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The impact of chemistry in Catalonia's industrial development during the 20th century

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Introduction

Catalonia is a country with practically no raw materials. It also has little water and few energy resources. By definition, chemistry is the science that studies the transformation of materials, and the chemical industry needs enormous quantities of energy and water to efficiently and safely carry out those transformations. The great chemical industry of Europe developed along the basins of the mighty Rhine, Rhone, and Meuse Rivers, among others, all of which had both natural and energetic (iron and coal) materials in abundance. Our country does not share the characteristics of the Black Forest, North Rhine-Westphalia, Rhône-Alpes, Belgium, etc. Unfortunately, neither have we had academic and university systems worthy of consideration, nor have we been a people known for its research. It is thus an even greater paradox that nearly 50% of Spain's chemical industry production is based in Catalonia. With few coal mines, no petroleum or natural gas beds, few or nearly no metals—such as iron, copper, aluminum, zinc, nickel, or tungsten—and relatively shallow rivers (except the Ebro), it is hard to comprehend how a powerful industry was able to develop in Catalonia, one that was able to provide basic chemicals and to carry out their transformations. Beyond the entrepreneurial nature of the Catalan people and the help of the foreigners who settled in our country, the deeper reasons for this paradox remain to be ascertained. A rigorous analysis has yet to address this historical development, and perhaps such studies are still premature. Instead, this review provides an account of the facts and is not intended as historical research; as such, it does not aspire to solve this paradox.

Chemical industry

The first factor to be considered in the development of Catalan chemical production is the exploitation of water and the use of falling water as a source of primary energy. The Catalan forge is the most compelling example. Despite meager coal and iron availability, a significant metallurgic industry became established in the country. Its growth paralleled that of the textile industry, which in turn, was a second driving factor. Obviously, the chemical industry of Catalonia cannot be compared with Basque ferrous metallurgy, but it does constitute the basis for the industrial network in our country. Here, the first Industrial Revolution of the 19th century had a significant mechanical element but very few chemical contributions, unlike in the rest of Europe where, during the second half of the century, a very important fraction of the economic growth consisted of chemistry-related industries. And yet these two sectors, metallurgy and textiles—along with others, including leather, construction, and those related to life sciences, such as agriculture, hygiene and health—would drive the need for chemical products. Of particular interest were inorganic compounds, such as hydrochloric, sulfuric and nitric acids; alkalis, such as soda (sodium carbonate), caustic soda (sodium hydroxide), lime; ammonia; products related to leather tanning (chromate, dichromate); and organic compounds (benzene, toluene, naphthalene, aniline, pyridine, toluidine, sulfonic acid, ethanol, methanol, ether, diethyl ether, etc.). With these products, the demands of the dye, soap, glass, construction, pharmaceutical and explosives industries, among others, could be met.

Despite the vicissitudes arising over the course of the 20th century (grave socio-economic conflicts, World Wars I and II, the Spanish Civil War, dictatorial and centralist politics) and the massive changes that occurred as coal was largely replaced by petroleum as an energetic and organic material source, in Catalonia, the chemical industry and its related sectors were consistently at the leading edge of development and innovation. Together, they consolidated an important business network of small, medium, and large companies, as dynamic and diversified as it was complementary and efficient. Today, the chemical activity of those companies based in Catalonia, according to the *Federació Catalana del Sector Químic* (Catalan Chemical Industry Federation, FedeQuim), is 50% of the total in Spain. The value of the chemical sector's production for the Spanish state is approximately 40 billion euros, 40% of which are accounted for by basic chemistry (organic and inorganic, industrial gasses, raw materials, synthetic rubber, artificial fibers, fertilizers, colorants, and pigments), 27% by chemicals related to human, animal, and agricultural health (raw materials for pharmaceuticals, specialized zoosanitary and phytosanitary products), and 33% by industrial chemicals and those targeted for consumer use (paints, dyes, enamels, adhesives, oils, explosives, detergents, soaps, perfumery and cosmetics). In terms of turnover, this means that the activity in Catalonia is superior to that in several European Union member states, such as Austria, Denmark, Greece, Portugal, Finland, and even Sweden.

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In the first third of the 20th century, diverse companies that met the growing need for chemical products were already established and as such made importation unnecessary. In the following discussion, many of these emblematic and paradigmatic companies in the industrial development of Catalonia are mentioned, some in detail.

Perhaps the most important of these companies was the *Societat d'Explotació de les Mines de Sal de Cardona i Súria* (Corporation for the Exploitation of the Salt Mines of Cardona and Súria), a major supplier of raw materials. Its mines exploit one of the few treasures contained in the Catalan subsoil, providing not only sodium chloride (the basis for chlorine, hydrochloric acid, and sodium hydroxide production) but also potassium chloride (the basis for potassium hydroxide and potassium fertilizers). The mines of Cardona are currently inactive, although those in Súria are still being worked.

The Cros Corporation is the oldest chemical company in Catalonia. Founded in 1817 by François Cros, the company was established in Sants (Barcelona). *Francesc Cros i Companyia* initially produced aqua fortis (nitric acid), various copperas (e.g., ferrous, zinc, and copper sulfates), and tin chloride. When Francesc Cros died (1831), the business was handed down to his sons under the trade name *Joan Timoleont Cros i Germans* and the manufacture of sulfuric acid and hydrochloric acid was added while production of the above-mentioned compounds was continued. The factory's move to Badalona took place in 1878 and by 1896, under the aegis of Amadeu Cros, the company entered into the fertilizer business while concurrently expanding production throughout Spain. In 1904, this family business became *Sociedad Anónima Cros* (Cros Corporation), which undertook the construction of new factories that increased both the presence of Cros products in Spain's main agricultural areas and overall production. In the early 20th century, an era of expansion took place throughout Spain in which the chemical industry focused mainly on fertilizers, especially superphosphates.

The Cros Corporation would undergo various changes during the second half of the 20th century. In 1969, the Di Mora Livanos (Italian-Greek) holding company bought ~30% of its capital, later acquired by *Banco Santander* (Santander Bank) which became the primary shareholder in the corporation. In 1982, Torras Hostench, under the control of the KIO group, bought 15% of Banco Santander's capital, which reduced the bank's participation. Later, in 1986, Banco Santander sold the remainder of its shares to Torras Hostench. Two years later, in 1988, Rio Tinto Explosives and Cros Corporation agreed to a merger, thus creating the present-day Ercros, with its affiliated companies Amoníaco de Tarragona, S.A. (ATSA); Asociación Flix-Coquisa, S.L.; Sociedad Electro-Química de Flix; Cloratita, S.A.; Comercial de Productos Agrícolas, S.A. (COPRA); Cros Pinturas, S.A.; Distribuidora Doctor Andreu, S.A. (DISDASA); Electro Metalúrgica del Ebro, S.A. (EMESA); Hoechst Ibérica, S.A.; Industrial Química de Zaragoza, S.A. (IQZ); Industrias Químicas de Tarragona, S.A. (INQUITASA); Lisac, S.A.; Primma, S.A.; Prodecros, S.A.; Productos Químicos Ibéricos, S.A.; Química Mediterránea, S.A. (QUIMESA); Servicios Auxiliares Tarraco, S.A.; Sintesa, S.A.; Transportes, Aduanas y Consignaciones, S.A. (TAC); and Grupo Derivados Forestales, S.A. Among these companies, the electrochemical company Flix is particularly noteworthy as a pioneer in the hydroelectric exploitation of sodium chloride in order to produce basic inorganic substances and in its applications for obtaining chlorine-based solvents. Curiously, Flix is one of the few electrochemical companies situated on the great Ebro River, although it has been joined in Tortosa by others.

The basic organic compounds from the dry distillation of coal at the *Catalana de Gas* (originally Gas Lebon) in Barceloneta provided Barcelona with gas (a mixture of carbon monoxide, hydrogen, and simple alkanes) for home gas ranges and lighting. This distillation also yielded ammonia, benzene, toluene, xylene, naphthalene, phenol, cresol, pyridine, etc. With the commercialization of natural gas imported from Algeria, *Catalana de Gas* went from being a chemical company to an energy company.

At the end of the 19th century and during the first half of the 20th, aromatic chemistry—or one based on benzene—made up the foundation for obtaining colorants and explosives. In fact, through the nitration of benzene, for example, nitrobenzene was obtained, which could then be reduced to yield aniline, a substance that (among others) is indispensable for the synthesis of azo dyes. The nitration of toluene gave off trinitrotoluene (TNT), which for the most part substituted for nitroglycerine (dynamite).

The supplying of charcoal, necessary for obtaining carbon disulfide and indispensable as a solvent in the manufacture of artificial silk (viscose) from cellulose fell to the *Derivats Forestals de Sant Celoni* company. Charcoal was obtained from the dry distillation of wood (coming mostly from ground clearing of the woods in Montseny, Montnegre, and other regions), which also resulted in pyroligneous acid, an aqueous distillate made up of 2—3% methanol, 7—9% acetic acid, ~0.5% acetone, and the wood tar used to prepare antiseptics and disinfectants. The company was able to adapt to the times, eventually importing methanol, which was efficiently oxidized to formaldehyde, obtained as a highly concentrated formol. This latter was key in developing urea-formaldehyde and melamine-formaldehyde resins—essential adhesives for manufacturing agglomerated and laminated wood. The know-how for this transformation was sold all over the world under the business acumen of Dr. Pere Mir and the technical skill of Drs. Marcel Ciutat and Lluís Eek. All three were disciples of Professor Buscarons (see below).

Throughout its history, Catalonia has attracted foreign investors and capital, both of which have been crucial in its industrial development. The chemical sector is a good example, as evidenced by the establishment of German, Belgian, Dutch, and British companies such as Bayer, Solvay, Akzo-Nobel, and ICI.

Bayer took root in Barcelona in both the pharmaceutical field as well as in the production of dyes. During the era of the dictatorial autocracy, the Catalonian sister company to IG Farbenindustrie AG, which encompassed BASF, Bayer, and Hoechst, was called Unicolor and it competed with the autochthonous *Fabricación de Colorantes y Explosivos* (FNCE) that

was based in Sant Adrià. Later on, Unicolor would be divided among those three German companies and all of them would contribute to establishing the petrochemical industrial park in Tarragona.

Belgium was represented by Solvay, which was located in Martorell (chlorine, vinyl chloride, etc.), while the Dutch Akzo-Nobel would merge with La Seda, initially a producer of viscose and rayon from cellulose through the xanthate method. The British company ICI is also represented in Catalonia through ICI España, ICI Paints España, and Astra-Zeneca.

Finally, through the Ensesa family of companies in Girona, Catalonia has become one of the world's leading producers of tartaric acid, synthesized from the by-products of winemaking.

The paint sector has also contributed significantly to the industrial development of Catalonia, although it may seem that paints have little to do with chemistry since they are a mixture or formulation of previously synthesized or manufactured products (pigments, dyes, impregnations, unsaturated oils, solvents, etc.). However, the paint industry and its subsidiary industries have provided basic materials. Titan, Valentine, Lacas, and Pinturas, S.A. (LIPSA) —the latter located in Benicarló— are points of reference in this sector. In the second half of the 20th century, and with the development of polymer impregnations (polyesters, polyurethanes, etc.), the paint industry experienced a robust resurgence.

The pharmaceutical industry is firmly established in Catalonia as well and represents approximately 50% of the economic volume of this sector within Spain. There are two types: the pharmaceutical laboratories themselves, dedicated mainly to chemical and pharmacological research in terms of galenic formulation and the elaboration, packaging, sale, and distribution of drugs, and the factories where the active ingredients are produced. The greater part of both industries is located in Barcelona and its surroundings (L'Hospitalet de Llobregat, Sant Just Desvern, Sant Fost de Campsentelles, la Llagosta, Montmeló, Mollet del Vallès, Malgrat de Mar, etc.) and in the area around Girona (Celrà).

The beginning of the pharmaceutical industry was domestic, for example Laboratoris Doctor Andreu, pioneers in the production of sulfamides; Laboratoris Doctor Esteve, producing hemostatics; and Laboratoris Uriach, important manufacturers of Biodramina and nitrofurantoin. However, as noted above, foreign capital also made its contribution, for example, Bayer AG (aspirin) and Sandoz (ergot alkaloid). This network would expand rapidly during the second half of the 20th century, with laboratories backed by domestic capital, such as Almirall (later Almirall-Prodesfarma), Cusí, Farma-Lepori, Ferrer, Fides, Gelos, Hosbon, Huber, Inibsa, Lacer, Lasa, Leti-Uquifa, Salvat, and Vita, and those backed by foreign capital, such as Astra, Boehringer Ingelheim, Ciba-Geigy, Hoechst, Madaus Cerafarm, Menarini, Merck, Solvay-Pharma, and Zambon.

Two clearly defined eras can be identified in the evolution of the pharmaceutical industry. The first was before the Spanish Civil War and coincided with the development of sulfamides, the first tuberculosis treatments (PAS and isoniazides), and analgesics. These compounds were produced by a fairly important domestic pharmaceutical industry along with the establishment of foreign companies, the latter almost exclusively in Catalonia. The second was during Franco's dictatorship and coincided with the discovery of modern antibiotics (penicillin, streptomycin, tetracyclines, etc.) and with an inrush of foreign companies, mainly from North America, to Madrid and surrounding areas. Today's map also reflects this dichotomy with respect to fine-chemical production in the areas surrounding Barcelona (Esteve Química, Urquima, Uquifa, Farmhispania, Menadiona, Medichem, etc.) and Madrid-Alcalá de Henares (Química Sintética), and in the northern part of the peninsula (Cantabria, Bilbao, Asturias). This is, however, a fluctuating field market-wise, given the constant mergers and amalgamations between pharmaceutical companies and their divisions.

Another important organic chemistry sector in Catalonia is the flavor and fragrance subsector, involved in the manufacture of perfumery and foodstuffs. Domestic-capital companies that are producers of basic substances (Lucta, Daksa) and those that formulate perfumes and flavorings (Myrurgia, Puig, Legrain, Agrolimen-Gallina Blanca, etc.) have likewise joined with foreign-capital companies (Givaudan, Firmenick, Nestlé, Kao Corporation, Fragrance Science, S.L., etc.).

The pesticides and herbicides industry should also be taken into account. The production of pesticides, and especially insecticides, is closely linked to the chlorine industry inasmuch as the first-generation insecticides were chlorine-based (DDT, lindane, etc.). Since Catalonia is a significant producer of chlorine, (Electroquímica de Flix, Solvay, Aragonesas, etc.), it was logical that companies dedicated to the production of these insecticides (Cruz Verde, Industrias AC Marca, etc.) would develop here. Once the damaging effects of these chlorine-based insecticides on the environment were recognized, many of these companies redirected their business toward second-generation pesticides, including organophosphates, and even toward more ecological methods, such as sexual attraction pheromones (used, for example, on the processionary, a pest that frequently invades our pine and fir forests).

Finally, a brief discussion of the plastics industry is required. This enormous sector includes the manufacture of monomers and polymers, polymerization, polymer formulation, and the actual transformation into a finished product (with all the dependent industries: additives, plasticizers, colorants, etc.). Thus, the plastics industry comprises large manufacturing companies, i.e., those that create basic substances (ethylene, propylene, butadiene, vinyl chloride, styrene, acrylonitrile, diisocyanates, etc.), as well as companies dedicated to polymerization and formulation and those dedicated to transformations resulting in the manufacture of elastomers or final products. To mention all these companies' names would be an endless task, but it should be noted that this sector gave birth to the petrochemical industry in Tarragona.

In terms of subsectors, the main activity is basic chemistry, whose specific contribution accounts for approximately 48% of production. The importance of the Catalan basic chemistry sector within the Spanish sector is currently around 60%, and is thus even greater than the sum of the remaining parts. The significance of other subsectors, e.g., fine chemistry, which is 66% of the Spanish total, is likewise also noteworthy. These

numbers reflect the concentration of the chemical sector in the area surrounding Tarragona, whose petrochemical park is considered one of the main centers of the chemical industry in southern Europe. In the Tarragona area alone, 47 companies generate 4900 jobs directly and 25,000 jobs that are indirectly associated. These companies have a production capacity of nearly 18,300 metric tons per year, with an annual gross income of 5.6 billion Euros and making up some 25% of Spanish chemical production. The largest companies in this park are Grup BASF, Dow Chemical Ibérica, Ercros Tarragona, Lanxess Chemicals, Repsol Química, and Bayer Hispania Industrial.

Such a strong and powerful industrial presence—geographically embedded mainly in a 50-km radius around Barcelona, as well as in the city of Tarragona, in Tortosa, Flix, and the city of Girona and in regions on the border of Catalonia (Vinaròs, Benicarló, Monsó)—would not have been possible were it not for an academic foundation upon which the teaching of chemistry and chemical engineering gradually developed. Paradoxically, however, this foundation was neither strong nor powerful, at least not in the 19th century nor at the beginning of the 20th.

Basic and applied research

Academic development in chemistry in Catalonia has a long history of struggle. The University of Barcelona was essentially abolished and moved to Cervera after the defeat of 1714, while all other university studies were eliminated, including at the Estudis Generals de Lleida and at other university institutions, even those that were not a wellspring of the scientific and innovative ideas originating in the European Enlightenment. The teaching and introduction of new chemistry, that is, an experimental science based on qualitative and quantitative analyses, in contrast to older approaches and to the practice of chemistry, was to be found at the *Junta de Comerç* (Board of Trade), the *Reial Acadèmia de Ciències i Arts de Barcelona* (Royal Academy of Sciences and Arts of Barcelona), and the *Escola Industrial de Can Batlló* (Can Battló Industrial School). However, it was only during the 20th century that chemistry and chemical engineering studies were cultivated and, indeed, standardized, in the Science Department of the since restored University of Barcelona, in the *Escola Superior d'Enginyers Industrials* (Superior School of Industrial Engineers), on Comte d'Urgell Street (along with the *Laboratori d'Estudis Superiors de Química*, Laboratory of Superior Studies of Chemistry), and at the Sarrià Chemical Institute (IQS). These institutions comprised a professional cohort that would infuse related industries with knowledge, wisdom, and the fruits of its efforts. If academic chemistry did not partake in fundamental research, as we will see further on, at least it was able to convey the advances of modern science that were taking place in European universities.

From the last few decades of the 18th century onward, the commercial leadership of the *Junta de Comerç*, a board specific to Barcelona within the Spanish organization of the *Junta General de Comercio y Moneda*, allowed for the founding of an important network of technical teaching, with the direct involvement of manufacturers and businessmen. The *Junta de Comerç* sought a better technical qualification for its new industrial workers, a progressive application of the new science, and the internationalization of the new technologies.

In Barcelona, no *Sociedad Económica de Amigos del País* (Economic Society of the Friends of the Country) existed. The central Protomedicate, which standardized the medical profession, was opposed to the education of Catalan doctors in the universities at Huesca, Montpellier, and Toulouse, and, during the second half of the 18th century, at the *Col·legi de Cirurgia* (College of Surgery) and the *Acadèmia Medicopràctica de Barcelona* (Academy of Practical Medicine of Barcelona).

The *Reial Acadèmia de Ciències i Arts* de Barcelona was founded by Charles III in 1764 as the *Conferencia Físico-Matemática Experimental* (Experimental Physical-Mathematical Lecture) and shortly thereafter became the *Real Academia de Ciencias Naturales y Artes de Barcelona* (Royal Academy of Natural Sciences and Arts of Barcelona), a century after the Royal Society of London and the Académie des Sciences of Paris were founded. Both institutions were a kind of university of the sciences that made up for the lack of university studies of this type. A detailed study of experimental sciences in Catalonia in the last 250 years is beyond the scope of this review but they have been well documented in several works of the *Societat Catalana d'Història de la Ciència i de la Tècnica* (Catalan Society of the History of Science and Technology), an affiliate of the Institute for Catalan Studies, in such books as *La Reial Acadèmia de Ciències i Arts de Barcelona als segles XVIII i XIX: història, ciència i societat*, by Agustí Nieto and Antoni Roca. Both *Junta de Comerç* and *Reial Acadèmia* institutions cooperated closely, especially in terms of what is nowadays referred to as science communication, as shown, for example, by the pneumatic experiments for atmospheric air analysis of Professor Antoni Martí i Franquès and by the public chemistry exercises led by Francesc Carbonell, Professor and Director of the *Escola de Química de la Junta de Comerç* (Chemistry School of the Board of Commerce). These and other, similar initiatives continued through the 18th and 19th centuries, confirming the new chemistry's rapid entrance into Catalonia due to individual and associative entrepreneurial efforts unrelated to university life. Another account of the development of chemistry studies in Catalonia up until the year 1950 is that of Josep Pascual Vila, in his inaugural speech from the academic year 1951—1952, "La química en la Facultad de Ciencias de Barcelona (Chemistry in the Faculty of Sciences of Barcelona.)"

Despite the University's return to Barcelona in 1837, it was not until 1845, following Pedro José Pidal's syllabus (for general chemistry), the first of its kind in the contemporary era, that a Chemistry Department was founded. It was supervised by Joan Agell i Torrents, who had been trained at the l'Escola de la Llotja de la Junta de Comerç and, indeed, was better known for his knowledge of electricity than for chemistry. According to Eduard Fontseré, "Agell was the man who knew the most about electricity in all of Barcelona." His scientific works prove this to be the case. He died in 1868, eleven years after the passing of another key law in the development of the Spanish university, the Claudio Moyano Law (September, 1857), which

would transform the sections of the Faculty of Philosophy into independent faculties. That of sciences was named the *Facultat de Ciències Exactes, Físiques i Naturals* (Faculty of Exact, Physical and Natural Sciences) and its studies were divided into three periods corresponding to undergraduate, master's, and doctoral degrees. However, it was not until 1867 that instruction in inorganic chemistry was differentiated from that in organic chemistry. The two subjects were taught successively along with general chemistry by Miguel Maisterra Prieto and José Ramón Fernández de Luanco until 1879, when Eugenio Mascareñas y Hernández (inorganic chemistry) and Victorino García de la Cruz (organic chemistry) joined the faculty following an open search. Luanco left the greater impression, as he subscribed to the new theories that modernized chemistry, including molecular, atomic, and valence theory. While Luanco and Mascareñas were undoubtedly good educators and taught in Barcelona for many years, they did not stand out in research. This was due in part to the fact that neither the conditions, nor the atmosphere, nor the financing, nor even the desire to investigate could allow serious or innovative lab work. Likewise, neither García de la Cruz nor his successor Miquel Bonet i Amigó stood out as Chairmen of Organic Chemistry.

Indeed, it was not until into the 20th century (1915) that research of distinction began to take place, with Professor Antonio García Banús (organic chemistry). This was facilitated by the new curricula for 1921 and 1922, which considerably reduced the physics and mathematics requirements in favor of chemistry: the three classical chemistries (general, inorganic, and organic) plus theoretical and physical chemistry, electrochemistry, and technical chemistry; the latter even required a Saxon (either German or English) language base.

García Banús served as Professor until 1939, when he was forced into exile. Once the conflict ended, he was replaced by Professor Josep Pascual Vila, a paradigm of the scientific and chemical development in Catalonia in the second half of the 20th century. García Banús studied in Germany under J. Schmidlin (1910–1912) and continued his work on organomagnesium derivatives and the Grignard reaction in organic chemistry laboratories in the Faculty of Sciences of the University of Barcelona. He also directed numerous doctoral theses (which had to be presented and defended at the University of Madrid), among which was that of Pascual (1922). García Banús and Emilio Jimeno Gil, Mascareñas' successor in the Department of Inorganic Chemistry, were the driving force behind the field of chemistry within the Department of Sciences.

According to the accounts of Pascual, from 1868 until 1875, there were four to five graduates in physics (which included chemistry) each year, including in 1917, the year of his graduation. Between 1921 and 1936, only nine doctoral theses were presented and approved while only 28 works were published in *Anales*, a Spanish journal with what would be recognized today as a very low impact factor.

The period beginning in 1940 saw very little change. Chemistry was taught almost exclusively (except organic chemistry) through the voluntary efforts of Professor Vericat. Professor Josep Castells, a current member of the IEC, has over 90% of his grade slips signed by Doctor Vericat! There were only 15 graduates in chemistry between 1940 and 1950 and only 31 works were published in *Anales* (which seems to have been the only journal in which publication was possible). As late as 1951, it was still necessary for a student to go to Madrid to defend his thesis.

It should be mentioned that Spanish (Madrid-based) science's recovery was closely linked to the Institución Libre de Enseñanza (1876), to the Junta para Ampliación de Estudios (1907) and, for chemistry in particular, to the Laboratorio de Investigaciones Físicas, known as the Spanish Rockefeller Institute based on the building that was inaugurated in 1932 with financing from the Rockefeller Foundation. The government that emerged from the Spanish Civil War consolidated the network created by these institutions into the Spanish National Research Council (CSIC), which had a very meager presence in Barcelona and arrived far too late.

In Catalonia, science's renewal came with the foundation of the Institute for Catalan Studies (IEC) by Enric Prat de la Riba (1907), who soon thereafter established the *Secció de Ciències* (Science Section). The IEC did not defend experimental research, mostly out of a lack of resources. Nevertheless, its work has been very important in the standardization and maintenance of Catalan in teaching chemistry, providing, for example, a translation of the rules of systematic nomenclature of the International Union of Pure and Applied Chemistry (IUPAC) into our language.

The academic panorama at the university level for much of the 20th century was of little merit, despite the efforts of the above-mentioned institutions. Except for the critical research of Santiago Ramón y Cajal (Nobel Prize in Medicine, 1906), an individually pursued and isolated research that was partially undertaken in Barcelona, few other figures working at the turn of the 20th century are worthy of mention. The will for change promoted by those institutions and by Cajal himself was curtailed by the socio-economic convulsions of the 1930s and, finally, by the Civil War in 1936. Even in Barcelona, in the 1950s, 1960s, and well into the 1970s, only two branches of chemistry (organic and analytical), headed by Professors Pascual and Buscarons, were comparable, to some extent, with their European counterparts. Finally, however, the greatest stimulus to university chemistry came from the many researchers who were initially schooled in Spain and then expanded and developed their studies abroad through postdoctoral positions. These scientists returned to Spain, taking up positions at the university or the CSIC. While many names could be mentioned here, among the most important in the early stages were Granados, Ballester, Serratosa, Castells, Casassas, and Izquierdo. The career trajectories of these individuals, along with the institutional and economic support of the democratic governmental administrations from 1975 onward, encouraged other researchers to specialize in chemistry and in other branches of science (physics, biology, biochemistry, etc.). As a result, the investigative panorama at the end of the 20th century was completely distinct from that of the 1950s. However, vigorous collaborations between industry and the university world were still lacking.

Concurrently with university studies, for most of the 20th century a private institution affiliated with the Society of Jesus took on a supplementary or subsidiary role in the training of

chemists, analogous to the same Society's activities in the 18th century, at the Col·legi de Cordelles (Rambla dels Estudis) for the teaching of physics and mathematics. Although in the IQS, no great research has been done, it has produced good chemists with industrial training who have rejuvenated Catalan chemical companies. These, in turn, have been an entrance point for new technologies, especially analytical methodologies that have helped to consolidate quality protocols. In this context, P. Vitòria, P. Montagut, and J.J. Bonet, among others, should be noted as frontrunners of this institution and of Catalan chemistry.

The contribution of the *Escola d'Enginyers Industrials* (School of Industrial Engineers) can be viewed in a similar light. The school has always offered a specialization in chemical engineering, even early on when this field was not consolidated as such in science faculties, and later, when it was offered in *ad hoc* schools in different universities. Indeed, industrial engineers have been a point of reference in the establishment and functioning of many chemical companies, especially in the heavy-chemical industry (electrochemistry, petrochemistry, etc.). Chemists such as Eveli Dòria i Bonaplata, Esteve Terradas, and Josep Agell i Agell are linked to the *Escola*. Others, including Fernando Jimeno and the civil engineer Pere Duran Farell, have contributed to establishing Catalonia's solid-chemical industry. Pompeu Fabra himself was a chemical engineer who taught chemistry and mathematics at the Superior School of Industrial Engineers in Bilbao, before switching to linguistics in his efforts to bring uniformity to Catalan.

This framework, as already noted, has greatly expanded basic as well as applied research activities, both of which are tightly and directly linked to the chemical companies of this country. The old, yet renovated institutions (University of Barcelona, Center of Research and Development of the CSIC, IQS) together with the new institutions (Autonomous University of Barcelona, University of Girona, Rovira i Virgili University, Scientific Park, Institute of Chemical Research of Catalonia, etc.) have contributed to this expansion. The IEC aptly promotes different bibliometric studies and statistically monitors data reflecting the development of chemical research in all the Catalonian territories. The health of all this academic activity is such that a historical review of the developments in last 20 years is now merited, with a wider perspective and taking into account the contributions of the new generation of chemistry researchers.

This review of the development of chemistry in Catalonia is too brief to resolve the paradox of how, given the country's feeble academic and investigative framework (subjected to the administrative and centralist rules of civil service, still alive and well after 30 years of democracy), such a strong industrialization could take root around one particular branch of science. Perhaps because, to paraphrase a comment from the wonderful recent exhibition held under the auspices of the Catalan Society of Chemistry "everyhing is chemistry, and because we Catalans are better able to identify ourselves with the eccentricity (*rauxa*) of chemistry rather than with the formality (*seny*) of physics, a structured analysis of this question remains a challenge."