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## The excitement of colours and scents

Renee M Borges

“Out of a swarm of bees, one-fifth went to a *kadamba*-flower, one third to a plantain-flower, and three times the difference of those, O doe-eyed one, to a *kutaja*-flower. One remaining bee, tempted at the same time by the scent of a jasmine and a pandanus, hovered and wandered in the air; tell me, beloved, the number of bees.” From *The Lilavati* of Bhaskaracharya

From Bhaskara’s data, the *kutaja*-flower appears to be the most attractive (six bees out of fifteen go to this flower). Bhaskara’s problem also implies that the sensory modality being used by the bees to approach the flowers is floral scent, although this is made explicit only in the case of the one confused bee that “hovered and wandered in the air” tempted simultaneously by two equally attractive floral perfumes. This could have been a description of an olfactometer experiment on a population of wasps, ants or bees being conducted in my laboratory, except that we would know the number of test organisms in advance and the unknown quantity that *Lilavati* would have to determine here would be the preference of the insects for the scent of the different simultaneously available flowers. My current work on the chemical communication between plants and animals would offer Bhaskara many contexts for the composition of complicated mathematical problems.

I am a strong believer in instinct. It was instinct that made me realise when I was very young that the only subject that could hold my attention was the natural world. Having been born into a family where medicine was an important vocation, this fascination with the natural world translated into an early desire to become a veterinarian (around the age of seven). My indulgent family responded to my request for a dog, and my dog and I grew up together, providing me with insights into animal behaviour that have helped me in my professional career.

Intellectually, I believe my greatest development took place in the first two years at Saint Xavier's College, Mumbai. I joined a Creativity Group formed by the ever-enthusiastic Jehangir Mistry, a teacher in the Physics Department. Our small group of sixteen students, drawn from diverse disciplines and interests, bonded immediately, and collaborated on science projects that culminated in an exhibition. The atmosphere of freedom, excitement and joy in the learning process that I experienced here is something I have attempted to retain all my life. I consequently decided to do a Bachelor's degree in zoology and microbiology in the same college.

Another important event in my development was joining the Bombay Natural History Society (BNHS), which was a haven for the serious amateur naturalist and the committed professional. During my BSc, I spent evenings working with Humayun Abdulali at the BNHS, on the bird collections of the Andaman and Nicobar Islands. This gentleman-naturalist frightened off people with his penetrating questions and caustic humour, but he and I got on famously, and I learnt much about scientific rigour from this seventy year-old man. I got to know Abdulali's cousin, Sálím Ali, at whose suggestion and under whose supervision, I wrote a series of popular articles on ecology and evolution while pursuing an MSc in Animal Physiology at the Institute of Science in Mumbai. I admired Sálím Ali for his wit, passion, and uncompromising striving for perfection. Nothing was ever good enough for him.

By this time, I "knew" that I wanted to make a career in ecology and evolution. I also realised that I could not do this in India. I decided to join the University of Miami, Coral Gables,

Florida, where I received a Maytag PhD Fellowship and the opportunity to work in their extremely successful Tropical Biology Programme. The Miami experience taught me scientific independence because graduate students had to write their own grant proposals and obtain their own research funds. This was especially true for me, because my PhD supervisor, Ted Fleming, worked on bat–plant interactions, and I was not inclined to study bats. However, Ted gave me free rein, and with my now, more focussed interest in plant–animal interactions, I developed a proposal to study the relationship between phytochemistry and food choices in the herbivorous Indian giant squirrel *Ratufa indica*. But I still had to get the money to do this research. At this point, I approached the Office of International Affairs of the United States Fish and Wildlife Service. I must record my gratitude to David Ferguson who not only supported my Ph.D. research through this office but later also my post-doctoral work. With this support, I was able to spend two years in India, a year each in Magod, North Kanara, Karnataka, and in Bhimashankar, Maharashtra, collecting data for my degree. These years were perhaps the most formative in my personal development, because I lived alone in these forests, drove my own jeep through the forests, hired my own local field assistants, and made enduring friendships, both personal and scientific. Since giant squirrels are found only in dense forests, in remote areas, these two years also gave me, an urban product, my first contact with true rural India. Back in Miami to write up the thesis, I found the international atmosphere most invigorating. My fellow students were working in or were from geographical areas as diverse as Papua, Peru, Venezuela, Costa Rica, Ghana and Europe, and I happily adopted global intellectual citizenship.

Returning from Miami with my Ph.D., I continued to work on giant squirrels with a five-year post-doctoral support grant routed through the Wildlife Institute of India (WII) in Dehradun where Hemendra Singh Panwar, one of India's most renowned Indian Forest Service (IFS) officers, was the Director. He very kindly gave me adjunct status in the Institute. During this same period I joined the Bombay Natural History Society as Deputy Director (Research) and encountered Hema Somanathan and Subhash Mali,

my first two Ph.D. students who worked both on giant squirrels and on plant–pollinator interactions within the seasonal cloud forests of Bhimashankar, under the aegis of this cross-institutional collaboration.

By this time, the Centre for Ecological Sciences (CES), Indian Institute of Science (IISc), advertised faculty positions, and I was fortunate to be accepted. Here, I believe I have found my bearings, and indeed everything that I could possibly have wished for in terms of scientific atmosphere, and most importantly, academic freedom. I will never forget the first meeting I had with Raghavendra Gadagkar after I joined CES. Gadagkar was Chairman of the Department, and when I, perhaps a little self-consciously, went to meet him in his office, I was most pleasantly surprised when we discussed academic freedom instead of duties and responsibilities. This is what I enjoy the most about IISc, and what I believe any wonderful institution such as IISc, should foster and celebrate.

Here at CES, I have been able to develop a lab that is dedicated to asking questions on the interactions between species within the framework of evolutionary biology. I have wonderful colleagues, students, research associates, and research assistants, and every day brings new excitement, scientific friendships and collaborations. Together we have found the world's first truly nocturnal bee that can pollinate plants and see colour in starlight; we have studied arboreal earthworms that live within ant-plants; we have found out that ants can learn the odour of wasps that they prey upon; we have discovered that male ant-mimicking spiders can find out whether a silken nest belongs to a virgin female just by chemical cues of the silk; we have discovered how crab spiders can be successful at mimicking flowers; we have found that plants produce scents to attract appropriate visitors and also scents to repel inappropriate ones, which may explain Bhaskara's observations to Lilavati on the visitation patterns of bees.