

avocational basis'. It has, by now, become a powerful movement and bird watchers continue to play a significant role in this form of knowledge generation. The data on birds of United States, collected through Audubon Society's Christmas Bird Count, which began in 1900, has been compiled and analysed to yield many valuable insights such as those captured in J. H. Brown's 1995 book *Macroecology*. The Internet has been a boon to citizen science, and we have today a large number of websites that serve communities of citizen scientists. As expected, bird-watchers are by far the most significant component of this community; notable examples include: BirdSleuth K-12, birdsleuth.org; Celebrate Urban Birds, CelebrateUrban-

Birds.org; eBird, ebird.org; Great Backyard Bird Count, birdsources.org/gbbc; NestWatch NestWatch and finally India's own MigrantWatch, supported by the National Center for Biological Sciences in Bengaluru through the initiative of a young ornithologist, Suhel Quader.

Zafar was a large-hearted, highly cultured man, singularly devoid of any class, caste or communal prejudices. Despite his many achievements, which included the Vice-Presidency of the International Union for Conservation of Nature, Order of the Golden Ark, the Karnataka Rajyotsava award and the Padma Shri, he never thought of blowing his own trumpet. He had a large circle of friends from a wide diversity of backgrounds with whom he shared a love of

nature and whom he tried to help without any reservations. He was a man of genuine social commitments, focused on the conservation of nature and the study of the natural world. Regrettably, the cause of nature conservation that he espoused over his long life today appears to be floundering. But it is a tribute to him that the seedling of citizen science that he nurtured with so much affection seems to be thriving robustly.

MADHAV GADGIL

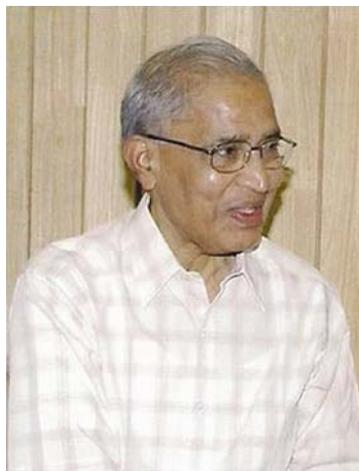
*A-18, Spring Flowers,
Panchavati, Pashan,
Pune 411 008, India
e-mail: madhav.gadgil@gmail.com*

Vallurupalli Sita Raghavendra Rao (1931–2013)

During the silver jubilee of the Department of Crystallography and Biophysics, University of Madras in 1978, the Nobel Laureate Dorothy Hodgkin remarked in her presidential address that Madras (currently Chennai) is synonymous with conformation. This was a glowing tribute to the original contributions made on all the three biopolymers at the Centre. Madras school then was perhaps the only Centre that dwelt on the fundamental study of the conformational aspects of proteins, nucleic acids and polysaccharides. This is understandable as the group had taken the lead and recognized the universal applicability of the stereochemical methods for exploring the conformational properties of other biopolymers as well. Vallurupalli Sita Raghavendra Rao (V. S. R. Rao) led the polysaccharide group successfully through his pioneering contributions and steering conformational aspects of carbohydrates to new heights. He passed away on 26 September 2013 quietly, typical of his way of doing things.

During his postdoctoral tenure with Joseph Foster at the Purdue University, Rao published some important papers based on the experimental work on carbohydrates including the one in *Nature* (1963, **57**, 200). After this, G. N. Ramachandran chose Rao to pursue experimental line of studies on polysaccharides. Rao in fact built a functional light

scattering set-up. However, it was the good fortune of carbohydrate chemistry that triggered Rao into thinking about applying the computational methods to address some of the basic, unanswered



questions in carbohydrate chemistry about which he was very familiar. At that time, there was still a lingering question of whether D-glucose prefers 4C_1 chair or one of the boat forms. It was argued by some of the notables that the former would be improbable for α -D-glucose in view of steric conflict that it would encounter due to the axial disposition of the glycosidic C–O bond with 1,4 linkages. Then there was the question of whether amylose chains exhibit helical or totally

random coil conformation in solution. While most argued for the random coil, Rao's NMR work during his postdoctoral tenure suggested that the chain is a random coil with helical segments. He wanted to employ computational approaches to resolve these and other unexplored avenues in carbohydrates.

Computational methods were evolving at that time, and the Madras group was making seminal contributions to polypeptide, protein and nucleic acid conformations. Perhaps inspired by the novel and successful approach to decipher conformational aspects of proteins at the Centre, Rao made the decision to switch to computational approaches. It was a learning curve for him and his first student (P.R.S.) had the benefit of learning the basics from C. Ramakrishnan. Apparently, Ramachandran was quite upset by this development, but reconciled when he recognized that Rao had advanced way ahead. In fact he joined as a co-author along with Ramakrishnan in the first research article by Rao and his student; it appeared in the proceedings of an international conference held in 1967 at Chennai, participated by luminaries such as Linus Pauling and Paul Flory. Being a total outsider, it was a great relief to Rao that Ramachandran reconciled; the other faculty members were either direct students of Ramachandran or he knew of them. Rao never looked

back and came out with several novel research findings and Ramachandran candidly expressed deep appreciation for many of his research contributions.

By a quirk of fate, Rao's first exposure to research began with Aneesur Rahman, though only for short while, when he joined him as a graduate student in Osmania University, Hyderabad. Later he came under the influence of S. Bhagavantam, who was then the Vice-Chancellor and he also left to join Indian Institute of Science (IISc) as its director. This in a way helped Rao to access experimental facilities at IISc to complete his research work on synthetic high polymers and get his Ph D in 1960. Incidentally, Rahman was the first to carry out (1964) a realistic molecular dynamics simulation.

Rao's exemplary work on stereochemistry of pyranose sugars, their derivatives and a host of $1 \rightarrow 2$, $1 \rightarrow 3$ and $1 \rightarrow 4$ linked polysaccharides have stood the test of time and are widely referred. They received rave reviews from the examiners of the Ph D theses of his students, one of us (P.R.S.) went on to work with Paul Flory, the renowned polymer chemist and Nobel Laureate. Rao was particularly elated when he was able to show that the random coil conformation of amylose is comprised of largely left-handed helical segments interspersed with short right handed helical segments to account for its low value for unperturbed end-to-end dimension, notwithstanding the extremely limited conformational space. Apparently, he got this idea when he was taking a stroll on the Marina Beach in Chennai in a perturbed mood. He often rejoiced the exciting and pleasant phase at the University of Madras.

Rao relocated to IISc in 1973 at the invitation of Ramachandran who established the Molecular Biophysics Unit dur-

ing 1970–71. Rao's group indigenously developed docking strategies and used these to explain how lectins recognize the subtle configurational differences in saccharides. The effectiveness of this approach was amply demonstrated when the predicted binding modes were indeed observed in the X-ray crystallographic structures of concanavalin A and pea lectin. Those were the days when there were no graphics user interface-driven molecular modelling and docking software. Rao's significant contributions on cell-wall polysaccharides and beta-lactam compounds include conformation based rationalization to the action of penicillin and cephalosporin.

Rao published over 150 peer-reviewed research articles and guided 22 Ph D students. He is the key author and spirit behind the book *Conformation of Carbohydrates* (Harwood Academic Publishers, 1998). This book is the only one of its kind and was written when he was the visiting scientist at National Institutes of Health, USA during 1992–97. He served on the editorial board of *Carbohydrate Polymers* and the *International Journal of Biological Macromolecules*. His work was recognized by his election to the Indian Academy of Sciences in 1974 and the Indian National Science Academy in 1981. He was also the recipient of the JC Bose Award for Life Sciences of UGC in 1977. He was ASTRA Professor in Biological Sciences (1988–90). He served as the Chairman of Molecular Biophysics Unit and later as a Dean at IISc.

Rao was lucky to pursue science in an era when recognition and acceptance by peers around the world were the only indicators of the quality of one's work. Rao was ahead of his time and realized the importance of molecular modelling of carbohydrates when working on proteins and nucleic acids were considered

fashionable. A 2012 report published by the American National Academy of Sciences has listed glycosciences as one of the five major thrust areas. In 1990, the American Chemical Society brought out a volume on computer modelling of carbohydrates as part of its ACS symposium series and the editors Alfred D. French and John W. Brady, acknowledged Rao's ambitious computational approach to predict polysaccharide conformations.

Rao was self-effacing and mild mannered almost to a fault. He was a great mentor, and a patient teacher, removed obstacles that interfered with the progress of students and subordinates. He was most accessible to all students who will remember him for his kindness, simplicity and compassionate outlook besides his academic achievements. He was a gentle person, who respected everyone and was respected by all.

He leaves behind his wife and son, who both are accomplished scientists in their own right. It was our good fortune to have had the benefit of working with such a kind-hearted scientist.

P. R. SUNDARARAJAN¹
P. V. BALAJI²
N. YATHINDRA³

¹Department of Biochemistry,
Carleton University,
1125 Colonel By Drive,
Ottawa, ON K1S 5B6, Canada

²Department of Biosciences and
Bioengineering,
Indian Institute of Technology Bombay,
Mumbai 400 076, India

³Institute of Bioinformatics and Applied
Biotechnology,
Electronic City, Phase I,
Bangalore 560 100, India
*e-mail: yathindra@ibab.ac.in