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The American Chemical Society lists Professor Csaba Horváth alongside such great scientists as James Watson, Linus Pauling and Ernest Rutherford, individuals who have contributed significantly to the developments of chemistry in the 20th century.

Csaba Horváth is widely acknowledged as a pioneer of modern separation science, particularly of high-performance liquid chromatography (HPLC) between the late 1960s and early 1980s. During recent decades he made further important contributions to electrodriven separation techniques, especially to capillary electrophoresis (CE) and to capillary electrochromatography (CEC).

Born in 1930 in Szolnok, Hungary, he graduated in chemical engineering from the Technical University of Budapest in 1952, where he remained until 1956. Following the revolution in Hungary he left for West Germany and got a job at Farbwerke Hoechst AG involving chemical process technology. In 1961 he returned to academia and started doctoral studies in gas chromatography under supervision of István Hálász at the J.W. Goethe University in Frankfurt am Main. Horváth developed novel columns types, and one of them, the support-coated open-tubular column (SCOT), was later successfully commercialized. After receiving his PhD he emigrated to the USA, was one year at Harvard and since 1964 has been associated with Yale University in New Haven, starting as an associate professor in the School of Medicine. In this laboratory he started to develop, what later became known as HPLC. In fact it was Csaba Horváth, who first named the technique “High Performance Liquid Chromatography” in a lecture at the 1970 Pittsburgh Conference. A year later at a seminar in Rome, Italy, everybody was talking about “akka-pée-ella-chi”, which means HPLC and sounded beautiful also in Italian.

Csaba has frequently demonstrated a particular interest in the philology of words connected to separations, and today many well-known terms originate from him, for example pellicular packings, stratified stationary phases, hetaeric chromatography as a synonym for ion-pair chromatography using hetaerons (“counter-ions”) and multimodal separations.

Csaba Horváth (Roberto C. Goizueta Professor, Chemical Engineering Department, Yale University, New Haven, Connecticut, USA), the founder of modern HPLC, the pioneer of reversed-phase chromatography died on 13 April 2004 after a series of strokes. He was 74 years old.
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Towards fundamental studies on reversed-phase chromatography (RPC). He adapted the solvophobic theory and developed a universal thermodynamically based model for the retention mechanism in RPC. Treating solute retention as a reversible association of the solute with hydrocarbonaceous ligands of bonded phases, he was able to describe liquid-solid chromatography in a fundamental fashion and established a basis for the use of the technique for physicochemical measurements. The theory had a major impact on the separation science community resulting in extraordinarily high citation numbers. The unexpected success of RPC with UV detection resulted from the fact that it is a mechanically robust technique employing siliceous bonded phases, easy to use because of rapid column regeneration and is selective using a wide variety of mobile phases.

RPC revolutionized “normal” phase chromatography, in which silica columns and non-polar organic eluents were applied — incompatible with aqueous life science samples because of emulsion formation in the UV detector cells. The application of aqueous mobile phases in RPC made possible the analysis of non-volatile water-soluble molecules, such as peptides and proteins.

Csaba Horváth and his co-workers found, that retention in RPC is dominated by the lipophobic forces of water in the aqueous mobile phase. The lipophobility in the eluent is proportional to the amount of water (%A) and can be reduced by mixing methanol or acetonitrile with water. Based on this theory, C18-modified silica columns, which were needed in biochemistry and pharmaceutical research, quickly emerged in the 1970s and revolutionized life science. Surface silanols enhance the selectivity of HPLC columns under a given set of conditions. Today there are approximately 750 different RP columns available, demonstrating the great popularity of the technique in pharmaceutical and biotechnological applications, which were the main driving forces for the rapid development of RPC.

He calculated and published the effect of secondary equilibria in RPC, such as the mobile phase pH on the retention of ionizable molecules and he also investigated ion-pair interactions for changing selectivity in a continuous way in RPC. Csaba Horváth returned to the solvophobic theory in 1998 and stated that partition and adsorption could both be explained well in the frame of the solvophobic theory of RPC, which meant that the composition of the eluent has a dominant role governing RPC retention and that the ligand chain length has a much smaller effect on selectivity, than the influence from the mobile phase.

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Csaba Horváth (centre) pictured with Günther Bonn (left) and Imre Molnár (right).
During several decades Horváth concentrated his research in HPLC and was one of the first to investigate the highly efficient separation of amino acids, peptides and later proteins, comprising both high-speed analytical methods and preparative separations.

Of special interest was the refinement of displacement chromatography for preparative separations, a technique pioneered by the Swedish Nobel Laureate, Arne Tiselius. The technique has recently been applied to enhance sensitivity in analytical peptide separations coupled to mass spectrometry (MS).

Miniaturization and the availability of fused-silica capillaries brought about major instrumentation changes in the early 90s and Csaba immediately started exploring electric field mediated separations in narrow bore tubings. First, he applied this technique to the analysis of complex carbohydrates in collaboration with Andras Guttman, who worked at Beckman Instruments at that time. Later his attention turned to the understanding of the fundamental issues of capillary electrochromatography, a hybrid between µLC and capillary electrophoresis (CE).

His research interests included fundamental and applied studies on CE and capillary electrophoresis (CEC). He pointed out that by running CE at ~17 °C, the resolution of optical isomers can be improved by a large factor. Also, because the conductivity and viscosity are lower, one can apply a higher field, which reduces analysis time. Analysis of various conformers of peptides is also possible by running at less than 0 °C. He also continued the development of new adsorbents for biopolymer separations, theoretical and applied non-linear chromatography, high-speed HPLC, and biomacromolecular interactions. He was also an expert of “hydrophobic interaction chromatography (HIC)” for protein separations.

Csaba was famous for his humour. Before RPC became popular, everybody used chromatography with unmodified silica and organic mobile phases, that was “normal”. Later in the 80s, in view of the great popularity of non-polar (reversed) phases in HPLC, he suggested that the use of “normal” stationary phases should be termed “reversed RPC.”

The success of HPLC was delayed in protein biochemistry as conditions had to be selected carefully so as not to destroy biological activity. Csaba Horváth tried to calm the fears, and in so doing, help the biochemists to cure their “litho-, sidero- and barophobias”, their fears of sharp silica edges, from metal ions and from high pressures damaging the biological active tertiary structure of proteins.

In recognition of his fundamental and innovative scientific work essential for the development of separation science to a mature tool, especially in the life sciences, Csaba Horváth was honoured by numerous awards from all over the world. These include:

- Dal Nogare Award (1978)
- Anniversary Medal of the All-U nion Scientific Committee in Chromatography of the USSR Academy of Sciences (1979)
- M.S. Ts wett Chromatography Award (1980)
- Humbold Award of the German Federal Republic (1982)
- National Award in Chromatography of the American Chemical Society (1983)
- Chromatography Award of the Eastern Analytical Symposium (1986)
- Van Slyke Award of the New York Metropolitan Section of the American Association of Clinical Chemists (1992)
- Alasz Medal (1997)
- Michael Wildmer Award of the New Swiss Chemical Society (2000) sponsored by Novartis
- “Ehrenkranz of Art and Sciences” of the Austrian Academy of Science (2002)
- Bergman Medal of the Swedish Chemical Society (June 2003)
- National Award of the Hungarian Chemical Society (October 2003)

Csaba was member of numerous scientific societies in several countries (Hungary, Germany, Sweden, Argentina to name a few).
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Few). In addition, he was an external member of the Hungarian Academy of Sciences, a member of the Connecticut Separation Science Council (CSSC) and the California Separation Science Society (CSSS).

His 70th birthday was celebrated at numerous events in several countries and to mark the occasion the "Horváth Symposium" was organized at Yale University by his former students in January 2000. To express their appreciation they gave presentations of their latest scientific results. The full programme can be found at the www.yale.edu and represents the still evolving fields of separation science initiated by Csaba Horváth.

These students form a truly international group, originating from Hungary, Germany, France, Sweden, The Netherlands, Russia, China, Italy, India, Lebanon and the USA. They have created a Yahoo newsgroup with 82 members proudly calling themselves “Csabaites”. Although they were in Csaba’s laboratories at different times, they all know each other because of regular visits, where they enjoyed stimulating discussions and listening to Csaba Horváth’s new visions and ideas.

Csaba loved to cook or eat in restaurants with his students. Many interesting scientific discussions were conducted at such occasions and Csaba never got tired of listening to his students’ ideas. He even went to New York to pick his students from JFK airport, as he was afraid that some would get lost as many didn’t speak English at all. In one instance, with Ziad el Rassi, Csaba tried to make conversation on the way back to Yale – without any success. Finally he asked Ziad, “Can you cook?” “Cook?” that was the first word Ziad did understand and he answered with a happy “YES”, so communication could start — by a joint cooking in the kitchen, continued with the amazing number of over 20 scientific publications in the years to follow.

It has to be remembered that Csaba Horváth was a hard worker. His curiosity for new scientific findings kept him in the laboratory until late at night, weekends included.

Unfortunately, his stroke took him away from us surprisingly quickly. He was still trying to work on a scientific paper during his final days in hospital.

In February 2004 he was elected to the National Academy of Engineering “For pioneering the concept and reduction to practice of high-pressure liquid chromatography (HPLC) and for leadership in the development of bioanalytical techniques.”

Unfortunately he died on the day that was selected for the celebration.

Csaba’s students are currently discussing how to honour him with their work. A special issue of Journal of Chromatography is being planned, containing review articles on work inspired by his achievements.

We are not only missing an outstanding scientific mentor but also a dear friend. Although we can not compare with his scientific excellence, energy and humour, his students will continue the work they started with him. Csaba will continue to live on in his family, the Csabaites and within the scientific community worldwide.

May God give you peace, Csaba, our dear friend.

References