

K. Chandrashekara (1957–2021)

‘One of the deep secrets of life is that all that is really worth the doing is what we do for others.’ These unusually prophetic words from none other than Lewis Carroll were the first to strike one of us (A.S.) when we heard of the untimely passing away, at a relatively young age of 63, of one of our closest friends, a dear friend to all who knew him – student, teacher or fellow researcher – Prof. K. Chandrashekara or ‘Chandru’, as he was affectionately known to us. There is no exaggeration in our deep belief that Chandru was easily one of the most inspiring figures that the student community of Bengaluru, in the field of entomology, looked up to and a most endearing individual with an uncanny ability to bond with all and sundry. It was common for him to exchange pleasantries with a smile and hit upon an interesting conversation, not necessarily academic, with anyone that he met, from any walk of life. And that is his legacy, what Chandru would have possibly liked to be most remembered for – an inordinate love for science (for beetles too, of course, as it was for one of his heroes, J. B. S. Haldane), for nature, for people, for the sheer wonder of being alive!

We had known Chandru from the mid-1980s, when he was a doctoral student at the Centre for Ecological Sciences (CES) at the Indian Institute of Science (IISc), Bengaluru. We cherish the times when he would take us to the India Coffee House and share snippets of his work and talk about the stream of eminent visitors that CES attracted during those days. One of us (R.U.S.) vividly remembers one such occasion, when I had just defended the first research project written by my colleague, K. N. Ganeshiah and myself before a formidable committee (that included professors like Madhav Gadgil, H. Sharat Chandra, Sulochana Gadgil, V. Nanjundaiah and several others) at the then Centre for Theoretical Studies, IISc. Chandru cycled up to us at the Coffee House soon after and, with a mischievous smile, asked me (R.U.S.) how it had all gone. Given the tough committee I had faced, I was sure that Chandru had thought that all was lost. I nonchalantly replied to him, with a poker face, that all had gone rather well and that we had been awarded the research grant! What I remember most from that

episode was the joyful smile with which Chandru greeted this news – I realized then and there how much others’ happiness moved him and the extent to which he cared for his friends.

In the years to follow, it was Chandru’s turn to be a frequent visitor to the campus of the University of Agricultural Sciences (UAS), Bengaluru, not only to meet us all, but also to hunt for colonies



of *Ropalidia marginata*, the primitively eusocial wasp that he was working on for his doctorate. Around the same time, he became a regular participant at our weekly Science Forum meetings and that truly cemented our friendship, we realized later, forever. This relationship with some of us only grew stronger after he joined UAS as an Assistant Professor in the Department of Agricultural Entomology.

Chandru’s doctoral research, under the guidance of Prof. Raghavendra Gadagkar at IISc, was unique in examining the social organization and individual behavioural profiles of female wasps of the species *R. marginata*. He conducted elegant statistical analysis of their time-activity budgets and discovered three behavioural castes, with striking differences in the division of labour between them. What Chandru was able to conclusively establish, in the course of his studies, was that effective division of labour and a supportive social organization had been achieved through a remarkable process of behavioural caste differentiation and not, as in many other primitive wasps, through a dominance hierarchy led by a

despotic queen suppressing all her nest-mates into worker roles. This thus suggested that behavioural patterns in such primitively eusocial insects were likely to be moulded by a complex interaction between selection at the individual and colony levels.

Chandru did not merely stop here, but successfully addressed a great variety of problems with his typical versatility and in collaboration with many of his former colleagues at CES. These included the development of sampling methods to evaluate insect species diversity in the tropics, an extensive exploration of ant species richness and diversity in the Western Ghats, and studies relating to dominance relationships, regulation of foraging and worker activity, serial polygyny and its implications for the evolution of eusociality, and inter-individual genetic relatedness in *R. marginata*. It was at this time that some of us (including A.S.) made an interesting, though fortuitous, discovery. We found a single colony of a behaviourally unknown species of what seemed to be a rather primitively eusocial wasp, *R. rufoplagiata*, remarkably enough, in the then home of Madhav Gadgil in Malleswaram, Bengaluru. Chandru, with his usual enthusiasm and skill, collected the colony with great care, transplanted it to the vespiary on the terrace of the erstwhile CES building, pored through dusty colonial zoological records to identify the species – which was, till then, apparently known only taxonomically from single specimens collected from Pune and the Andaman Islands – and led us on a voyage of discovery in behaviourally characterizing and describing the unusual life-history strategies of this unique wasp species. Looking back, it was not only the thrill of getting to know a ‘new’ species through scientific methods, initiated by Chandru, which made it all worthwhile, but also his unbridled enthusiasm and generosity of spirit that was so inspirational and emotionally moving.

To return to the time that Chandru joined UAS, the major focus of the Departments of Agricultural Entomology in various agricultural universities seemed to only educate students on how to eliminate insect pests from their crop hosts so that the farmers did not suffer huge losses. Understandably, thus, the majority

of the courses were devoted to themes such as insect taxonomy, insect pests of crop plants, pesticide chemistry and so on. Amidst such mundane topics, there were, surprisingly, two interesting courses, one on insect behaviour and the other on insect ecology that were gathering dust, primarily because of the lack of suitable expertise to teach them.

Fresh from CES, and having spent unusually long hours studying insect behaviour, Chandru's attention was naturally drawn towards these courses. He immediately developed the two courses with right earnestness and began to offer them to willing students, a process that he continued for years on end at UAS, his last lecture as recently as a couple of weeks ago. Chandru's lectures were a delight to listen to, sprinkled most generously with loads of anecdotes and, of course, with his typically rich insights. I (R.U.S.) must relate the story of a doctoral student of mine who wanted to register for Chandru's course on insect behaviour, knowing fully well that her thesis on endophyte molecular biology had absolutely no relation (by any stretch of imagination) to insect behaviour. But register she did. Her justification was simple, 'I find in Prof. Chandrashekara a person who wishes to communicate the excitement of doing science. For me, this is good enough a reason to register for the course, no matter how the subject matter of insects is itself unrelated to my PhD thesis.'

Another course that Chandru cherished deeply, and which was also a great favourite amongst his students, was on science communication. This course, he often used to say, was about the enjoyment of sharing the secrets of nature that research had helped unravel. Although these mysteries could be shared by informal and formal communication, through seminars or publications, Chandru always preferred the informal to the more formal approaches. He said that he would rather chat for hours and share science over coffee than give lofty lectures or write eruditely about scientific discoveries. While he certainly did not have the patience for the latter, he did spend long coffee times with students – and today, we realize that Chandru will be remembered, not for his scientific discoveries or publications alone but for reinforcing, almost singlehandedly and perhaps unconsciously, the old, historic Indian tradition of storytelling and of

oral communication of pure knowledge, across generations.

Chandru's research interests largely focused on insect ecology and evolutionary biology. He worked extensively and tirelessly on dung beetles, ants and, of course, wasps. Along with Ganeshaiah, he developed an improved method of quantifying species diversity of insects that also incorporated the phylogenetic relatedness of the community members. Called the avalanche index, this method, in a way metaphorically too, brought about a sea change in the measures of species diversity.

Chandru was amongst the first to demonstrate the use of the niche modelling tool, DIVA-GIS, for modelling and predicting the spread of an important agricultural pest, the sugarcane woolly aphid. This study was a forerunner to many more such investigations by groups all around the world and is widely cited as one of the pioneering examples of the use of this modelling tool.

In his later years, Chandru became interested in bioprospecting venom peptides from the venom glands of a number of insects, especially hymenopterans. His group, in collaboration with that of P. Balaram at IISc, was able to describe several novel anti-microbial peptides from ants, bees and wasps. This marked the beginning of his forays into the field of chemical ecology at UAS, yet another journey so typical of Chandru's quietly adventurous spirit.

Siloed as some of us were at UAS into departments such as Genetics and Plant Breeding, Crop Physiology, Agricultural Entomology and so on, Chandru was keen to have a forum that allowed for the free exchange of ideas and experimental work on questions relating to insect behavioural ecology, evolutionary biology and conservation biology. After persistent efforts, he was finally successful in establishing an interdisciplinary School of Ecology and Conservation (SEC) at UAS. The SEC, today, is amongst one of the most productive laboratories at UAS with students working on a range of cross-cutting themes, including ant foraging behaviour, plant–fungal interactions and plant–insect interactions. None of this would have, however, been possible without Chandru's deep love for these disciplines and his far-sighted concern that students must be made aware of the importance of fundamental biological knowledge in the development of applied

disciplines, such as agricultural entomology. It is a matter of great pride and joy for us that Chandru remained the Convenor of the SEC, right from the time of its establishment until his superannuation in November 2019.

Chandru had an irresistible urge to initiate discussions and seminars on just about anything that he considered good science and with which he could effectively engage his students and, perhaps to a lesser extent, his fellow faculty. He actively promoted the Friday Seminar series at the SEC and the Entomology Club meetings, and also helped organize the annual Coleman Lectures in honour of Prof. Leslie Coleman, who had started the Department of Agricultural Entomology in UAS a hundred-odd years earlier. Another unique meeting that Chandru was an active part of was the Avalanche Meeting. Held once every two years in a remote place, this meeting brought together about 15 to 20 active participants to brainstorm on particular subjects for two full days. These meetings were a watershed in the sheer sense of their intensity, and the length and breadth to which different topics would be discussed, often led by a rather breathless Chandru.

For the general public too, Chandru left an indelible landmark in the form of the Bangalore Butterfly Park at the Bannerghatta Zoological Park, which was sponsored by the Department of Biotechnology, Government of India, under the aegis of the National Bioresources Board. He was placed in charge of developing a state-of-the-art butterfly park, in collaboration with the Karnataka Forest Department. He was instrumental at all stages of the project, starting from designing the structure and components, drawing up the complete plan for its execution and finally, in establishing a fully functional park. He ensured that every important aspect of the garden, rearing protocols for the various butterflies, selection of host plants to be grown through the year, formulating a butterfly calendar and developing outreach material were laid out in ways that would promote the long-term sustainability of the park and its associated museum on their own. This park has now emerged to be amongst the most unique sites for outreach and conservation of butterflies anywhere in the country. And if the butterflies are still fluttering today, we owe it all, in no small measure, to the untiring

enthusiasm and valiant efforts of Chandru, once again almost on his own.

A most wonderful habit of Chandru's, especially in today's times, was his obsessive urge to read, extensively and voraciously, whatever he could lay his hands on, and to discuss threadbare all that he read with his many friends and colleagues. But what always amazed us was his capacity to do this even under the most trying circumstances. In September 2018, for example, he was battling a serious lung ailment at a local hospital, and yet decided to send an e-mail to one of us (R.U.S) on an ongoing debate of gender-specific language. We provide here a small excerpt from his e-mail: 'Amazing how languages evolved as did the plasticity of the brain. Which came first? The Chomskian idea that language is everything that perhaps shaped the brain is seriously being questioned by new evidence (See Science highlights may be two weeks back). ... But why did gender-specific lexicon evolve? Might it be a case of cultural evolution? Hard to see any fitness advantage for individuals within a group or fitness advantage for the groups'. We are sure that many of us, who have interacted intimately with him, might have countless such wonderful anecdotes to share.

Chandru was, undoubtedly, a great conversationalist, one who could and would chip in with his ideas and opinions on a wide range of issues, thanks to his erudition and eagerness to share his deep knowledge of all that he was interested in. We would often tease him as a good example of Desmond Morris' thesis on

humans being 'compulsive communicators' in his book, *The Naked Ape*. It is perhaps for this reason too that he will be sorely missed by his friends and colleagues. Chandru was friend, philosopher and guide for many of us, the go-to person for matters, personal or professional, even beyond the academic. A chat with him over coffee or even over Zoom during the more recent COVID-19 pandemic was usually comforting, often exhilarating.

For this very reason that Chandru was so accessible and knowledgeable, he became the favourite of many of the UAS' Vice-Chancellors. They would often seek him out for advice on matters relating to, but not limited to, various aspects of University administration; these could include the preparation of accreditation reports, proposals for DST-FIST or DST-PURSE grants and many such issues of importance.

Finally, on a more personal front, we should not fail to mention the almost superhuman role played by Chandru's life-partner, Yamini in supporting him through his often rather tumultuous health problems, for over the last three decades. On more than one occasion, we found her practical and protective care to be vitally important in ensuring Chandru's welfare and well-being – this was evident not only when Chandru was battling a life-threatening lung ailment in 1988, but also when he was suffering from yet another one just a couple of years ago. Her steely resolve to take care of his every need disguised her utmost affection and love for Chandru, until, of course, it tragically gave way on 3 April 2021.

On 18 March 2021, when Chandru had come to UAS, possibly for the last time, one of us (R.U.S) went to meet him to discuss financial matters relating to a project. He was masked and gloved, demonstrating the dissection of the venom glands of a wasp under a microscope to two of his master's degree students. Little did we realize that he had, by then, already been struck by the coronavirus. As the second wave of COVID-19 surges over us, we are reminded of Joseph Stalin's quote, 'A single death is a tragedy; a million deaths is a statistic'. Notwithstanding the many losses that we have suffered over the last year, Chandru's passing away remains an almost immeasurable tragedy for many of us. On 29 March 2021, while discussing his health, he wrote, once again, to one of us (R.U.S), 'I guess once the back is against the wall, the mind can summon all it has and depending on the situation, it is flight or fight'. Chandru fought valiantly all his life, if anyone ever did, for the cause of science, for research, for education, for his students and, above all, for the universe of his friends. We will always miss you, Chandru, our dear friend, always.

ANINDYA SINHA^{1,*}
R. UMA SHAANKER^{2,*}

¹*National Institute of Advanced Studies, Bengaluru 560 012, India*

²*University of Agricultural Sciences, GKVK, Bengaluru 560 065, India*
*e-mail: asinha@nias.res.in;
umashaanker@gmail.com