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SCIENTIFIC FAMILIES AND THE SHAPING OF AN EXPERTISE IN ANALYTICAL CHEMISTRY IN MODERN SPAIN.

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ABSTRACT: *This paper focuses on how two Spanish chemists—Antonio Casares Rodríguez (1812–1888), and his son José Casares Gil (1866–1961)—constructed their expertise in chemical analysis in modern Spain. It considers both their family connections and local networks as crucial elements in the consolidation of their scientific authority, as well as the importance of travels and textbook writing, in shaping expertise in places usually considered peripheral. Finally, this article shows how both experts were able to circulate between different spaces, notably the laboratory and the field, in this case natural springs and spas; the university and governmental committees and institutions, in this way forging new possibilities for the consolidation of analytical chemistry as a scientific discipline in Spain.*

Keywords: Antonio Casares Rodríguez, José Casares Gil, modern Spain, experts, chemical analysis

INTRODUCTION

This paper considers different elements in the construction of the scientific careers of Antonio Casares Rodríguez (1812–1888) and his son José Casares Gil (1866–1961), in particular, of their expertise in analytical chemistry in modern Spain. Kinship emerges as an important element in the shaping of their scientific authority as experts, which was not only the result of their academic and research activities, but also of their family connections. The study of their biographies contributes to a better understanding of how personal and family factors played a role in their scientific careers, facilitated their travels of learning, motivated their publications, helped them to configure their working spaces, and conditioned

their participation in scientific controversies.¹ From mid-nineteenth century to mid-twentieth century both chemists contributed to improve the visibility of analytical chemistry in Spain, because of their scientific and academic work, as well as their personal interest in addressing different audiences and creating new spaces with the help of their family relations and local networks. The comparison of their biographies shows different sorts of continuities, similarities and differences: both studied pharmacy, worked as university professors of chemistry, wrote numerous publications on chemical analyses, were integrated in various academic committees and government institutions, and naturally belonged to the same family. However, each of them was affected by their own temporal, social, and economic contexts.²

Other studies on experts—such as those by Harry Collins and Robert Evans—have pointed out that scientific authority, trust and credibility are important elements that should be carefully considered in the study of the shaping of expertise.³ As noted by Christopher Hamlin, between the mid-nineteenth and mid-twentieth century an intense process of scientific professionalization was produced. This process involved tensions and disputes between different groups of experts claiming their legitimacy on the discussion of issues such as public health, water and food analyses, or the use of scientific instruments.⁴

This paper is framed in the historiography on scientific experts and focuses on different elements contributing to the shaping of the scientific authority of Antonio and José Casares in Spanish chemistry from mid-nineteenth and mid-twentieth century: first, on how the Casares' family used its family connections, and local networks to promote the scientific career of its members, and to

¹ A similar approach is also considered by the research group STEP (Science and Technology in the European Periphery) (<http://step2.hicido.uv.es/?q=node/3>) (15/05/2017). It was created in 1999 in Spain, and now it includes scholars from many European nations, as well as from Asian and Latin American universities.

² Ignacio Suay-Matallana, *Chemical analysis and experts in contemporary Spain: Antonio Casares Rodríguez (1812–1888) and José Casares Gil (1866–1961)* (Ann Arbor: ProQuest UMI Dissertations Publishing, 2014).

³ Harry M. Collins; Robert Evans, “The Third Wave of Science Studies. Studies of Expertise and Experience,” *Social Studies of Science*, 2002, 32 (2): 235–296, on 237–238.

⁴ Christopher Hamlin, “Third wave science studies: Toward a History and Philosophy of Expertise?,” *The Challenge of the Social and the Pressure of Practice, Science and Values Revisited*, eds. Martin Carrier; Don Howard; Janet A. Kourany, (Pittsburgh: University of Pittsburgh Press, 2008), pp. 160–185.

reinforce the authority of Antonio and José Casares as experts in chemical analyses; then, on how their travels of learning as well as their textbooks were not only relevant to improve the prestige of both chemists, but also contributed to the consolidation of general chemistry, and analytical chemistry as university disciplines in Spain; finally, on how the academic and institutional positions of both chemists allowed them to be involved in a wide variety of issues, from water analyses of spas to governmental committees as well as in delivering public lectures for different publics. As a result, the ability of Antonio and José Casares to circulate between different spaces, such as mineral water springs, classrooms and laboratories, was also a key-element in the construction of their scientific authority.

SCIENTIFIC FAMILIES, AND THE USE OF LOCAL AND FAMILY NETWORKS IN THE CONSTRUCTION OF SCIENTIFIC AUTHORITY

In the last decades, the number of studies on family history has grown. A wealth of research has focused on “family history”—with contributions from sociology, ethnography and anthropology—to analyse the influence of kinship in the formation of local power elites. In contemporary Spain, many of these studies have shown the political use of family networks during the period known as the Restoration (the restoration of the Bourbon dynasty from the 1870s to the 1920s,) and have considered how individuals made use of “friendship networks” to promote social progress in a context where public welfare was still weak.⁵ Similarly, biographies of scientists, including their collaborations with colleagues and relatives, provide a better understanding of the “blurred boundaries” existing between domestic, academic and scientific fields.⁶ In the case of analytical chemistry, a notorious international example is the Fresenius family, a saga of German scientists

⁵ James Casey, “Prólogo. Linaje y parentesco,” in *Historia de la familia. Una nueva perspectiva sobre la sociedad europea*, eds. James Casey; Juan (Murcia: Universidad de Murcia, 1997), pp. 13–18.

⁶ Donald L. Opitz, Annette Lykknes, Brigitte Van Tiggelen, “Introduction,” in *For better or for worse? Collaborative couples in the science*, eds. Lykknes, Annette, Opitz, Donald L., Van Tiggelen, Brigitte, (New York: Birkhäuser, 2012), pp. 1–15, on p.7.

involved in chemical analyses, and editors of the journal *Zeitschrift für Analytische Chemie* during many generations.⁷

Antonio Casares Rodriguez was born in 1812 in Galicia (in NW Spain), where his father was a rural apothecary.⁸ In the late 1820s, he moved to Madrid where he completed a Bachelor's degree (1832), and a degree in Pharmacy (1836) at the Royal School of Pharmacy. Antonio Casares did not travel abroad during his formative period, but his long stay in Madrid was essential to complete his studies in pharmacy, to extend his education to other areas, such as geology and natural history, and to establish profitable relationships with science professors, and other influential members of the court. After returning to Galicia, he completed his education at the University of Santiago de Compostela with a Ph.D. in philosophy (1841), and, at the end of his career, a degree in medicine and surgery (1872).⁹

In contrast, José Casares Gil studied in his hometown, Santiago de Compostela, where he had the privilege of using the laboratories directed by his father and his uncle (Ramon Gil Villanueva, a university professor of physics).¹⁰ The privileged access to these laboratories provided him with a solid practical training in physics and chemistry, usually unavailable to most students of his time. In 1888 (when his father died), he completed a Ph.D. in pharmacy at the University of Santiago, and passed a public examination to become a professor of "chemical analyses and study of physical instruments" at the University of Barcelona. During his time in Barcelona, José Casares was elected dean of the Faculty of Pharmacy, conducted numerous analyses of mineral waters, published his first works, and start travelling abroad, mainly to Germany. In 1905, he moved to Madrid, where more academic, political and institutional opportunities were available, because of

⁷ Since 1990 the journal is titled *Analytical and Bioanalytical Chemistry*. Herbert August Laitinen and Galen Wood Ewing, *A History of Analytical Chemistry* (Washington: Division of Analytical Chemistry of the American Chemical Society, 1977), p. 15. About the Fresenius family and that journal see: Wilhelm Fresenius, "One hundred and forty years 'Fresenius' Journal of Analytical Chemistry' *Fresenius' Journal of Analytical Chemistry*, 2001, 371 (8): 1041–1042.

⁸ María Luisa Losada Sanmartín and Antonio Casares, *Ideología, ciencia y sociedad en la Universidad de Santiago en el siglo XIX* (Santiago: Universidad de Santiago de Compostela, 2015).

⁹ Ignacio Suay-Matallana, "Expertos, química y medicina: Antonio Casares (1812–1888), José Salgado (1811–1890) y la controversia en torno al análisis de las aguas del balneario de Carratraca," *Dynamis*, 2016, 36 (2): 419–441.

¹⁰ Román Casares López, "Recuerdos de una vida: José Casares Gil," in *Homenaje al farmacéutico español* (Madrid: Laboratorios Beecham, 1987), 107–118, p. 107.

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the large number of institutions existing in the capital, and the fact that the University of Madrid was the only university allowed to offer Ph.D. studies in Spain. Then, he was also appointed dean of the Faculty of Pharmacy (1921–1930), director of the central customs laboratory organised by the Ministry of Finance (1908–1952), senator (1905–1920), and then president of various Spanish Royal Academies and scientific committees. As it will be shown, his scientific trips to Germany, his treatises and textbooks, and his intense institutional and political activity facilitated his recognition as an expert, and contributed to the institutionalization of analytical chemistry as a discipline in Spain.

The impact of family connections of both Casares in their scientific activity, however, is strong. Antonio Casares built an extensive network with the elites of Santiago de Compostela thanks, in part, to his familial ties and kinship networks (fig. 01). His two marriages allowed him to connect with two influential families of that city, and offered him a privileged social position. Several members of these families held important academic positions as university professors and chancellors of the University of Santiago de Compostela. Eventually, Antonio Casares built a large family network in which several of his 12 children also became university professors. One of them was José Casares, who followed the paternal tradition. He was the main disciple of his father, continued some of his research lines, and inherited the prestige of his father as an expert in chemical analysis. The comparison of the pathways of Antonio and José shows how their scientific authority was not only gained thanks to their academic activities and their chemical work, but also because of the family networks they built in Galicia and Madrid.¹¹

¹¹ For previous reflections on that concept see: Mary Jo Nye, “Scientific Families: Biographies and ‘Labographies’ in the History of Science,” *Historical Studies in the Natural Sciences*, 2009, 39: 104–114, on 104.



Figure 1. Antonio Casares (centre), his wife, daughters and sons, including José Casares (left) (1870s). Courtesy of the Casares family.

TEXTBOOKS, THE PUBLIC AND THE CONSOLIDATION OF SCIENTIFIC DISCIPLINES IN MODERN SPAIN

One of the main elements contributing to the construction of the scientific authority of Antonio and José Casares were their treatises and textbooks in chemistry (fig. 02). From the early 19th century, science textbooks became an essential element in the education and training of secondary and university students. In Spain, the government created lists of “recommended textbooks” to be employed in official education. The main aim of such lists was “to spread science, not to promote progress,” and to “standardize education.”¹² Teachers and professors were only allowed to use books included in these lists, and students were required to buy them in order to create “their own library.” In 1841, an official commission was created to outline the first list of “recommended textbooks.” Two years later that commission was reorganised by the Royal Council of Public Instruction, and Antonio Moreno Ruiz (1796–1852) was appointed member of such an influential

¹² Real Decreto de 09 de agosto de 1849, in *Boletín oficial del ministerio de comercio, instrucción y obras públicas* (Madrid: Rivadeneyra, 1849), pp. 354–356.

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council.¹³ Moreno was a former professor of physics and chemistry at the Royal College of Pharmacy of Madrid, where he taught Antonio Casares.¹⁴ Moreno had important contacts in the court, and possibly helped Casares to be appointed assistant chemist at the Royal Pharmacy from 1835 to 1836.¹⁵ Although Moreno died in 1852, his presence in the Royal Council possibly facilitated the inclusion of several books authored by Antonio Casares in the first list of official textbooks. For some teachers and professors these lists meant education control and a limitation of their teaching freedom, whereas the authors of books included in these lists were greatly benefited. Authors like Casares not only profited from the sales of their books, which were employed in all official schools and faculties in Spain, but their scientific reputation also grew due to the prestige derived from being selected by the government.¹⁶

Antonio Casares had different books included in the list of recommended textbooks. They were used in different courses at the old faculties of philosophy, as well as at the new faculties of science, pharmacy and industrial schools created in the 1850s. His first textbook included in these lists was the *Tratado elemental de química general* (Elementary treatise on general chemistry; Madrid, 1848), and its success motivated the publication of a new one titled *Manual de Química General* (Handbook on general chemistry; Madrid, 1857) that was edited again in 1867, 1873 and 1880. Thanks to these books Casares gained privileged access to a huge “captive audience” of students, who had very limited options regarding the choice of books used in their lecture classrooms, in accordance with official syllabi.¹⁷ Authors of science textbooks had to adapt their pedagogic books and materials to the syllabi regulated and established by the government.

The organization and structure of a textbook was a key-element in contributing to the success of the book. Antonio Casares had a

¹³ José Luís Peset, “El real consejo de instrucción pública y la restauración canovista,” *Hispania*, 1989, 48: 989–1030.

¹⁴ *Gaceta de Madrid*, 3378, 1, (14/12/1843).

¹⁵ Eduardo Valverde Ruíz, *La Real Botica en el siglo XIX* (Madrid: Universidad Complutense de Madrid, 1999), p. 125.

¹⁶ Josep Simon and Mar Cuenca, “Science Education and the Material Culture of the Nineteenth-Century Classroom: Physics and Chemistry in Spanish Secondary Schools,” *Science & Education*, 2012, 21 (2): 227–244.

¹⁷ Bernadette Bensaude-Vincent, “From teaching to writing: lecture notes and textbooks at the French École Polytechnique,” in *Communicating chemistry. Textbooks and their audiences, 1789–1939*, eds. Anders Lundgren and Bernadette Bensaude-Vincent (Canton, Science History Publications, 2000), pp. 273–294, on p. 279.

great interest in expanding the audience of his books. His *Manual de Química General* addressed a wide audience that included both students and artisans. Casares strategically divided this textbook in two volumes: the first devoted to inorganic chemistry and the fundamental principles of chemistry; the second volume on “organic chemistry” had a greater emphasis on agricultural and industrial applications. Thus, the first volume was especially addressed to university students, who were a “captive audience” that followed a syllabus and attended the lectures; the second was much more practical and was particularly aimed at artisans, craftsmen and farmers. Thanks to the decision of adapting his book to different readers, Antonio Casares was recognized as a renowned professor as well as an expert on a number of issues related to industry and agriculture. Like many other nineteenth-century chemists, Antonio Casares supplemented his professorial salary with other work, notably as a consultant, in which he offered his “expert advice” in analyses of water, food and other products, and in many industrial processes.¹⁸

In Spain, the publication of scientific textbooks, both originally written by Spanish authors and translations into Spanish of foreign authors, had been promoted by the government since the mid-19th century. Most original books were secondary school textbooks or general science books for university students. This was the case of the publications by Antonio Casares, who published a successful book on general chemistry in Spanish, while translating two French treatises specialised in theoretical pharmacy and legal chemistry.¹⁹

Following in his father’s footsteps, José Casares started his career combining his university activities in Barcelona with the analysis of many mineral waters of that region. His pathway, however, coincided with the growing institutionalisation of science in Spain, as well as with the increasing power of German chemistry. He was especially known for his specialised work in chemical analyses, very well received by both science professors and students in Spain, and contributed to replace former translations of the treatises published by Heinrich Rose (1795–1864), Carl Remigius Fresenius (1818–

¹⁸ Katherine D. Watson, “The chemist as expert: the consulting career of Sir William Ramsay,” *Ambix*, 1995, 42: 143–159, on p. 143.

¹⁹ Antonio Casares translated the following two French textbooks: *Tratado de Farmacia Teórica y Práctica por M. Soubeiran* (Madrid: Sociedad de autores librerías-Calleja, 1847), and *Tratado de Química Legal escrito en francés por Mr. Gaultier de Claubry* (Madrid: Imprenta y Litografía de D. Juan Rey Romero, 1852).

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1897) and Frederick Pearson Treadwell (1857–1918) by his own books.

Like his father, José Casares also authored various books that contributed to the renovation of chemistry education in Spain during the first half of the twentieth century. In those years, there were no lists of recommended books for higher education, but the introduction of experimental techniques was a major challenge in Spanish lecture rooms. José Casares wrote one of the most used textbooks in Spanish chemical and pharmaceutical laboratories entitled *Técnica física de los aparatos de aplicación en los trabajos químicos* (Physics techniques for chemical works; Madrid, 1908). In this treatise—first published in 1908, and again in 1916, 1924 and 1932—José Casares argued that chemists needed a deep knowledge of physics, and remarked that a person incapable of managing a spectroscope or a polarimeter, or of determining a specific weight “could not be considered as a chemist.”²⁰ The publication of his book coincided with the development of teaching methods requiring textbooks and teaching materials focussed on and promoting experiment.²¹

The travels of learning of José Casares significantly influenced the publication of his treatise on chemical analysis. His first travel abroad took place in 1896, when he was already a professor in Barcelona. He went to Germany, where he studied with the future Nobel laureates Adolf von Baeyer (1835–1917) and Richard Willstätter (1872–1942), with the aim of improving his experimental skills, mainly in spectrometry.²² Then he benefited from his stays in Munich to publish some articles in well-known German scientific journals in which he used spectrometers to conduct water analyses.²³ In 1924, José Casares was awarded a

²⁰ José Casares Gil, *Técnica física de los aparatos de aplicación de los trabajos químicos* (Madrid: Imp. Viuda e Hijos de Tello, 1908), p. 1.

²¹ José Ramón Bertomeu Sánchez and Antonio García Belmar, “Pedro Gutiérrez Bueno’s Textbooks: Audiences, Teaching Practices and Chemical Revolution,” *Science & Education*, (Special Issue: Textbooks in the Scientific Periphery), 2006, 15 (7–8): 693–712.

²² José Casares Gil, *El espectroscopio y sus principales aplicaciones* (Barcelona: Hijos de Jaime Jepús, 1897).

²³ José Casares, “Ueber das Vorkommen einer beträchtlichen Menge Fluor in einigen Mineralwassern,” *Zeitschrift für Analytische Chemie*, 1895, 34 (1): 546–548. See also: José Casares, “Berichtigung zu N. Sahlbom und F. Willy Hinrichsen: Notiz über die Radioaktivität der Aachener Thermalquellen,” *Berichte der Deutschen Chemischen Gesellschaft*, 1906, 39: 3783–3784. See also: José Casares, “Über das Vorkommen beträchtlicher Mengen von Fluor in vielen Mineralwassern der Pyrenäenketten und im Geyser des Yellowstone-Parkes” *Zeitschrift für analytische*

Honoris Causa Doctorate from the University of Munich, and during the rest of his life he maintained strong links with German chemists, as emphasised by Eugen Bamann (1900–1981), the dean of the Faculty of Pharmacy of Munich, in the obituary he published in 1961 in the prestigious journal *Pharmazeutische Zeitung*.²⁴

A few months after his first travel to Germany, the publishing house Espasa released his textbook *Elementos de análisis químico cualitativo mineral* (Elements of mineral qualitative chemical analysis; Barcelona, 1897). In 1905 and 1918, the publishers Espasa and Calpe published two abridged versions (about 180 pages) of the José Casares treatise addressed to wider audiences.²⁵ These publications reflected the emergence of new audiences interested in chemistry in Spain, which not only included science students, but also students of vocational schools, and the increasingly educated middle class.²⁶

In 1911, José Casares included a number of additions in his book, reorganized its contents, expanded and published it with the title *Tratado de Análisis Químico* (Treatise on chemical analysis), which became his most famous book. This new version confirmed José Casares as a textbook author on analytical chemistry in Spain for various decades to come. This book, with ten editions from 1911 to 1975, reflected the evolution of his own research interests, and the development of new research topics in his university laboratory.²⁷ For example, the 5th edition of this book, published in 1948, was divided into three volumes and included a new line of research on food analyses. In addition, it was co-authored with his

Chemie, 1912, 44: 729. See also: José Casares, “Über die Ermittlung und Bestimmung des Fluors in Mineralwässern,” *Zeitschrift für analytische Chemie*, 1930, 81 (1): 66–70. See also: K. Diehm; José Casares; Román Casares, et al, “Mineralwässer und Moore,” *Zeitschrift für analytische Chemie*, 1932, 87 (5): 232–236. ²⁴ Eugen Bamann, “Don José Casares Gil, dem „Freund der Wahsheit,” zum Gedenken, *Pharmazeutische Zeitung*, 1961, 24: 714–715. He was also awarded with a Doctorate Honoris Causa from the University of Porto (Portugal) in 1942. See: José Casares Gil, “Discurso dado en la Universidad de Oporto en ocasión de ser nombrado doctor Honoris Causa de aquella universidad,” *Anales de la Real Academia Nacional de Farmacia*, 1943, 9: 538–541.

²⁵ José Casares Gil, *Análisis químico: (tratado elemental)* (Barcelona: Manuel Soler, 1905); José Casares Gil, *Análisis químico: (tratado elemental)* (Barcelona: Manuales-Gallach n° 19, 1918).

²⁶ Agustí Nieto-Galán, “Free radicals in the European periphery: ‘translating’ organic chemistry from Zurich to Barcelona in the early twentieth century,” *British Journal for the History of Science*, 2004, 37 (2): 167–191, on 190.

²⁷ The treatise was newly edited in: 1916, 1923, 1933, 1948, 1954, 1956, 1963, 1969, and 1975.

grand-nephew Román Casares López (1908–1990), who succeeded him as professor of chemical analysis at the Faculty of Pharmacy of Madrid following his retirement in 1936. The scientific collaboration between José and Román Casares is another element of family continuity and transmission of scientific authority in academic work, as the latter continued working as a chemist, professor, and author of textbooks. Therefore, José Casares contributed decisively to the consolidation and recognition of analytical chemistry as an academic discipline in Spain thanks to the appropriation and adaptation of analytical techniques to his local context, and the circulation of new chemical knowledge among different audiences. He used his prestige as an expert on chemical analysis to promote his textbooks, reinforce his participation in political and institutional bodies, and facilitate the academic careers of some of his relatives and collaborators.²⁸

The next section shows how Antonio and José Casares employed their prestige and authority to create new scientific spaces and expand analytical chemistry in Spain.



Figure 2. Textbooks written by Antonio Casares (left) and José Casares (right)

²⁸ Suay-Matallana, “Chemical analysis and experts,” p. 223-251.

MINERAL SPRINGS, LABORATORIES AND CLASSROOMS: SITES OF CHEMISTRY AND THE CONSTRUCTION OF SCIENTIFIC AUTHORITY

In the last years, history of science has experienced a “spatial turn” by concentrating on the active role played by geographical and spatial factors in the shaping of scientific knowledge and expertise.²⁹ Experts had to be able to circulate between different spaces and spheres, ranging from university and academic units, laboratories and the field, to bureaucratic, political and public institutions. Antonio Casares conducted numerous analyses of water, which not only contributed to the study of many rural springs, but also to their physical and economic transformation. His scientific publications and water analyses added a new economic value on many Spanish mineral waters and rural springs.³⁰ In addition, Jose Casares developed his scientific career in institutional contexts, where he had the opportunity of creating new laboratories that offered more opportunities to the practitioners of his discipline (Fig. 03).

The scientific work of Antonio Casares played an important role in the transformation of many rural areas (such as water springs) into economic and social spaces (such as spas). Not only chemists and other scientists—including physicians, pharmacists, geologists, botanists or engineers—were interested in the transformation of country springs into economic ventures based on the economic value of mineral waters, but the commodification of mineral springs was also an important question for spa owners, local authorities, and neighbouring regions. This social and economic transformation involved a variety of scientific fields ranging from soil studies, to collecting and sending water samples to be analysed, as well as testing the samples, and analysing their results. All these activities generated, on many occasions, scientific controversies in which not

²⁹ Diarmid A. Finnegan, “The Spatial Turn: Geographical Approaches in the History of Science,” *Journal of the History of Biology*, 2008, 41: 369–388. Concerning chemical spaces, the research project Sites of Chemistry 1600–2000 provides a stimulating historiographical framework to study the impact of space and geography in science, see: *Sites of Chemistry 1600–2000*, (<http://www.ambix.org/projects/sites-of-chemistry/>) (15/05/2017)

³⁰ Ignacio Suay-Matallana, “Between chemistry, medicine and leisure: Antonio Casares and the study of mineral waters and Spanish spas in the nineteenth century,” *Annals of Science*, 2016, 73 (3): 289–302.

only disciplinary or technical issues were discussed, but also the defence of one spa over another.³¹

Usually, chemical analyses were an additional resource in the “economic competition” between spa towns, and were employed “to promote one spa or denigrate another.”³² Casares emphasised the importance of chemical analysis, but he took into account the therapeutic properties established by physicians. Both chemists and physicians made several common requests, such as the improvement of visitors’ accommodation; the need for institutional support to construct better roads and convenient access to spas; or growing more trees to improve the spas’ surroundings.³³ The success of a spa often depended on the legitimacy of the experts involved in the dispute, and on their ability to show the advantages of one particular spa over the others. All these discussions were framed in the context of a growing popularisation of mineral baths, and spas, which had its heyday during the second half of the nineteenth century. Thus, the success of a spa involved a combination of various factors, such as its medical properties and chemical characteristics, climate and geography issues, its price and other economic questions, as well as factors associated with leisure, tourism and other social issues. Many of these elements, such as the situation of the spa, its landscape, and access and transportation show that the relationship between rural areas and spas is complex as the growth of the spa industry during the nineteenth century was not only related to the interest of the new bourgeoisie to leave the city temporally to enjoy the countryside.³⁴ In other cases, rural spaces were associated with underdeveloped areas and problematic places, plagued by diseases. Experts like Casares profited from such an ambiguous view of the rural world to promote new uses for the country water springs. For example, he employed his chemical analysis of the La Toja spring—in the province of Pontevedra—to

³¹ Christopher Hamlin, “Chemistry, Medicine, and the legitimization of English Spas, 1740–1840,” *Medical History, Supplement*, 1990, 10: 67–81, on p. 68.

³² Hamlin, “Chemistry, medicine, and the legitimization,” pp. 69–71.

³³ Antonio Casares Rodríguez, *Análisis de las aguas ferruginosas del Incio* (Santiago: Imprenta de Jacobo Souto e Hijos 1864), p. 21. See also: Antonio Casares, et al., *Análisis de las aguas minerales de Azuage en Gran Canaria e informe médico sobre sus cualidades* publicados por la Sociedad Económica de Amigos del País de las Palmas (Gran Canaria: Imp. La Verdad, 1869), p. 25.

³⁴ Enrique Perdigüero-Gil, “Las relaciones entre turismo y salud como construcción histórica,” in *Turisme, Gastronomia, Oci i Salut als municipis valencians: una perspectiva històrica*, ed. Mercedes Pascual Artiaga, et al. (San Vicent del Raspeig: Seminari d’Estudis sobre la Ciència, 2012), p. 27. See also: Hamlin, “Chemistry, medicine, and the legitimization,” p. 67.

once more draw attention to problems and inconveniences that had already been detected. At the same time he emphasised the therapeutic properties of the water of the La Toja spring;³⁵ he also highlighted that this spring was a place where visitors could not even find “a poor hut or a tree to shelter, pathways for a walk, or distractions” before its transformation into a spa.³⁶ On other occasions, Casares emphasised the benefits of enjoying the countryside and rural places in contrast to urban areas with “corrupted atmosphere and flurried activity.”³⁷

Water analyses conducted by Casares (like those carried out by other experts) contributed to the commodification of mineral water, and to increase the number of spas in Spain. During the nineteenth century water analyses were gaining importance mainly for three reasons: first, they began to be used by physicians as a scientific tool to reinforce their therapeutic legitimacy; second, they could be employed to compare different mineral waters, and present alternatives to the most famous; finally, they were increasingly being used in the teaching of chemistry.³⁸ Another argument in favour of chemical analyses advocated by Casares was their value to prescribe mineral waters “safely.”³⁹ Casares tried to persuade physicians of the importance of conducting the analysis of mineral waters prior to their therapeutic use, because as he remarked, they made possible to “perfectly know their properties,” and they prevent physicians from “prescription errors.”⁴⁰

Finally, chemical analyses were used to emphasise the potential economic benefits associated with the exploration of mineral water, which was considered as a “natural resource.”⁴¹ In addition to medical benefits, chemists, physicians and other experts emphasized that mineral water was an important economic resource not only for the place where a spa is located but also for neighbouring towns and regions. In an article published by Antonio

³⁵ Casares Rodríguez, “Análisis Isla de Loujo o Toja Grande,” p. 10.

³⁶ Antonio Casares, *Análisis de las aguas minerales descubiertas en la Isla de Loujo o Toja Grande* (Santiago: Imp. de la Viuda e Hijos de Compañel, 1841), p. 10.

³⁷ Antonio Casares Rodríguez, *Baños minero-termales de Lugo* (Madrid: F. Merino Encuadernador, 1856), p. 01.

³⁸ Christopher Hamlin, *A Science of Impurity: Water Analysis in Nineteenth Century Britain* (Berkeley: Univ. of California Press, 1990), p. 51.

³⁹ Antonio Casares Rodríguez, *Noticia de las aguas minerales de Sousas y Caldeliñas del valle de Verín* (Santiago: Ayuntamiento de Verín, Imp. Juan Rey Romero, 1854), p. 11.

⁴⁰ Casares Rodríguez, “Baños minero-termales de Lugo,” p. 1.

⁴¹ Casares Rodríguez, “Noticia de las aguas minerales de Sousas,” p. 16.

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Casares in 1862, he explained that thanks to the spring located close to the Galician town of Carballo such a small and poor place had increased its “size and prosperity.”⁴² He jumbled some news related to that town with historical anecdotes, descriptions of the landscape, and even included details of the meals served at the spa, as well as potential excursions and trips. All the elements mentioned by Casares were not just limited to technical details, and chemical questions, but also show his interest in promoting and advertising the spa and its surroundings; ultimately, they show the role he played in the commodification of such a rural spring.⁴³ Therefore, water analyses had an additional economic and social dimension that implied a complex decision-making process and discussions between different stakeholders. As a result, experts like Antonio Casares had to take into account a variety of questions associated with chemistry, medicine, geography, and economy, which were frequently located in the “blurry boundary” between the field and the laboratory.⁴⁴

The case of José Casares was slightly different because, unlike his father, he developed most of his scientific career in Madrid, not in a provincial city, and profited from the progressive consolidation of scientific institutions during the twentieth century, which entailed the creation of a large number of specialised scientific spaces. José Casares was an expert able to circulate between different spaces, from research and academic institutions, to academies, governmental committees, state laboratories, and, even, political and public spaces. He began his academic career in Barcelona in 1888, and moved to the Faculty of Pharmacy in Madrid in 1905, where he held the chair of chemical analyses until his partial retirement in 1936; he was also dean of the same Faculty in the 1920s and the 1940s.

The professionalization of scientific disciplines that took place from the second half of the nineteenth century onwards contributed to the specialization of scientific knowledge, and the creation of new barriers between experts and lay people. However, laboratories should not be considered as closed spots, but as

⁴² Antonio Casares Rodríguez, *Reconocimiento y análisis de unas aguas minerales nuevamente descubiertas en Carballo* (Santiago: Establ. Tipog. de Manuel Mirás, 1862), p. 03.

⁴³ Antonio Casares, “Memoria analítica de las aguas minerales de la fuente de las Bouzas,” in *Establecimiento de baños de las aguas minerales sulfurado-sódicas de las Bouzas de Rivadelago, Zamora*, ed. Pio Gavilanes (Astorga: Imp y Librería de López, 1878), p. 15.

⁴⁴ Opitz; Lykknes and Tiggelen, “Introduction,” p. 10.

permeable spaces where scientists can interact with society.⁴⁵ José Casares not only used the laboratory of chemical analyses that he headed at the University of Madrid to work with colleagues and students of pharmacy and medicine, but also contributed significantly to the activities developed by the *Junta para Ampliación de Estudios e Investigaciones Científicas* (JAE, Board for Advanced Studies), an institution created in 1907 with the intention of renovating Spanish science by promoting scientific travels, and improving practical and experimental scientific training.⁴⁶ Thanks to his collaboration with the JAE, the Casares' laboratory was opened not just to his students, but also to JAE fellows, many teaching in primary and secondary schools interested in learning chemical practices for didactic purposes. In this context, Casares employed his expertise to modify scientific spaces by giving them new uses that had not been initially foreseen. He adapted ideas, values and procedures learnt during his travels to Germany and transformed his laboratory into a place for teaching practical courses addressed to a wide range of students, each with different objectives.

Moreover, between 1908 and 1951, José Casares held the position of director of the central customs laboratory of chemical analyses. This laboratory was created by the Ministry of Finances in 1888 to fight against economic fraud. It was primarily focused on chemical analyses of wine, spirits, oil, steel and other goods in order to determine import and export duties, and to issue reports on international trade. In this case, Casares' responsibilities were not limited to his expertise in chemical analyses, but he also had to consider the claims of industrialists and traders as well as the economic interests of the Spanish Government.⁴⁷ Finally, José Casares also had other institutional duties, such as member of the Senate, president and member of Royal Academies, and cultural societies, as well as lecturer in conferences and public events. His interventions in all these different spaces gave him the opportunity of explaining his scientific ideas to different audiences and in different contexts, as well as of exhibiting and advertising his knowledge and expertise in various fields. In addition, they

⁴⁵ Graeme Gooday, "Placing or Replacing the laboratory in the History of Science?," *Isis*, 2008, 99 (4): 783–795, on 783.

⁴⁶ Luis Enrique Otero Carvajal and José María López Sánchez, *La lucha por la modernidad. Las ciencias naturales y la Junta para ampliación de estudios* (Madrid: CSIC, 2012).

⁴⁷ Ignacio Suay-Matallana, "Customs Laboratories, chemistry and excise: an historical introduction," *World Customs Organization News*, 2015, 77: 34–37.

facilitated his later claims for more economic resources, and recognition for his discipline, as well as reinforcing his scientific authority and contributing to more appointments to official positions.

José Casares understood that in order to advance his scientific career he could not restrain himself to academia and the laboratories he directed. He had to address different audiences, and participate in public activities in order to be recognized as a chemical expert by his peers, the authorities and the general public. The Spanish civil war (1936–1939), however, and the dictatorship (1939–1975) dramatically affected Spanish science. It also affected Casares' former collaborators, pupils and colleagues who were persecuted or exiled on political grounds, which greatly harmed the development of lines of research he had established, and the academic groups he had created. The JAE itself was closed down, and the newly created *Consejo Nacional de Investigaciones Científicas* (CSIC, National Research Council) only granted the material continuity of some research units, while it had different goals and procedures adapted to the agenda of the dictatorship. Franco's government, in addition, took advantage of the symbolic capital of José Casares. Although he had retired in 1936, after the civil war, he was reintegrated in the academic and political life, as dean of the Faculty of Pharmacy, president of the Academy of Pharmacy, president of the Science Academy, member of the Francoist parliament, and deputy director of the CSIC.⁴⁸ The government was surely interested in having a recognized expert with international contacts, and Casares profited from such opportunity to relocate analytical chemistry in the national scientific agenda, as well as to integrate former collaborators and relatives (such as Román Casares) in the institutions of the newly established government. All these elements show that scientists were not alien to political questions. José Casares' expert authority combined with his flexibility and diplomatic skills partially explain how he was able to fit different political regimes throughout the complex first half of the twentieth century in Spain.

⁴⁸ Ignacio Suay-Matallana, "La colaboración científica y los espacios de la química: un estudio de caso español en la primera mitad del siglo XX," *Revista Española de Documentación Científica*, 2014, 37 (4): 1-11.



Figure 3. Antonio Casares in his university laboratory (1860s) (left), and José Casares in the Customs laboratory (1920s) (right). Photographs taken from the exhibition *O Dr. Antonio Casares (1812-1888). Investigador e Reitor da Modernidade. 200 Aniversário do seu Nascimento*, held at the University of Santiago de Compostela, Spain, in 2012, and from the magazine *Revista Mundial* (1922), respectively.

CONCLUSION

The careers of Antonio and José Casares provide important clues on how expertise in a particular scientific field was built up in Spain from the mid-nineteenth-century to the first decades of the twentieth century. In this process, kinship and family networks together with travels abroad, the establishment of national and international scientific collaborative networks, the publication of textbooks, and the circulation between academic, public and political spaces were intertwined and emerge as crucial. Both Antonio and José Casares did not merely transfer and propagate scientific knowledge learnt in European centres such as France and Germany to a “periphery” like Spain; instead, they engaged in a genuine process of selective and creative appropriation of new experimental practices and models of teaching and research.⁴⁹

⁴⁹ Kostas Gavroglu, et al., “Science and technology in the European periphery: some historiographical reflections,” *History of Science*, 2008, 46 (2): 153–175, on 161.

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After Antonio Casares returned from Madrid to his home university, he became a mediator between different local scientific communities in order to create new chemistry courses in Santiago. José Casares' international connections, in turn, were much more relevant at the beginning of his career, when he studied with different German scholars, and contributed articles to German scientific journals. In both cases, their stays in Madrid and Munich were important elements for their legitimisation as experts on analytical chemistry. According to the terminology of Collins and Evans, both Antonio and José Casares had a certain degree of "contributory expertise" or ability to introduce novelties in their area; they could better be considered as "interactional experts" or scientists with enough expertise to interact interestingly with their colleagues.⁵⁰ Furthermore, Antonio and José Casares—as well as many other leading scientists of countries scientifically less developed—had to make an effort to reinforce their discipline, create new audiences and spaces, and legitimize academic and institutional policies, even in the case such attempts constrained their own scientific activities.⁵¹

The study of Antonio and José Casares careers has also shown that, in addition to travelling and visits to foreign laboratories, the writing of textbooks was not only an important element in legitimising a discipline and standardizing its teaching, but also in creating the authority of an expert in the European "periphery." Both authors selected topics, organised textbook contents, and made decisions on nomenclature, scientific disputes and controversies, bearing in mind their local context.⁵² Their publications reflected not only the general trends of European chemistry, but also the transformations that this scientific discipline was undergoing in Spain. While Antonio Casares visited Paris and began by translating some French treatises on chemistry prior to writing his own textbooks, some decades later, José Casares worked in German laboratories, published in German scientific journals and also authored textbooks addressing Spanish readers. Their respective textbooks were used intensely in Spanish lecture rooms, classrooms and laboratories, and became an important source of scientific credibility and authority for both chemists. They show, in addition, the emergence of new audiences for chemistry in an

⁵⁰ Harry Collins, *Are We All Scientific Experts Now?* (Cambridge: Polity Press, 2014), p. 62.

⁵¹ Nieto-Galán, "Free radicals," 190.

⁵² Bernadette Bensaude-Vincent, "Textbooks on the map of science studies," *Science & Education*, 2006, 15: 667–670, on 668.

European periphery such as Spain: in the case of Antonio Casares, pupils in secondary education and artisans; in the case of his son, José Casares, students of professional schools and the educated middle class.

The different dimensions of Antonio's and José's Casares respective careers were deeply marked by kinship, family connections and influence, despite the distinct social, political, cultural and scientific contexts that each had to face and deal with. Antonio Casares' two marriages proved decisive in achieving wealth and social and political status; José Casares, in turn, certainly was able to manage and profit from his father's scientific authority, but he also needed to establish new allegiances and put in place different strategies of legitimization, in a different period of Spanish history, notably that of Franco's dictatorship. In this article, the comparison of the careers of members of the same family in sequential generations has thus the advantage of showing more clearly the various and distinct mechanisms of construction of expert knowledge in the field of chemical analysis in contemporary Spain, by studying two scientists who marked indelibly the development of Spanish chemistry between the mid-nineteenth and the mid-twentieth century.

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