Hilda Cid: physicist, crystallographer, structural biologist

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Abstract. A brief review of Dr. Hilda Cid, Chilean scientist who excelled in the field of crystallography, is presented. Dr. Cid was born in 1933 in Talcahuano, where she completed her primary and secondary education, graduating as a Teacher of mathematics and physics from the University of Chile in 1958. She continued graduate studies at MIT, USA, where obtained the PhD in 1964. Upon her return to Chile, she joined the Austral University in Valdivia, where she dedicated to characterize, by X-ray, biological material. During that time, she was actively involved in the social changes taking place in the university and in the country. Thus, following the bloody coup of 1973, she and her family were persecuted and forced to go into exile to Sweden. In the decade of the 1980 she returns to Chile, and settles at University of Concepción, where she teaches, conducts research and organizes a number of latino-american courses and symposiums. Knowing that Hilda Cid formed a real school, where her students -now distinguished professionals and researchers- cast their teachings through Chile and other countries, we ended the article with a reflection about why Hilda Cid, despite its obvious scientific achievements, remains ignored by most of the scientific establishment in Chile.

1. Introduction
Crystallography in Chile has a long history. Chile, as a mining country, have always required people and techniques in order to characterize the riches extracted from the earth. In the mid-nineteenth century, the State hired a chemical engineer of the French school, the Polish Ignacio Domeyko to teach mineralogy. The aim was to teach the new generations the latest hasten in exploration, prospecting, mining, as well as in the characterization of minerals.

Domeyko, educated in the Ecole de Mines in France, knew the state of the art on the subject, in particular the study of crystallography, which was in full bloom after the magnificent treaty by René Just Haüy was published in Paris in 1822 [1], a book which Domeyko knew well. Under the Government’s mandate, Domeyko was sent to the northern city of Coquimbo and then Copiapó, creating the first School of Mines in the country. Crystallography was one of the main subjects in the school’s program. There he introduced the concepts of crystallographic planes, and polymorphism symmetries, among others. Domeyko later moved to Santiago, where he started the area of materials science. Later he became rector of the main institution of higher education, the University of Chile.

The imprint of Domeyko had influence in Chile. The new generation of physicist in Chile reproduced in the late nineteenth century, soon after, the discovery by Roentgen, the X-rays.
Three months after the German scientist presented the x-ray picture of his wife’s hand, Arturo Salazar and Luis Ladislao Zegers, obtained in Chile a photograph of the bones of their own hands: this radiograph was the second in America and the seventh in the world [2, 3].

Following these paths, in the early 1950s, when basic science began to professionalize at the University of Chile, crystallography was chosen as one of the key disciplines, along with nuclear physics and cosmic rays [3, 4]. The laboratory was formed in the Pedagogical Institute, led by Nahum Joel, who studied in Paris and England under professor J. B. Bernal [5]. Researchers were recruited among students of physics education, and among them two women: Hilda Cid and Isabel Garaycochea. In the following we review some aspects of the multifaceted biography of Hilda Cid.

2. From Talcahuano to Concepción and then to Santiago
Hilda Cid Araneda was born in Talcahuano, a small port in southern Chile, on February 20, 1933, within a family of primary school teachers aware of the importance of education. Her father, Jose Cid Bastías, and her mother, Hilda Mendoza Aranda, formed a family in which their three children were university graduates. Daughter of public education, Hilda attended primary school at School No. 7 and 8 of Talcahuano, and her secondary education at the Liceo Fiscal the same city between 1944 and 1949. Outstanding student, as a teenager she began studying violin and then she took part of the Chamber Orchestra of the city of Concepción.

After successfully passing the Baccalaureate (the entrance exam to the University), in 1951 she enrolled in the Teacher’s career in physics and mathematics at the University of Concepción, led by an early vocation for teaching. She worked as supervisor at the Laboratory of optics between the years 1954-55 and in 1955 won the University prize awarded to the best undergraduate student in physics and mathematics. This was an incentive to move to the Pedagogical Institute of the University of Chile, in the capital, Santiago, where she completed the requirements for obtaining the title of Teacher of Physics and Mathematics in 1958, with distinction (summa cum laude). Hilda moved to Santiago because there were opportunities to do research in physics. She worked in the laboratory of crystallography, while she was an assistant professor in the Optics lab. The research carried out between the years 1955 to 1958 allowed her to write her thesis degree entitled “Some optical methods in determining the crystal structures by X-ray”, that was the basis for her firsts scientific papers. One of them was published in 1961 with Isabel Garaycochea, which is the first and (maybe still) the only paper published in the area of physics and materials science from Chile whose authors are two women [6]. Besides it scientific contribution, this paper is highly important for the history of exact sciences in Chile, as is among the firsts articles published from Chile.

3. From Santiago to Boston, nonstop
The passion for scientific investigation lead her to pursue postgraduate studies, being accepted into the Massachusetts Institute of Technology (MIT) in the USA. In September 1960, she undertook the trip to Boston, with two sons (Rodrigo, 4 years old; Jorge, 3 years old) and her husband. At MIT she continued her crystallography studies under Professor Martin J. Buerger, a world authority on that subject, who held the title of Institute Professor awarded in 1956 from MIT. Hilda Cid graduated of Master of Science in 1962, while pregnant with her third daughter, Rossana. Her thesis was about the determination, by X-ray, of the structure of a complex compound, the hexatitanate potassium [7]. Aware of the ability and talent of Hilda Cid, her advisor M. J. Buerger offered her to continue in MIT in order to obtain the Ph.D degree. MIT at that time was a redoubt formed almost only by men, both among its teachers and students. The doctoral program of the Geology department, at which M. J. Buerger worked, had graduated only 4 women between 1894 and 1964 (1931, 1939, 1948 and 1953) [8]. There was no customary for women to study science. An anecdote from the very Hilda Cid reveals
the situation: when pregnant with her daughter Rossana and her belly growing remarkably, no one in the laboratory spoke a word of the situation. Only at the time of birth she told her advisor that would be missing a couple of days: “I am going to give birth to a daughter”, to what Professor Buerger laconically replied: “OK”. The situation was so unusual that neither the student nor the Professor knew how to proceed.

By working on her doctorate, in just two years she ended up her thesis, obtaining the PhD in 1964. She became the first Chilean woman to earn that degree in the area of the exact sciences [9]. Her thesis, entitled “Crystal structure of the turquoise group minerals,” dealt with the determination of the atomic structure of a mineral called turquoise, which are phosphates of copper and aluminum. It gave her great knowledge and expertise in using X-rays to determine the structure of large and complex molecules. In this way, in 1964 she was able to determine the structure of the larger molecule resolved by this methodology to date: the atomic structure of terramycin [10].

4. From Boston to Valdivia
In 1964, upon receiving her doctorate, Hilda returned with their children to Chile, whereas her husband George Dresdner stayed on for another year in the USA to complete his Ph.D. in Biology. She joined the Lab of Crystallography at the University of Chile, now located at the School of Engineering, doing research, writing lectures notes and training new scientists, while waiting for her fourth son, Marcos. During the year 1965 she participated in the foundation of the Chilean Physical Society (Sociedad Chilena de Física, SOCHIFI). The decree of foundation of the Society appeared in the Official Gazette on November 9, 1965, and in Article 2 states that its purpose is “to encourage scientific research in the field of physics and related sciences, disclosure of this discipline and contact people whose primary occupation is the practice of this science”. The document details the first Directive: President: Dr. Jorge Zamudio Cristi; Secretary General: Dr. Hilda Cid-Dresdner; Treasurer: Engineer Egbert Schneider Hesse; Directors: Mr. Ruben Toro Valenzuela and Mr. Jorge Garcia Ruffinatti. This action is of prime importance: The SOCHIFI is the organization that would bring together the nascent Chilean physics community and organize, among other things, the bi-annual Symposia maintaining in contact Chileans physicists for the past forty years.

In 1967 she moved to the Austral University in Valdivia, eight hundred kilometers south of Santiago. This not only represented a change of city, but also a change of research topic. While completing her work on determining atomic structure of inorganic materials, she turned to biophysics, beginning to study the structure of macromolecules and biological material by means of X-ray diffraction. There were times of great effervescence in Chile, not only in the scientific field, but also at the university. There was a clamor for deep social changes in the country, which in the scientific community was expressed in the First National Congress of Scientists, one of whose objectives was to discuss a national science and technology program [11]. This Congress began with regional meetings in late 1971 and culminated in a major national meeting in July 1972. Hilda Cid participated actively in this process. In one of its resolutions, the Congress formally recognized the essential responsibility scientists and technologists had in devoting their research to solve the problems the country faced at various levels. The government, as expressed by socialist President Allende in his speech to the Parliament in 1973, was determined to implement the scientific community’s mandate. However, it all ended in September 11, 1973 with a bloody military coup.

5. From Valdivia into exile to Uppsala
The coup changed violently the situation of Hilda Cid: she and her husband, who was the Dean of the Faculty of Science in Valdivia, were exonerated from the university, and persecuted. Finally, they were pushed into exile. In February 1974 the Dresdner-Cid family landed in Arlenda,
Sweden, from where they travel to Uppsala, where they settled in a small apartment in the neighborhood of Flogsta. Hilda joined the Wallenberg Protein Laboratory at the University of Uppsala, where she devoted herself to the characterization by X-ray diffraction of biological molecules composed not only by the hundreds, but by the thousands of atoms. During her “swedish time” Hilda Cid published key articles on this topic. With her working group, she crystallized and characterized for the first time non-muscle actin. Also, they were able to determine the three-dimensional structure of carbonic anhydrase, an enzyme responsible for setting erythrocyte and convert carbon dioxide. Thus, she returned to the classic paradigm of molecular biology, which has brought so much success since the work of Watson and Crick, the close relationship between structure and function: “If you want to understand function, study structure” wrote Crick. Regarding the importance of her new research on protein tertiary structure, in an article published in 1980, she wonders if it’s worth the effort it means. In what might be considered as her researcher philosophy testament, she responds: “The question is whether it justifies the enormous effort of 5 years of work by a group of researchers who must bring together biologists, chemists, biochemists and crystallographers in determining the tertiary structure of a protein. The answer is yes. It is justified for some proteins. This means that the problem to be addressed should be relevant to justify the effort. In addition to the undeniable importance in the development of biological knowledge that has to determine the exact configuration of a protein molecule it must also be satisfied with the solution of a relevant problem.” [12].

6. From Uppsala to Concepción
In the late seventies, having already become a prestigious researcher in the field of protein structure, she decided to return Chile from exile in 1979 to her alma mater, the University of Concepción. She arrived to the Department of Physiology, to settle later in Molecular Biology, until her retirement in 1996. She brought a microdensitometer, microscopes and software donated by the University of Uppsala, and installed them in the Laboratory of Molecular Biophysics. There she developed a fruitful research activity in the area of structure and protein...
crystallography, in addition to lecture at undergraduate and graduate level. Participated and organized numerous national and international courses and congresses and symposia, becoming a Latin American authority on the subject. During this time she married for the second time, forming a new family with Nelson Saavedra, professor at the University of Concepción. In parallel, driven by her strong commitment to social justice, she became actively involved in the pro-democracy and human rights movement that took place in the 1980s in Chile. In particular, she was instrumental in the organization of the Association of Academics of the University of Concepción, being elected President, and in supporting the student movement against the military intervention of universities. In this process, in the mid-eighties she was exonerated again from the university. The great pressure exerted by, and the solidarity of, the community, forced the authority to reconsider the call. That was the leadership of Hilda Cid.

7. The living legacy of Hilda Cid
As noted by Dr. Marta Bunster [13], her colleague and disciple of the University of Concepción, Hilda Cid formed a “real school, where her students -now distinguished professionals and researchers- cast their teachings through Chile and other countries ... ”. And Dr. Bunster continued: “It is admirable that Hilda Cid, with an initial training in physics, has successfully penetrated in the study of protein’s structure-function, marking the beginning of these research in Chile. Dr. Cid is also a pioneer in promoting interdisciplinary scientific work, which she boosted in a visionary way, incorporating physical, mathematical and computational methods to their molecular biology research. Finally, an important feature that characterizes her entire research career is the persistent insistence on the need for science in Chile as an engine for development”.

Hilda Cid is an uncommon human being. A great female scientist; a great south American scientist; a committed social person. With so much scientific talent, when one searches Google, the only reference about her comes from the History of the 100 years of the Department Geology at MIT [8]. Little or nothing of her activities in Chile. Hilda Cid reunites not only a superior talent and a supreme human quality, but also features all that is negligible in our society today: she is female; she is provincial; she is the daughter of modest family; she was educated in public schools. Moreover, she did not follow a traditional career path: she sought the inter-discipline and changed research subject without complex: for physicists, she was a biologist; for biologists, she was a crystallographer. We could say that in a one-dimensional environment, she committed the sin of being expert in various fields, and not settle for lifelong keep singing the same ditty. To all of this, one should add her deep social commitment in difficult times in her country. The outcome is not difficult to guess: the silence, until today, of the establishment. It is time for the rest of us to honor the memory of Hilda Cid.

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