

## Kuppuswamy Nagarajan (1930–2023)

The Indian scientific community lost one of the doyens of chemistry, Professor K. Nagarajan. He passed away on 8 April 2023 at the age of 92. He was affectionately known as KN by his colleagues and admirers.

I have the fondest memories of KN, whom I have known for over four decades. His intelligence and sharp wit always bring a smile to my face. One particularly memorable moment was during our Recon days in Bengaluru when we moved to a new R&D facility with beautiful landscapes and potted plants everywhere. When his secretary took one of the colleagues to show the new foliage installations in his office, arranged nicely in new brass planters, the younger colleague responded with a 'Wow!'. Just then, Nagarajan walked in and, without batting an eyelid, in his inimitable style, said, 'Well, what did you expect? This is the top BRASS'. His quick wit and humour lit up the room and brought us joy. Even the young colleague, who was initially a bit nervous, was put at ease by his playful spirit.

I had the honour of collaborating with Nagarajan, who was not only brilliant but also an exceptional individual. He treated all his colleagues equally, introducing them as peers rather than subordinates or assistants. His love for science was infectious, and he possessed the patience and expertise to explain even the most complex concepts straightforwardly and provide practical solutions. He was undoubtedly one of the most outstanding scientists I have ever had the privilege of working with.

KN was born on 15 September 1930 in Siruvalai village in Tamil Nadu, to K. Kuppuswamy Iyer and K Rajammal. He was one of seven brothers, all of whom were highly educated, with a few even holding doctoral degrees in Chemistry. He attended P. S. High School and Ramakrishna Students Home in Chennai, where he imbibed values of excellence and humility that remained with him for life. His father was a renowned science teacher at P. S. High School in Mylapore. He completed his intermediate course from Presidency College in Chennai and his B.Sc. (Hons) from Loyola College. At 23, he obtained his Ph.D. from the Presidency College in Chennai under the guidance of T. R. Govindachari, one of the triumvirates of Chemistry at that time.

Nagarajan's unwavering commitment and diligent efforts as a post-doctoral researcher

in the laboratory enabled him to acquire expertise in Indian medicinal plants, including *Tylophora asthmatica*, *Aristolochia indica* and *Wedelia calendulacea*. This experience proved invaluable for his subsequent research pursuits, as he developed a profound comprehension of natural products, their isolation, structure elucidation and applications. His dedication to his work and fervour for research serve as a source of inspiration for those in his circle.



During the years 1957–59, KN worked as a post-doctoral fellow with C. L. Stevens at Wayne State University in Detroit, USA, focusing on amino-sugar nucleosides. He then spent a year with D. Roberts, a well-known physical organic chemist at the California Institute of Technology in Pasadena, USA, studying nuclear magnetic resonance (NMR) spectroscopy and small ring molecules. He also spent a year as a post-doctoral researcher with Schmid at Zurich University in Switzerland, where he worked on alkaloid chemistry as part of a pre-employment stint with CIBA. These experiences gave him valuable insights into the use of NMR for studying complex molecules and reaction mechanisms, especially in the early stages of the development of NMR technology. Throughout his career, KN used his experience to identify impurities in products by analysing minor peaks in an NMR spectrum, even if they were present in less than one or two per cent. It is important to note that during his time, NMRs operated at a frequency of 60 MHz, as opposed to the 600 MHz NMRs used today.

Nagarajan gained experience in industrial research by starting his career as a trainee at CIBA in Basel, Switzerland. He later became an exchange scientist at their facility in New Jersey, USA. While many Indians chose to stay in the USA, he returned to India to become the head of medicinal chemistry at the newly opened

Hindustan CIBA-GEIGY Research Centre in Goregaon, Mumbai. His Ph.D. mentor, Govindachari, was the head of the centre. At the time, CIBA Research Centre was among the most advanced research centres in Asia for drug discovery.

At CIBA, Nagarajan specialized in medicinal chemistry, specifically synthetic heterocyclic chemistry and natural products. He was able to create more than 15,000 new chemical compounds, with 20 of them undergoing clinical trials to treat various ailments such as filaria and hypertension. Some of his notable contributions include selling the antidepressant Sintamil and acquiring marketing permissions for tranquiliser Taomax, nasal decongestant Varsyl, anthelmintic Ancletol and antiprotozoal Satranidazole, which was marketed by Alkem laboratories in March 2000. He also extensively researched a novel anti-TB preparation, CGI 17341. For almost two decades (1963–1984), he headed the Medicinal Chemistry division of CIBA Research Centre, concentrating on drug discovery. Several new reactions were discovered during this time, and their mechanisms were elucidated. Additionally, a new method of peptide synthesis was established, and he was able to publish a large number of articles on his research. His outstanding contributions to medicinal chemistry earned him the prestigious Shanti Swarup Bhatnagar Award at age 44 – perhaps the first person to receive this award while working in the industry. In 1984, KN became the Director of R&D at Searle (I) Ltd, now known as RPG Life Sciences. He was responsible for leading a team of more than 50 scientists who researched active pharmaceutical ingredients (APIs) and agrochemicals, as well as analytical development. During his eight years at Searle, he was instrumental in introducing new, cost-effective technologies for producing pharmaceutical and agro-chemical products. Additionally, he oversaw the formulation, development and marketing of pesticides such as Cypermethrin, Flucythrinate, MTI 500, Butachlor and MON 7400. He also mentored students pursuing doctoral degrees from Mumbai University while at Searle.

Nagarajan joined Recon Limited (previously known as Bangalore Pharmaceutical & Research Laboratories) in Bangalore as the Director of R&D and a Board Member after he retired from Searle India. During his time there, he led a team of more than

80 scientists who worked on API development, pharmaceutical formulations, and pilot plants. He played a significant role in establishing a brand new R&D centre that had state-of-the-art equipment and dedicated laboratories for chemistry, pharma and analytical purposes. Under his supervision, innovative and patented processes were introduced for newer APIs and dosage forms. One of the noteworthy achievements was the introduction of Nimesulide, a new anti-inflammatory drug in India, after completing all the regulatory requirements. Similarly, a novel process for an anti-epileptic drug called Gabapentin was successfully introduced in the market and is still being used to manufacture and export multi-ton quantities of this drug. Recon's business also expanded into contract research and manufacturing, resulting in the synthesis and supply of over 250 new chemical intermediates, some of which are still being exported in bulk today.

KN played a crucial role in establishing the 'National Organic Symposium Trust' (NOST), a non-governmental organization based on the Gordon Research Conferences in the United States. The aim of NOST was to gather all organic chemists in India, along with some professors from foreign universities, to discuss the latest developments in the field. Thanks to his dedication, the association was a great success, and young chemists considered it an honour to receive an invitation to present their work at NOST. As a result, the junior NOST was formed, which provided a platform for doctoral students in chemistry to showcase their research.

After Hikal Ltd took over Recon Limited, KN stayed on as an advisor and formed a scientific advisory committee with distinguished scientists from both industry and academia. This committee helped guide and develop science policies for the organization. Despite being 85 years old, he continued to visit the production facilities and provide suggestions. He also authored several publications during this time. Sadly, due to the pandemic, he had to stop actively participating in his beloved chemistry activities temporarily.

Nagarajan has received several prestigious awards, including the Bhatnagar Award and fellowships from the Indian National Science Academy, the Indian Academy of Sciences, the Maharashtra Academy of Sciences, and the New York Academy of Sciences. In addition, he received the Lifetime Achievement Award from the Chem-

ical Research Society of India in 2004. He has also been invited to give lectures at universities both in India and abroad, including Wayne State University, the University of California Irvine, and Arizona State University in the USA, as well as Zurich University and Berne University in Switzerland, the University of Wurzburg, Kohn University and the University of Marburg in Germany and the University of Paris. He has participated in several national and international workshops and was invited to chair a session at the Natural Products Symposium in Delhi and the 10th International Conference of Organic Synthesis in Bangalore in 1994. Additionally, he has worked with several laboratories and universities, including Endo Laboratories, CIBA Pharmaceutical Company, and various national labs and IITs in India.

Nagarajan held several prestigious positions throughout his career, including President of the Indian Chemical Society in Bombay and Vice-Chairman and Board of Trustees of NOST. He also served as a member of the Editorial Board for several publications, such as the *Indian Journal of Chemistry*, *Proceedings of the Indian National Science Academy*, *Proceedings of the Indian Academy of Sciences*, *Indian Journal of Pharmacy*, and the *Journal of Aromatic and Medicinal Plants of India*. He was a respected lecturer and delivered talks, such as the Chevalier Machado Endowment Lectures at Madurai Kamaraj University, as well as lectures through the visiting Professorship Scheme, including the Professor K. Venkataraman Endowment Lecture at Bombay University, the Shah Endowment Lecture at Bombay University, and the Suresh Sethna Endowment Lecture at M. S. University, Baroda. Additionally, he presented the Platinum Jubilee Lecture at the Indian Science Congress. Throughout his career, Nagarajan also served as a distinguished research council member for various institutions, including NCL, IICT, CDRI, IIIM, and CIMAP, as well as an expert for several DBT and DST projects. Nagarajan had a thriving career in chemistry, providing advice and consultation to pharmaceutical companies, guiding scientists and teachers pursuing Ph.D.s, and publishing research papers until 2022. Despite his busy schedule, he made time to collaborate with renowned chemists from India and around the world, resulting in numerous publications. Over his six-decade career, he authored more than 300 papers in peer-reviewed international journals and

held multiple patents. Even in his final months, he continued contributing to the field, publishing a paper just eight months before his passing. Nagarajan also acted as a consultant for M/s Rallis India Limited, Astra Zeneca Research Centre, and Alkem Laboratories, utilizing his expertise to benefit these organizations.

In 2006, Nagarajan visited Roberts and managed to obtain a sample of a compound he had synthesized in his lab in 1959–60. This compound's structure was unknown then, but with the help of Guru Row at IISc, Bangalore, Nagarajan used the XRD technique to solve it. This work was published in the *Journal of Organic Chemistry* under the title 'Chemistry of 1-Fluoro-2,3,4-triphenylcyclobutadiene Dimers' (*J. Org. Chem.*, 2007, **72**(25), 9732–9735). Nagarajan's generosity extended to helping teachers and students from less privileged academic institutions. He offered his assistance not only in obtaining IR, UV, and NMR spectra but also in researching chemicals and providing interpretation when needed. During his active period, Nagarajan was a highly sought-after examiner for M.Sc. dissertations and Ph.D. theses from various prestigious universities, IITs, IISc and national laboratories.

Besides his knowledge of chemistry, he had a vast interest in sports, classical Carnatic and Hindustani music, and gardening. He was active and proficient in various sports activities. His interest and knowledge of Carnatic music were so immense that he could recognize the ragas and discuss the mannerisms of the artists, both of the yesteryears and the current ones. He even helped publish a treatise, *The Spiritual Heritage of Thyagaraja* (edited by late V. Raghavan). His interests also included ancient Tamil literature.

Nagarajan's spouse, Padmalochana, was an accomplished Bharata Natyam dancer. Unfortunately, she passed away four months before Nagarajan. His daughter, Shobana Sridharan, is a post-graduate in nutrition science and his son, Srivatsan, holds a Ph.D. in physical chemistry. Both of them reside in the USA.

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