member of the technical staff of 'Sociedad Mexicana de Crédito Industrial' (Somex) [Mexican Society of Industrial Credit], suggested the substitution of the fractioned crystallization process for the addition of carbon dioxide to the brine, that were first concentrated in the solar evaporator named El Caracol [The Snail]. This process allowed the separated carbonate and caustic soda to be obtained and commercialized. When the soil cleaning was suspended a decade later, there was another contribution from Madinaveitiain relation to the utilization of the subsoil brine, which allowed the plant to operate for many more years.

Mexican Disciples: Jesús Romo Armería and Humberto Estrada Ocampo

This acute practical intelligence did not exclude, but was rather supplementary with, his formation, interest and science vocation. Antonio Madinaveitia was also a central figure in what is a magnificent example of the coincidence between needs and wills; of the way the interests of Mexico concurred with those of the scientists expelled from Spain by fascism: the foundation of the Institute of Chemistry of the National University.

All of the above gives sufficient grounds to his contribution to the 'Mexican scientific school' by means of his teachings at the Mexican 'Instituto de Química' [Institute of Chemistry], where two of his most distinguished Mexican pupils were Jesús Romo Armería (León-Olivares, 2007)—born in Aguascalientes and a member of 'El Colegio Nacional', an organization that brings together the most selected Mexican scientists and humanists. The second was Humberto Estrada-Ocampo—born in Toluca and Emeritus Professor of the Universidad Nacional Autónoma de México (Garritz, 2008).

José Giral Pereira

At Sixty Years Old He Arrived to Mexico, but Gave a Lot Yet.

José Giral Pereira was born in Cuba in 1879, when it was still a Spanish colony, and as a young child he was moved to Madrid. He obtained his Bachelor degree in Pharmacology and in Physical and Chemical Sciences (1902); and their respective Ph.D. degrees (1903, 1904) from the University of Madrid. In Spain he developed a diversity of professional activities either as a Pharmacist or as a Chemist. His academic life started as a professor at the same university. In 1905, by competitive examination, he was awarded the Chair of Inorganic Chemistry at the Sciences School of Salamanca University, where a close friendship was born with Miguel de Unamuno, famous President of the University. He moved in 1921 to Madrid to become director of the Chemistry section of the Oceanographic Spanish Institute. There he carried out an intense and varied university and political life, including: professor of Biological Chemistry; permanent State Councilor; deputy at 'Cortes Constituyentes' [Constitutional Courts] in 1931; and in the same year President of the University of Central Madrid and Navy Minister; in 1936, deputy at Cortes, Navy Minister and President of the Ministers Council of the Spanish Republic; and Foreign Business Minister in 1937 (see Figure 2).

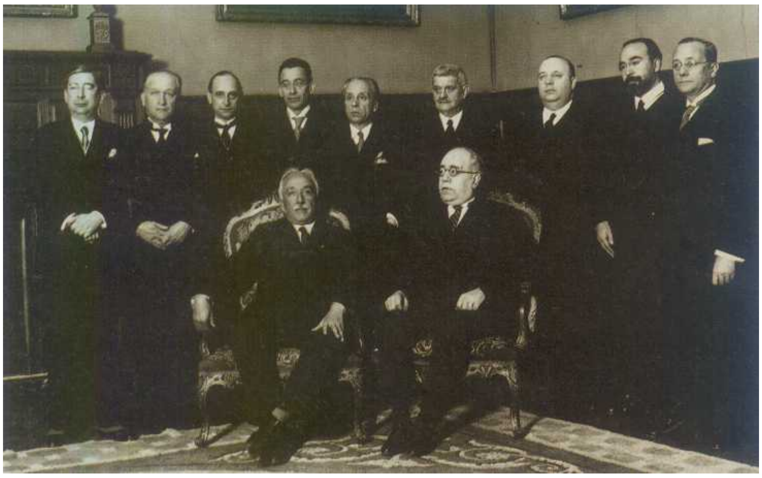

Figure 2. The government of Azaña in 1936. Seated: Niceto Alcalá Zamora and Manuel Azaña. Standing, left to right: Marcelino Domingo Sanjuán, Francisco Largo Caballero, Santiago Casares Quiroga, Luis de Zulueta Escolano, Álvaro de Albornoz, Luis Nicolaud' Olwer, Indalecio Prieto Tuero, Fernando de los Ríos Urruti and José Giral Pereira.

Ignacio Bolívar y Urrutia describes with sobriety, but with all its severity, the feelings regarding the Spanish academic's exile: "To the general problem of reconstructing our private life in exile, we had to add an imperious need. That was for us a sacred duty: to reconstruct our intellectual life". This new beginning must have been twice as hard for those who left behind the work of almost a lifetime. That was the case of José Giral Pereira, who arrived to Mexico when he was sixty years old, at the peak of his professional, political and college achievements; with enough character and energy to rebuild his intellectual life, as Madrazo-Garamendi (1991, head of the Chemistry School at UNAM) points out. His university activity in Spain concluded definitively at the end of the war, only to be resumed in Mexico.

In 1940, immediately after his arrival in Mexico, Jose Giral joined the IPN as professor-researcher in the Biological Sciences and Rural Medicine Schools as a teacher of Biological Chemistry. He remained there for five years, during which he encouraged the magnificent group of researchers including Guillermo Massieu, who years later would be General Director of the institution; Rene Cravioto, who became Food General Director at the Mexican Health Department; Jesus Guzman, who after wards distinguished himself at UNAM's Medical and Chemistry Schools, and at CONACYT [the National Council for Science and Technology], and some other people.

In 1947 Rafael Illescas, Director of UNAM's National Chemistry School, invited Dr. Giral to join as a full time professor. Little is spoken about this, even if it meant at the time an important 'breaking point', since for the first time a full time Chair was created; an issue that provoked serious doubts as this kind of professorship was not completely understood. Nevertheless, it was necessary, and happily it was arranged that Jose Giral could take that chair with his scientific stature, his above average intelligence, his prudence, kindness and sensibility. In 1944 he was also invited by the University of Nuevo Leon (Monterrey) to lead research in food chemistry.

As a consequence of his scientific activities in America, the following Mexican Universities granted him an *honoris causa Ph.D.* or an excellence recognition: Michoacán, Nuevo Leon, Guanajuato y Guadalajara; as well as from other Iberian-American countries: La Habana (Cuba), Puerto Rico, Panama, Central de Venezuela, Nacional de Colombia and Nacional Mayor de San Marcos (Peru).

He published a considerable number of books and original papers. Those related to his work in Mexico appeared mostly in the journal *Ciencia*, where he collaborated at its editorial council from the beginning. The vast work from Jose Giral is impressive. Suffice it to say that that he supervised 150 dissertations, most of the mat UNAM Chemical Sciences School, concerning a wide variety of topics such as Mexican food, natural products, organic and pharmaceutical compounds, chemical, clinical, biochemical and pharmaceutical analysis. "Jose Giral, who had are markable self-taught discipline, formed in our country the first research group in food chemistry […] what is now properly called food science" (Madrazo-Garamendi, 1966, preface). Giral died in 1962.

Modesto Bargalló Ardévol

A Spanish Chemist That Became Mexican by His Books.

Science cannot prosper in a healthy way if it does not first have solid foundations on a quality education. García Camareno (1978, p. 201) says: "[…] of those who were obliged to exile at the end of the war […] an important case because of his dedication to Chemistry didactics and the history of this science is Modesto Bargalló"

Modesto Bargalló Ardévol was born in Sabadell, Cataloniain 1894. He graduated in Spain as teacher in 1911 and with a Ph.D. in natural sciences in 1931 at the 'Universidad de Madrid'. He soon stood out because of his teaching ability. From 1916 to 1938 he published dozens of paper sand essays about pedagogy, didactics and the history of science in journals and books for schools, including the journal *Faraday*, founded by him. He translated several foreign works, such as *Elementos de Química* by Ostwald, or *Química Popular* by Meyer. He collaborated with Ignacio Bolivary Urrutia at the Madrid Natural Sciences Museum. Numerous Spanish libraries keep his written work from before the war, which is composed of diverse books dedicated to support teachers. Table 2 lists some examples.

Table 2

Books Published by Modesto Bargalló in Spain (1919-1934)

Title in Spanish	[Translation]	(Year)
Manual de Química	[Chemistry Handbook]	(1919)
La Vida de las Plantas: Experiencias Sencillas para la Escuela Primaria	[The Life of Plants: Simple Experiments for Elementary School]	(1920)
Cómo se Enseñan las Ciencias Fisicoquímicas	[How to Teach Physicochemical Sciences]	(1923)
Manual de Física	[Physics Handbook]	(1925, 1932)
Metodología de las Ciencias Naturales y de la Agricultura	[Natural Sciences Methodology and Agriculture]	(1932)
La Agricultura en la escuela primaria	[Agriculture in elementary school]	(1934)

He arrived to Mexico in 1939, where he continued his significant activity as a chemistry historian. His studies on pre-Hispanic and Colonial mining and metallurgy are outstanding, and are gathered in his book *La química inorgánica y el beneficio de los metals en Mexico prehispánico y colonial* [Inorganic chemistry and the benefit of the metals in pre-hispanic and colonial Mexico], published by UNAM in 1966. In this book heal so describes metal extraction techniques, among which he points out the Bartolomé de Medina's yard method of cold extraction, by amalgamation with mercury (1555), as the 'best Iberian-American legacy to universal metallurgy'.

He was an inorganic chemistry teacher at IPN since 1940. After more than twenty years of hard work, in 1962 he managed to complete his *Tratado de química inorgánica. Fundamental y sistemática*, [Treatise on Fundamental and Systematic Inorganic Chemistry], with an extension of 1133 pages. In this book, he tackles the most advanced topics of inorganic structural chemistry. Bargalló must be considered one of the pioneers of the modern structural chemistry teaching, and of Pauling's ideas about chemical bonding. He collaborated with many diverse Mexican and Spanish exiled chemists who helped him with the writing of several chapters. This work is a milest one of inorganic chemistry written in Mexico.

Other books he published in Mexico are shown in Table 3.

Table 3

Books Published by Modesto Bargalló in Mexico (1940-1969)

Title in Spanish	[Translation]	(Year)
La física en la escuela primaria	[Physics in primary school]	1940
La minería y la metalurgia en la América española durante la época colonial	[Mining and metallurgy in the Spanish America during the colonial era]	1955
Curso de Química General	[Course on General Chemistry]	1958
Curso de química descriptiva (Inorgánica y orgánica)	[Course on Descriptive Chemistry (Inorganic and Organic)]	1959
Tratado de Química Inorgánica	[Treatise on Inorganic Chemistry]	1962
Las ferrerías de los primeros veinticinco años del México independiente y la contribución de Lucas Alamán	[Iron and Steel Industry in the First Twenty Five Years of Independent Mexico and Lucas Alamán's Contribution]	1965
La amalgamación de los minerales de plata en Hispano-América colonial	[Amalgamation of silver minerals in the colonial Spanish-America]	1969

Modesto Bargalló always defended the name *erythronium* instead of *vanadium* for the chemical element discovered in Mexico by Andrés Manuel del Río.

When he received recognition in 1968 from the Sociedad Química de Mexico (see Figure 3) he said:

Figure3. Modesto Bargallo Ardevol receiving an acknowledgment by Guillermo Cortina Anciola, president of the Mexican Chemical Society in 1968.

> The Diploma […] is in a place of honor in my office, because it is an accurate example of the kindness, gentleness and benevolence of my Mexican colleagues towards an old Spanish teacher who has no other merit than having fulfilled his duties with teaching and with Mexico, a country which is in his heart and generously has given him shelter for almost three decades. (Bargalló, 1968)

Another great recognition he received was the "Dexter Award for Outstanding Achievement in the History of Chemistry" given by the American Chemical Society in 1977.

Modesto Bargalló died in Mexico in 1981.

Francisco Giral González

He is Another Example of Personal Commitment.

Francisco Giral González, the son of José Giral, was born in Salamanca in 1911. Besides the familiar examples, the scientific profile of Francisco Giral was formed thanks to teachers like Miguel Catalán, who in the baccalaureate introduced him to chemistry and physics. Enrique Moles was his teacher of inorganic chemistry, and Antonio Madinaveitia, director of his professional dissertation. Giral got his two Ph. D. degrees, in pharmacology and in chemical sciences, at the Universidad Central de Madrid. He completed his education during a postgraduate stay at Heidelberg, Germany. He got there following the counsel of the famous teacher of Madinaveitia, Richard Willstäter, who had recommended him with his youngest pupil, Richard Kuhn, later Nobel Prize in 1939. Along with Kuhn, Giral published several works, between 1933 and 1935, in Spanish and German scientific journals. This period of his academic life was, without doubt, crucial for his career as a researcher. When he had to leave his country, he was the youngest Spanish professor and was at the beginning of his scientific life.

His first years in Mexico coincided with the beginning of the campaign against malaria, one of the most important carried out in the field of public health. At the time, Dr. Giral held the post of director of the laboratory of synthetic anti-malaria treatment and was in charge of manufacturing the necessary drugs. Those were the hard times of the Second World War and "[…] pharmaceutical industry, as other industries, that had German capital or patents, were confiscated by the Mexican government and the company "Industria Nacional Química-Farmacéutica" [National Chemical-Pharmaceutical Industry] was created. From 1949 to 1955, he was appointed founding director of the central research laboratory. Dr. Giral was also manager and technical director of "Química Shering Mexicana". In these laboratories he carried out research on steroids which was mainly focused on competitive methods to industrialize the steroid sapogenine" (Espejo, 1991). He was the principal chemist of "Laboratorios Hormona" [Hormone Laboratories], where he conducted, for the first time in Mexico, the manufacturing of neosalvarsan, among other arsenic compounds, from synthetic drugs such as prontosil and the synthesis of some sexual hormones.

His activities at Pemex, at the "Instituto de Salubridady Enfermedades Tropicales" [Health and Tropical Diseases Institute], and within the pharmaceutical industry did not separate him from Mexican academic life. By 1940 he was already profess or at UNAM's School of Chemical Sciences. He took it on as a fulltime position in 1965 and created the postgraduate studies in chemical-pharmaceutical sciences. He is, without doubt, the most prolific of the exiled Spanish chemists. It is impossible to review his vast body of work here. However, to highlight some of his major achievements: he directed around 200 dissertations (undergraduate, masters and doctorate); published over a hundred scientific papers related with topics such as phyto-chemistry, steroids, anti-malaria drugs, vitamins, animal and vegetal fat chemistry, and insect chemistry, among others.

Additionally he published close to 200 articles and leaf lets dedicated to communicate, discuss and propagate the teaching of chemistry, natural products, food, and the history of chemistry and of pharmacology. He was author of more than a dozen books and translated texts that, due to its importance, have become classics. Among the most outstanding distinctions he received during his academic and professional performance are his appointment as emeritus professor in UNAM; his *honoris causa* Ph.D.'s from UNAM, La Habana, Lima, Caracas and Sao Paulo Universities; his national awards "Leopoldo Río de la Loza" in pharmaceutical sciences, "Andres Manuel del Río" in chemistry, "Martín de la Cruz" from the Health Ministry and the award "Universidad Nacional". He was also advisor to the United Nations Organization for Education, Science and Culture and to the World Health Organization.

Being a fundamental figure in the development to pharmaceutical sciences in Mexico, and a man of profound convictions, Giral returned to Spain after democracy was reinstalled in order to regain the Chair that was snatched out of his hands in 1939 (Giral-González, 1980). Afterwards, he came back to Mexico to continue his productive academic job until his death in 2002. If there cognitions he received are numerous and well deserved, may be the worthiest is that acknowledged by his countless pupils on the quality and virtues of his teaching. One of them, Jaime Kravzov (1996), says:

> That quality is a synthesis of generosity, wisdom and extended criteria, capable of transmitting on to those around him the passion for knowledge, that makes them interested in the path of knowing, giving continuity to his search for a more humane application of science […]. We, his pupils, recognize that Dr. Giral, besides his pharmaceutical teachings, knew how to instill in us the love for science, the commitment to truth, an unyielding ethics in the face of our discipline and the inevitable duty to fight for a fairer world for all. (p. 97)

José Ignacio Bolivar Goyanes

A Young Exile but a Great Chemistry Writing Promoter.

Among the chemical disciplines, the pharmacists were the larger group and many exiles worked in laboratories already established or that were already founded. Laboratories such as "Laboratorios Labys", "Laboratorios Kriya" or "Industrias Químico-Farmaceúticas Americanas", created by the Comité Técnico de Ayuda a los Refugiados Españoles [The Technical Committee to Help Spanish Refugees]. It is worth noting the case of a laboratory that opened its doors to the professional exiles "Laboratorio Zapata". There, under the leadership of José Ignacio Bolivar Goyanes, a fruitful collaboration between research and production was achieved. In the words of Bolivar: "The laboratory is small, in comparison with the total volume of the industry production, but it has prestige. It keeps developing new ideas. Everything is done in collaboration with the National University (UNAM) […]". With this view and the dedication of distinguished exiles it was possible to start in the 1940s the production of immune serum and vaccines that were not manufactured in Mexico until then. Years later, this spirit survives and the laboratory makes incursions into biotechnological production with genetically modified organisms.

In 1956 the "Sociedad Química de México" [Mexican Chemical Society] was created (more than half a century later than in Spain). It groups the chemistry professionals and other scientists related to chemistry. Several years after its creation, during the inauguration of the III Mexican Congress on Pure and Applied Chemistry, the President of the Society said:

> Today we can be gathered thanks to the job started by a group of professionals 12 years ago, which, with great effort, achieved the high prestige this Society has. Their names are: Rafael Illiescas Frisbie, Alfredo Sánchez Marroquín,

Adalberto Tirado Arróyave, Manuel Madrazo Garamendi, Santos Amaro y José Ignacio Bolívar (Cortina-Anciola, 1968, p. 134).

José Ignacio Bolívar Goyanes is one of the young people who was exiled during their adolescence and ended their formation in Mexico, giving the country the best of his work. He was born in Madrid in 1924; he was only 15 years old when he arrived to Mexico, where he studied chemistry at UNAM. He got his Bachelor degree in 1946 and went to the Harvard Medical School to study a specialty in protein chemistry and electrophoresis, getting his diploma in 1947. Since he returned to Mexico in 1948, he was a teacher at the National School of Chemical Sciences. He became a member of the editorial board of the journal *Ciencia* since 1945; the same year he published in it a paper called "Nueva forma de clasificaciónperiódica de los elementos" [New way of classifying elements periodically], when he was only 21 years old.

José Ignacio Bolívar Goyanes was appointed president of the 'Federación Latinoamericana de la Industria Farmaceútica' [Latin-American Pharmaceutical Industry Federation] in 1965, during the times of establishment of Mexican scientific policy. The next year he became the director of 'Laboratorios Zapata' where he implemented techniques to commercially produce a serum against diphtheria and tetanus, for the first time in Mexico. Between 1965 and 1975 he created and directed the journal *Revista de la Sociedad Química de México*, which now is almost fifty years old and has a new name: *Journal of the Mexican Chemical Society*. Likewise, he directed between 1966 and 1974 the *Revista Iberoamericana de Educación Química*, [Iberian-American Journal of Chemical Education] that later was discontinued for some time until it reappeared under the name *Educación Química* in 1989. He was a founder of the 'Federación Latinoamericana de Asociaciones Químicas' [Iberian-American Chemistry Societies Federation] and held the Mexican representation from 1962 to 1968. The 'Sociedad Química de México' granted him in 1967 the National Chemistry Award 'Andres Manuel del Rio'. He was the organizer of the First North America Chemistry Congress, which took place in Mexico in 1975. He died in 1982.

Conclusions

Going back to what was said in the start of the introduction, we move through time between oblivion and memory, in this case, mainly the collective. Therefore:

> The history of chemistry is the history of the men and the women who look for understanding and modifying the world. A part of that history is also today our history. To know their successes will allow us, perhaps, to avoid their failures. (Chamizo, 2004, p. 165)

Xavier Polanco (1986) has coined the provoking expression 'Fuga interior de cerebros' [internal brain drain] to refer to the posture adopted by many Iberian-American scientists who, without leaving their countries, direct their work towards the kind of science that obeys the reward systems of developed countries. It is the voluntary and professional subordination, the 'intellectual exile'. Paradoxically, the five Spaniards we have briefly depicted and that represent several generations of exiles devoted themselves to the double task of rebelling, in the first place against fascism that expelled from their country, and in the second against the intellectual comfort (Their ages when they arrived to Mexico were: José Giral, 60 years; Modesto Bargalló, 55 years; Antonio Madinaveitia, 49 years; Francisco Giral, 28 years; and José Ignacio Bolivar, 15 years.). This attitude allowed them to evolve and develop the vast field of chemistry that from the research, the education and the industry (chemical and editorial) now is Mexican.

For that reason, we cannot avoid comparing the situation of the Spanish exiles in Mexico with the sad experience that had Enrique Moles, the most distinguished Spanish chemist of his time. Moles exiled to France and later returned to Spain in 1941. He was then imprisoned by the Franco regime for two years, and was stripped of his positions and properties, and finally died in 1953.

Exiled Spanish chemists, as the vast majority of people who accompanied them—with their generational differences, had the extraordinary opportunity to belong to several worlds within their own life, from the most influential to the humblest, by creating institutions, translating books, or teaching. We remember them by an anonymous and forgotten job that we want to highlight here: in post-revolutionary Mexico and during the development decades. The exiled chemists left a mark due to their tragedy and their hope in the future.

To end with this reflection, here are the words of Francisco Giral:

> Spaniards worked mixed with Mexicans. It has to be emphasized that they were important not because they had done great things nor great contributions, but because they were pieces of work that provided small things. But supporting Mexican groups, great things were achieved. (Maya-Nava, 1982)

To end this paper here is a short quotation of acknowledgment from Madinaveitia to (at the time) Mexican President Cárdenas:

> I am pleased to express to the general D. Lázaro Cárdenas my deep gratitude, as a Spanish academic, for the deference to bring us to work in this country of brothers; giving us the chance to escape the horrors of Europe, where all scientific research is currently impossible. Antonio Madinaveitia (Giral-González, 1994, p. 316)

What luck for the country that welcomed them!

What a loss for the one that let them go!

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