

## Henry Taube and his Legacy to the Chemistry in Brazil

Science has lost Henry Taube, one of the most creative contemporary scientists, who shaped the Chemistry of Alfred Werner into a new dimension, exploiting and constructing new connections between structure, thermodynamics and kinetics. He discovered the secrets embedded in the labile/inert behavior of the metal ions in solution, and the complex pathways of the electron transfer reactions, demonstrating for the first time the tunneling mechanism through a bridging molecule. With the puzzling Creutz-Taube molecule, he renewed the chemistry of mixed valence compounds, anticipating the age of intervalence transfer and molecular electronics.

Henry Taube was born in Neudorf city (Saskatchewan, Canada), in November 30, 1915. He was grown up on a farm, in contact with nature and rural life. From the University of Saskatchewan, Taube received his B.S. (1935) and M.Sc. (1937). At Saskatchewan, under the influence of Gerhard Herzberg, a Canadian refugee from Germany (Nobel Prize, 1971), Henry Taube decided to move to the United States in 1937, to complete his education at the University of California (Berkeley). After obtaining his PhD in 1940, under the guidance of William C. Bray, Taube remained for a year in Berkeley as instructor, becoming American Citizen in the next year. In 1941, supported by a strong recommendation from Gilbert N. Lewis, Taube was hired at Cornell University, working for five years as Assistant Professor. In 1946 Taube moved to the University of Chicago, where Herzberg was then working. At Chicago, he started his seminal work on metal complexes substitution and electron transfer reactions which would change the course of Inorganic Chemistry. There, Taube rose through the academic ranks to professor and department chair. His special way of thinking and teaching Chemistry, was characterized by a triangular approach based on structure, thermodynamics and kinetics, reflecting the influence of Herzberg, Lewis and Bray. In 1962 Taube moved to Stanford University (California), where he became the Marguerite Blake Wilbur Professor of Chemistry. At Stanford he conducted the most productive part of his career, investigating the mechanisms of inorganic reactions, and the role of  $\pi$ -backbonding in transition metal complexes. He highlighted the chemistry of Ruthenium and Osmium elements. Henry Taube was the winner of the Nobel Prize in Chemistry, in 1983. Taube's Nobel citation asserts his role in the leading edge of research in several fields, exerting decisive influence on the developments. He was recognized in eighteen listed instances, where he has been first with major discoveries in the entire field of Chemistry. His laboratory at Stanford produced many outstanding chemists, some of them well known to the Brazilian community, such as Thomas J. Meyer, Peter C. Ford, Carol Creutz, Stephan Isied, Rex Shepherd, John M. Malin, Patrick R. Jones and Michael Clark. Taube was Honorary Member of a dozen of Academy and Scientific Institutions. Besides the 1983 Nobel Prize in Chemistry, he also won a long list of prizes and honors, including two Guggenheim Fellowships (1949, 1955), the National Medal of Science (1977), the National Academy of Sciences Award (1983), the Robert A. Welch Award in Chemistry (1983) and the Priestley Medal of the American Chemical Society (1985).

Taube first interactions with Brazil dated from 1969, when he accepted the challenge of conducting the *NAS/CNPq* Program in the Inorganic Chemistry area at the University of São Paulo, together with the Brazilian Professor Ernesto Giesbrecht. This Program represented a novel initiative, which led to the innovation of the Chemistry in Brazil from 1969 to 1977, by locally producing qualified human resources under the guidance of renowned American Scientists. The key role in the Program was played by young American fellows, who established scientific connections and interacted strongly with the Brazilian students at the University of São Paulo (USP) and the Federal University of Rio de Janeiro (UFRJ). One of the aims was to prevent the so called brain drain, often observed as consequence of the better opportunities offered by the developed countries to the Brazilian and foreign graduate students, inhibiting their return after accomplishing the PhD program abroad. For Henry Taube, another challenge was to prove that it should be possible to produce high quality science in Brazil by providing the necessary support, as typically found in the developed nations. Such conditions

required efficient scientific interchange, new instrumentation for research and rapid importation of consumables and services. In fact, at that time, for the sake of success, the official rules were occasionally broken and even the Brazilian Air Force was demanded in order to speed up the transport of equipments and supplies. There was a real commitment between the Government and the *NAS/CNPq* Program, because of the highest ranking of the American and Brazilian scientists involved and of the expected international impact associated with such initiative, as a model program for future application in other developing countries. Now, making a retrospect, among the problems and success of the Program, it becomes clear that the Human factor was of uppermost importance. And in this sense, a special credit should be given to Henry Taube, for his role in the Program, as remarkable Scientist and Humanist.

At the University of São Paulo, a Fast Kinetics Laboratory incorporating stopped-flow and relaxation techniques was established at the end of 1970 under the competence of John Michal Malin, the first American fellow designated by Taube. After the first three years term, Malin returned to US, but the Laboratory kept working under the supervision of Henry Taube up to 1977, with a brief participation of the American fellow Edward R. Dockal, until the graduation of the first student, Henrique E. Toma, in 1974. Augusto L. Coelho (UFC) and Mercedes S. Pereira were also part of this group. The frequent visiting of Henry Taube to Brazil were rather exciting and productive. Traditionally, the discussions proceeded from early morning to late evening, even on Saturdays and Sundays, always accompanied by a wager on the conflicting results. Invariably, he was always right. In 1977, when Luiz A. A. de Oliveira obtained his doctoral degree under the supervision of Toma, the Brazilian Group had accumulated enough training and reputation to proceed independently, and Henry Taube considered his task and challenges successfully accomplished. There is another interesting aspect to mention. Along the eight years of the *NAS/CNPq* Program, the USP Laboratory had published many high impact articles in *Journal of the American Chemical Society* and *Inorganic Chemistry*, as highlighted in Current Contents. However, in spite of being the group's mentor, Taube has never accepted any co-authorship in the papers, taking personally his involvement in a truly humanitarian endeavor. Later, in confidence, he explained that, as an author, the merit of the publications would be credited mainly to him, rather than to the Brazilian group and the *NAS/CNPq* Program.

At the end of the Program, Taube and his former students opened their laboratories to the Brazilian students, starting a new decade of fruitful collaborations, particularly with Douglas W. Franco, at São Carlos and Elia Tfouni at Ribeirão Preto. Taube's last Brazilian graduate student was Fabio Souza Nunes, from the Federal University of Paraná. Along the years, the increasing number of scientists and research groups multiplied Taube's scientific heritage in Brazil, producing hundreds of fellows spread all over the country. The *NAS/CNPq* Program showed the importance of developing Science in the international context, and provided the clues, strategies and confidence for launching new initiatives in Brazil, such as the National Program of Chemistry, *PRONAQ* (1980-1985) and the National Program for the Development of Science and Technology, *PADCT*, (1985-2005).

Henry Taube devoted a very especial affection to Brazil, sharing his knowledge, friendship and enthusiasm during his visiting as invited lecturer or consultant of the Special Evaluation Group (*GEA*) of *PADCT* for many years. He joined the Editorial Council of the *Journal of the Brazilian Chemical Society*, since its foundation in 1990. Nowadays, *JBCS* has reached a top position, as the highest impact scientific journal of Latin America. He also contributed to the Science in Argentina (M. A. Blesa) and Chile (C. G. Andrade-Plaza). In 1991 Taube became Member of the Brazilian Academy of Sciences, and in 1994, he was honored with the Grã-Cruz Medal from the Brazilian Government.

The Brazilian Chemical Society sadly misses his absence, since November 16, 2005.

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