Gérard Descotes: a pioneer of French modern carbohydrate chemistry

Jean-Pierre Praly,*[a] Grahame Mackenzie*[b] and Yves Queneau*[a,b]

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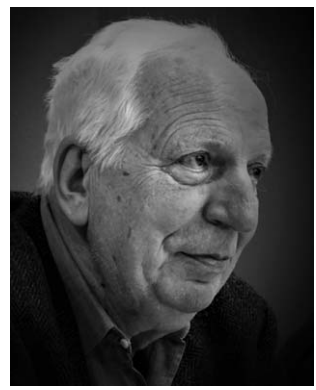

Professor Gérard DESCOTES
(1933–2020)

Gérard Descotes was born in Lyon on the 6th May 1933 and spent his childhood in the La Croix-Rousse neighbourhood. He gained his degree of Ingénieur-chimiste de l'ESCIL (Ecole Supérieure de Chimie Industrielle de Lyon) in 1954 and embarked on a career at the University of Lyon as a CNRS research Fellow. There, he conducted a thesis entitled 'Use of chlorobutynol and chlorobutenol in the synthesis of primary alcohols with complex functions', under the supervision of Jean Colonge and was awarded ''Docteur *es* Sciences Physiques'' in 1958. Returning to Lyon after having served in the Alpine Hunters for his military service, he was appointed as lecturer at the University, ESCIL and CNAM (Conservatoire National des Arts et Métiers). In 1962, at only 29 years of age he was appointed as ''Maître de Conférences'' (the current grade of Professor) at the University of Lyon.

At that time, he created the LCO2, ''Organic Chemistry Laboratory II'' of ESCIL in the rue de Marseille building that has since disappeared,

[a]*Université de Lyon, CNRS, Université Lyon 1, INSA Lyon, CPE Lyon, ICBMS, Institut de Chimie et de Biochimie Moléculaires et Supramoléculaires, UMR 5246, Bât. E. Lederer, 1 rue Victor Grignard, 69622 Villeurbanne, France. E-mail: yves.queneau@insa-lyon.fr*

[b]*Department of Chemistry, University of Hull, Cottingham Road, Hull HU6 7RX, UK. E-mail: G.Mackenzie@hull.ac.uk*

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prioritising initially on the chemistry of oxygenated heterocycles and on thermal and photochemical cyclisations of alcohols. In 1967, he moved to the then new ESCIL building on the Doua Campus, which offered a more functional laboratory environment. Annie Briant, as secretary and Marie-France Cadot, as NMR technician, were recruited by Gérard Descotes at this time and both remained with him as faithful collaborators throughout their entire careers. Also, for many years, Adrienne Uberty ensured the cleanliness of the laboratory and, through her unparalleled culinary talents, enhanced the convivial post thesis examination celebrations, with her specialty 'mâchons' (of course, of the type Lyonnais) and other memorable delights. Particularly awaited by the team was the end-of-year outing, to Morestel or Fleurieu-sur-Saône where Gérard Descotes and his wife Colette opened their country house to the whole lab team who, once entertained, indulged in ping-pong, tennis, pétanque or enjoyable swimming. Even though many years have passed since, the spirit has remained, and the laboratory is still present in 2021 under the name ''LCO2''. Gérard Descotes with his colleagues Maurice Chastrette and Jacques Goré led the evolutions and regroupings that took place over the years, in association with the CNRS.

Early in his career in the 1970s Gérard Descotes turned his attention to the field of sugars, an area of research that he considered to be of much significance for the future because of the emerging importance of sugars in industry, synthetic chemistry, biology and health. Much was still to do in the field, considering their abundance as a plant biomass resource and their potential for presenting new challenges in chemistry; their complex nature offered opportunities for a wide range of new products to accommodate a wide variety of potential applications. His first work was concerned with the anomeric effect using dipolmetry and pycnometry, then using Nuclear Magnetic Resonance (NMR), which although in its infancy, allowed determination of coupling constants helped by Jean-Claude Martin and Marie-France Cadot.

From the very beginning of his career, and against the tide of a certain reluctance by others in the academic world, Gérard Descotes showed the capacity and personality to develop links with industry, which included several companies in Lyon and the region for example, Rhône-Poulenc Textiles, Le Dauphin à Bourgoin-Jallieu, PéPro, Lipha and CIRC. Due to the variety of areas of production by these companies, he was able to introduce a diverse range of research themes and skills within his group that was also of use to these companies. Throughout his career, he was keen to lead parallel fundamental and applied projects, which often attracted collaborations outside of the region and many foreign academics.

As early as 1975, Gérard Descotes joined a collaboration initiated by André Laurent with chemists from the University of Łódź in Poland. He and Denis Sinou became key players in this collaboration, which was extended for several years, forged by links with Romuald Skowroński, Jan Michalski, Bogusław Kryczka in Łódź, and Aleksander Zamojski and Sławomir Jarosz in Warsaw. As well as many Polish students, many other nationalities from all over the world frequented the laboratory, including

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Iran, Syria, Lebanon, Morocco, Madagascar, Tunisia, Ivory Coast, Brazil, Canada, China and Vietnam, along with Germany, Hungary, Romania and the UK. Robert J. Ferrier spent a few months in Lyon and some Lyonnais students and post-docs were received by Henry Kagan in Orsay, Sir Derek Barton in London, Richard Schmidt in Constance and Raymond Lemieux in Edmonton. Gérard himself, was hosted as a visiting professor in Edmonton, Montreal, Constance and Antananarivo.

It is of note that Gérard Descotes' work pertaining to the chemistry of sugars, was approached using diverse and original methodologies. Within his early studies notable examples of innovative work include: catalytic hydrogenation by homogeneous and heterogeneous methods (with Jean Sabadie); catalytic hydrogen transfer (with Denis Sinou); the metathesis reaction (with Jean-Marie Basset and Jan Ramza), following an earlier joint work (Paul Chevalier PhD thesis, 1975) with Dr Yves Chauvin, who shared the 2005 Chemistry Nobel prize. Photochemistry was also prominent in his works, for example in photo-oxygenation reactions with Louis Cottier giving cycloadducts between singlet oxygen and 5-hydroxymethyl-2-furaldehyde, which is a heterocycle resulting from the breakdown of sugars and present in some food products when exposed to heat (work with the company Nigay in Feurs). Photochemistry can involve mild reaction conditions, which enabled brominations and spirocyclisations with acetals and sugars. This technique showed the potential of radical reactions, little known at the time, with major progress having been made in collaboration with Jean-Pierre Praly, using tin derivatives to synthesise new *C*-glycosyl compounds and in explorations into various reductions and cyclisations. Reactions of sugars using polar conditions were also explored in collaboration with Paul Boullanger, Dominique Lafont and Joseph Banoub. In their explorations on glycosylations of glucosamine, they produced various modified sugars to include mono- and oligosaccharides of biological interest (*e.g.* antigens, modified nanoparticles). These two general approaches enabled Gérard Descotes to develop new chemistry at the anomeric position of sugars in mild and stereoselective reaction conditions. Under the umbrella of sugar chemistry, the synthesis of nucleosides was also explored in Gérard Descotes' laboratory in collaboration with Annie Grouiller, Grahame Mackenzie and Joseph Banoub, with support from the CNRS and the National Agency for Research against AIDS (ANRS).

While pursuing his fundamental project on new methodologies at the interface between chemistry and biology, Gérard Descotes entered into a long collaboration with the Béghin-Say group, supported by the CNRS. It was initiated in 1980 through the supervision of a thesis, undertaken and defended successfully by Julio Mentech. Many more theses were to follow, during which this collaboration had taken on increasingly structured forms. In this respect, in 1985 there was the creation of a consortium on 'Sucrochemistry' associating a dozen laboratories within the University and the CNRS. The teams of Gérard Descotes, André Lubineau, Jacques Defaye, Michel Fontanille, Jacques Gelas, Claude Lamy, André Mortreux and Julio Mentech met annually or even twice a year for almost 10 years. During a further ten years they united in the

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formation in 1995 of a Mixed Research Unit, sponsored by the CNRS and Béghin-Say, involving the same members as advisers joined by Serge Perez. This unit was co-directed successively by Julio Mentech, Gérard Descotes and Yves Queneau, and was installed on the INSAVALOR premises to accommodate Gérard Descotes' former doctoral students who then became members of the Béghin-Say R&D team. Members included Alain Bouchu and Jean-Paul Maitre, and more than ten doctoral students until 2002. An incredible disciplinary richness (synthesis, materials, electrochemistry, modelling, catalysis, chemistry in water, sonochemistry ...) were the ingredients of this remarkable adventure, throughout its various phases as a consortium or defined team. This period was also the golden age of the ''Carbohydrates as Organic Raw Materials'' congresses, which was a series of meetings that Gérard helped launch, notably with Frieder Lichtenthaler in Darmstadt. In July 1992 Gérard Descotes organised in Lyon the 2nd edition of this series as a satellite meeting of the Paris 'International Carbohydrate Symposium' chaired in by Pierre Sinaÿ. Emerging from this congress in Lyon was a book edited by Gérard Descotes and published by Wiley-VCH in 1993.

Gérard Descotes' influence on the French and international scientific communities was and continues to be very important. This is reflected first in his role as mentor for several generations of scientists, French and foreign, including more than 100 doctoral and post-doctoral students between the 1960s and 2000s. His scientific work has been rich in innovation and quantity reflected by nearly 400 articles, book chapters, and patents. It is remarkable in its thematic and methodological diversity, combining organic synthesis, catalysis, photochemistry and radical chemistry, covering issues ranging from biology extending to recovery of plant biomass.

Finally, resulting from his commitment to serving the carbohydrate community, he was elected president of the French Carbohydrate Group in 1980 and 1981 and organized a very successful conference in Aussois in 1980. Extending upon his decisive role in the implementation of Carbohydrates as Organic Raw Materials congresses, he was also one of the regional editors for the Journal of Carbohydrate Chemistry (Marcel Dekker then Taylor & Francis) from its launch in the 1980s, with continuity over 20 years, until 2001 when he retired. He continued to be interested in academic life. In 2004 he published an article in l'Actualité Chimique, entitled ''Sugars and Chemistry'' to follow his conference presentation on the 19th June 2003 as part of the symposium devoted to ''V. Grignard and the Treaty''. In his article he covered the history and advancements of knowledge in sugar chemistry and its many applications since the Second World War.

Gérard Descotes was honoured with several awards over the years. Notably, celebrating his links with Poland, he was awarded with the honorary insignia of the city of Łódź, followed by the prestigious Maria Skłodowska-Curie Medal in 2000. He also received two titles of Doctor Honoris Causa, awarded by the University of Łódź and by the University of Debrecen. To acknowledge the significant contribution to industrial partnership and sucrochemistry, he was also awarded with the ''Europol'Agro'' prize in 1998 jointly with his team at UMR Sucrochimie.

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As part of a global sustainable development approach, all of these outcomes as outlined herein, reflect a great intellectual openness, which has facilitated the dissemination of new knowledge and ensured the continued international influence and reputation of the LCO2 laboratory in Sugar Chemistry. Gérard Descotes died on March 17, 2020. Very many are those who owe him a lot and who appreciated him, are keeping the memory of a man of action, a man of culture, and a jovial personality enjoying the pleasures of life ... à la Lyonnaise!

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