Vijay Kumar Sharma (1967–2016)

Vijay Kumar Sharma, a familiar face in the community of biological sciences, passed away in Bengaluru on the morning of 24 October 2016 at a young age of 49 years. He has left a deep footprint in the area of research on biological rhythms. The scientific community has lost a young, energetic and affable colleague.

Sharma was born at Khardah, West Bengal to Kamala Sharma and Sri Laximi Narayan Sharma on 29 September 1967. He got his B Sc (Hon.) and M Sc in Physics in the years 1988 and 1990 respectively, from the University of Calcutta. He then joined the Department of Biophysics, North-Eastern Hill University, Shillong to carry out his research in the area of biological rhythms, mostly based on theoretical perspectives (first in the country), and earned his Ph D degree in 1997. Around the same time (1995–96), Sharma started his postdoctoral research on biological rhythms in the laboratory of the renowned chronobiologist M. K. Chandrashekaran at the Madurai Kamaraj University. This association with Chandrashekaran lasted for many years at the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru. Between 1997 and 2000, Sharma also received his postdoctoral training at various institutions including the Indian Institute of Science (Bengaluru), University of Tubingen (Germany), Norwegian University of Science and Technology (Trondheim), and University of Groningen (The Netherlands).

Sharma joined the Evolutionary and Organismal Biology Unit of JNCASR as a Fellow in 1998, subsequently became a Faculty Fellow in 1999, Associate Professor in 2005 and full Professor in 2011. He had also been a visiting scholar/professor at several institutions abroad, including North Eastern University (Boston, USA), University of Massachusetts (Worcester, USA), Imperial College of Science Technology and Medicine (UK), Leicester University (UK), Stavanger University College (Norway), New York University (USA) and University of California (Irvine, USA).

Whereas many researchers usually concentrate on a single driver of a phenotype, Sharma used an integrated approach encompassing neural, behavioural, evolutionary, social and molecular parameters to understand the adaptive significance of internal timekeeping. He was open to foray into newer areas, and in recent years, after few brainstorming sessions with one of us (M.S.), he had become inclined towards looking at the ecological aspects of biological rhythms.

Most of Sharma's research centred around the study of the adaptive significance of circadian clocks. After the initial few years of his postdoctoral work on field mouse *Mus booduga*, Sharma's laboratory concentrated work on *Drosophila melanogaster* (fruit fly) as a model system, although in parallel there were some studies on a cave-dwelling millipede, *Glyophylus cavernicolus*, an ant species *Camponotus compressus*, and a plant *Desmodium gyrans*. In a series of publications during the 1990s on field mouse, Sharma showed that the precision of a circadian clock had a nonlinear relationship with period (τ). The clocks that have a period closer to 24 h show more precision than those that are away from the 24 h period. His studies on mice showed that biological ageing and ageing of circadian clocks are not parallel processes, since τ in young animals decreases drastically until the age of about 100 days, but remains unchanged thereafter. In further studies on the fly system, Sharma showed that τ was shorter in animals raised in constant darkness (DD), compared to those raised in constant light (LL) or light–dark (LD) cycles. A daily phase shift corrects deviations in τ from 24 h and synchronizes the endogenous circadian clocks to external LD cycles. There is a sigmoid relationship between phase shift and τ and the clocks that have a shorter τ tolerate much shorter nights than those with longer τ. Sharma also demonstrated that exposure to brief light caused phase-dependent changes in phase and τ of the clock in mouse. The phase shift activity rhythm in mice could be synchronized with injections of melatonin, and this finding has implications for the re-entrainment of internal rhythms with a new phase after experiencing jet lag. Further, his publications showed that the administration of lithium lengthens τ and reduces glycogen synthase kinase3β level in flies, a finding that has implications for the management of bipolar disorder.

Sharma's research significantly contributed to the idea that circadian clocks have been shaped by natural selection and hence must have adaptive functions. He showed that the flies with rhythmic clocks had a survival advantage over those with arrhythmic clocks. His group assayed lifespan of both rhythmic and arrhythmic wild type as well as clock mutant flies and established that the reduction in lifespan mediated by circadian dysfunction can be rescued by maintaining arrhythmic flies under periodic condition. His group maintained more than 600 generations of flies under aperiodic laboratory environment, but these flies still exhibited circadian rhythms in adult emergence, egg-laying and activity. If flies were exposed to continuous LL conditions, several rhythms such as adult emergence and activity are abolished; however, the egg-laying behaviour continues to follow a circadian rhythm. The group demonstrated that egg-laying rhythm is not controlled by ventral lateral neurons; the electrical activity of the clock neurons may be necessary for the maintenance of circadian homeostasis but not for persistence of the rhythm. In a fascinating observation in cave (constant) environment, Sharma found circadian activity rhythm in a considerable proportion of the millipedes. Further, in order to find out the role of the seasonal timers in modulating development rates, his lab carried out studies on two sympatric species of *Camponotus* social ants. It was found that the day-active species developed faster under long days, whereas the night-active species developed faster under short days, indicating species-specific seasonal differences in developmental rates. The findings establish that the circadian organization is

plastic and may respond to the needs of a colony.

Sharma's group not only studied behavioural phenotypes, but also the underlying neurophysiological mechanisms that regulate behaviour. They carried out electrophysiological characterization of the clock neurons in the *Drosophila* brain, and demonstrated that neuronal firing was controlled by the endogenous calcium and sodium channels. The circadian neural network uses global mechanisms for its own stabilization in response to perturbations in membrane electrical properties. Interestingly, the group determined that, by manipulating electrical properties of clock neurons, the diurnal flies can be made nocturnal. Recently, his laboratory was engaged in studying mechano-sensory stimulation that could promote sleep in fruit flies and found that this was mediated by the activation of proprioceptors.

Sharma was gifted with excellent communication skills. Apart from his responsibilities at JNCASR, he was always ready to speak to students, and impart education whenever requested. He was a most common face of the INSPIRE teaching programme, lectures at various universities, and the faculty in the last eight schools of 'Schools in Chronobiology'. He was also involved with the organization of different 'Schools in Life Sciences', and was always entrusted with the selection of the best students for the course. He was a pillar at the Indian Society for Chronobiology, serving in different capacities during the last 15 years, including as Vice President. At the time of his demise, Sharma was Secretary-Elect of the Society, a position that he would have held until April 2017.

Vijay Sharma was awarded the INSA Young Scientist Medal in 1998 and was selected as an Young Associate of the Indian Academy of Sciences (IAS, Bengaluru) from 1998 to 2002. He received the A.K. Bose Memorial Award of the Indian National Science Academy (INSA, New Delhi) in 2001 and C.N.R. Rao Oration Award in 2010. In recognition of his contribution to science, Sharma was elected Fellow of IAS in 2012 and INSA in 2013. He served as a member of the Editorial Board of the *Journal of Circadian Rhythms*, *Journal of Genetics* and *Current Science*. He was a reviewer for several highly reputed journals. He also served as a member of the Programme Advisory Committee in Animal Sciences of the Science and Engineering Research Board (SERB). Sharma was also actively involved in training students and teachers in SERB schools on chronobiology and insect biology. He delivered over a 100 invited talks at various symposia/conferences in India and in several other countries.

Those of us who have interacted closely with Sharma over several years have known him to be a warm person, a loyal friend, a trusted colleague and a wonderful human being. He is survived by his wife and daughter.

Sharma's present batch of graduate and postdoctoral students have jointly sent us the following write up: 'Words are not enough to describe how wonderful VKS (as Professor Vijay Kumar Sharma was fondly called by us) was, as a mentor and a teacher. To begin with, doors to his lab were always open to younger students so that they could experience a rich research environment. VKS, being an excellent critic with an eye for the smallest detail, would shrewdly observe our progress and make sure that we took the task at hand to completion. Moreover, his willingness and open-mindedness to trust us and let us try something new all by ourselves is a life-lesson in itself. He had a tenacious quality of sticking to his viewpoint on matters close to his heart, and perhaps due to his hold on the subject and/or his strong oratory skills, he would eventually convince us to align with him. VKS was also extremely comforting and supportive, when we spoke to him about problems, both personal and professional, without impinging on personal space. His classes were entertaining, punctuated with personal anecdotes which he recounted with inimitable enthusiasm, and which he managed to relate to the topic at hand in quirky ways. He encouraged participation in his classes and patiently answered questions until we completely understood difficult concepts. Above all, VKS nurtured both the "scientist" and the "teacher" in us since early on in our academic careers by considering our opinions and seriously discussing issues on designing course syllabi, structuring assignments, and reviewing scientific literature, thereby being an excellent guide and teacher who shall be dearly missed.'

MEWA SINGH[1,*]
VINOD KUMAR[2]

[1]*Biopsychology Laboratory, University of Mysore, Mysuru 570 006, India*
[2]*Department of Zoology, University of Delhi, New Delhi 110 007, India*
**e-mail: mewasinghltm@gmail.com*