Obituary

G. N. Ramachandran (1922–2001)

There are few instances where research from a comparatively obscure laboratory, far removed from the main centres of international research, has made a lasting impression on world science. The work of G. N. Ramachandran, the renowned crystallographer and molecular biophysicist (or structural biologist in the current parlance), is one such rare example. Ramachandran died at Chennai, formerly Madras, on 7 April 2001. It is also remarkable that he produced so much seminal work even after withdrawing from mainstream research while still quite young.

Ramachandran had his early education at Ernakulam, now in the southern Indian state of Kerala, and earned his first degree in physics at St Joseph's College, Trichy, in Tamil Nadu state. He joined the Indian Institute of Science, Bangalore, in 1942 to study electrical engineering. But he soon came under the spell of the Nobel laureate, C. V. Raman, and — to the consternation of the professor of electrical engineering — shifted to the physics department. After earning his MSc and DSc under the supervision of Raman, he moved to the Cavendish Laboratory, Cambridge, UK, on a scholarship, where he took his second doctorate. He returned to the Indian Institute of Science in 1949, working as an assistant professor in the physics department until 1952.

It was his move to start a physics department at Madras University, at the comparatively young age of 29 for a full professor, that marked the beginning of an extraordinarily productive phase in Ramachandran's career. This period saw his greatest achievements, including determination of the structure of the protein collagen, and was characterized by what I can only think was a unique relationship between a senior university official and a young scientist. A. L. Lashmanaswamy Mudaliar (here on the left, with Ramachandran in the centre), the university's vice-chancellor, treated Ramachandran almost as a son and provided him with full administrative and financial support. Ramachandran's mandate was to develop a world-class research centre at Madras, which he duly did.

Twenty years on, however, he found it difficult to adjust to the new regime when Mudaliar retired. In 1971, he returned to the Bangalore Institute to establish the molecular biophysics unit, which today remains a major research centre. He largely withdrew from mainstream scientific research in the mid-1970s, and

Renowned crystallographer and structural biologist

subsequently worked on mathematical philosophy and logic until he was incapacitated by bad health.

It was discussions with J. D. Bernal, who visited Madras in 1952–53, that led Ramachandran to the problem of the structure of collagen. Collagen is the fibrous protein found in skin, bone and tendon, and it was to long defy attempts to solve its structure using X-ray fibre diffraction and modelling. By the early 1950s Linus Pauling had already predicted the existence of the famous α-helix — a characteristic structural feature of proteins — using simple modelling, and Watson and Crick's structure of DNA was shortly to appear. More than one group were at that time working on collagen, but Bernal felt that the problem was still open.

Following his advice, Ramachandran and Gopinath Kartha set to work, and within a couple of years developed the three-stranded, coiled-coil, helical model of collagen. This was followed by what in retrospect appears to be needlessly acrimonious controversy over the details. Ramachandran and his colleagues continued to refine the structure by including water molecules. Some 50 years on, the Ramachandran model has stood the test of time.

The controversy over the structure had two effects on Ramachandran, one negative and one positive. On one hand, he felt that there was undue hesitation in according him the credit due to him. On the other, it led him to an intense study of the core issue in the debate, the minimum possible distance between two non-bonded atoms. This investigation eventually resulted in the celebrated Ramachandran map, proposed in 1963 by Ramachandran, C. Ramakrishnan and V. Sasisekharan. The map sets the limits imposed on polypeptide chain conformation by the need for non-bonded atoms to keep out of each other's way.

Eventually the Ramachandran map turned out to be much more broadly applicable than had perhaps been originally intended. Today it provides the simplest complete description of protein conformation. It is also the most important tool for the validation of protein structure and, in a way, has immortalized Ramachandran. But he and his colleagues' research on proteins other than collagen, and on nucleic acids and polysaccharides, was also monumental. And Ramachandran was among the pioneers who laid the foundations of the thriving field of molecular modelling.

His early work in optics, X-ray diffraction and diffuse scattering stood Ramachandran in good stead when dealing with problems in X-ray crystallography. He illuminated the field with imaginative theoretical ideas as much as he suggested practical solutions. His 1956 contribution on the use of anomalous dispersion in phase determination in X-ray structure analysis is a landmark in the development of the field. He initiated studies on crystallographic statistics. And his work on Fourier methods, along with others such as R. Srinivasan, created part of the foundations of modern X-ray crystallography. Finally, he contributed to developments in three-dimensional image reconstruction, an aspect of his work that is insufficiently appreciated. It is fitting that the last major award he received, in 1999, was the Ewald Prize of the International Union of Crystallography. This prize is awarded only every three years, and went to Ramachandran for his huge overall influence on crystallography.

To scientists of my generation in India, Ramachandran was a source of scientific and personal inspiration. Most of his contributions were based on simple, yet striking, ideas; and he showed how international science could be influenced even from less well-endowed neighbourhoods. Ramachandran left structural biology and mainstream research about a quarter of a century ago. Yet his presence in the area remains as vibrant as ever.

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