In this issue

What can we learn from the croak of a frog?

For the common man, frogs bring on the image of slimy, creepy, ugly things that croak without a trace of decency. For the Indian undergraduate student of zoology, frogs must appear as having been created by God for the sole purpose of being used for teaching and learning how to dissect animals and study their anatomy. But like the princess in the fairy tale who kissed a frog and turned him into a prince, Debjani Roy and her students might well bring to the frog a large measure of respect and admiration.

On **page 265** of this issue, Debjani Roy, Bijoylakshmi Borah and Amarendra Sarma describe experiments that permit a deeper understanding of the role of frog calls in their courtship behaviour. Because of the feebleness of their calls and perhaps at least in part because of the gender of most previous researchers on frogs, the calls of the female frogs have largely been neglected. Most previous work has concentrated on male calls and has created the view that males advertise themselves so that females have no difficulty in finding them. The present study has made a special attempt to go beyond the din created by the male frogs and attempt to listen to what the females have to say. The recordings and analysis of the female calls suggest that females are calling in response to the males and in the context of courtship. Typical of males in general, the male frogs call as loud as possible in an attempt to get the attention of the females. On the other hand, the females' feeble call is probably testing the sensitivity of the males!

In any case this study suggests a much more active role for the female frog in matters of mate choice and courtship than has been hitherto suspected. This is reminiscent of the more general shift we are now witnessing, from a view of animal courtship based largely on male–male competition for access to the passive females towards a view where female choice has a significant role in deciding *who mates with whom*. That somebody has thought it worthwhile to leave the laboratory bench and the dissection tray and go to the inhospitable marshes at night, and that too in North East India, to learn from living frogs, augurs well for Indian zoology. There is so much to learn from the croak of a frog.

R.G.

NMR: Fifty years on

Almost fifty years have passed since Felix Bloch and Edward Purcell independently reported the observation of nuclear magnetic resonance (NMR) in bulk matter. Conceived as an esoteric technique to measure nuclear magnetic moments accurately, hardly anyone in the late 1940s could have foreseen the impact that NMR was to make in the fields of chemistry, biology and medicine. The first sign that NMR was too useful to be left entirely *to physicists came early on; the* proton resonance frequencies in the samples used by Bloch (tap water) and Purcell (mineral oil) were different. Clearly, chemistry was at work, modifying Larmor precession frequencies. A more dramatic manifestation of the role of chemical environment in influencing nuclear resonance frequencies was provided in 1951 with the famous demonstration of three chemically shifted groups of proton resonances in ethyl alcohol by Arnold, Dharmatti and Packard. The last named was to go on to developing commercial NMR instrumentation, while Dharmatti was to introduce the NMR technique at the then fledgling Tata Institute of Fundamental Research (TIFR) in Bombay. Interestingly, the first magnetic resonance experiments in India were conceived and executed by G. Suryan in the Physics Department of the Indian Institute of Science, Bangalore, in 1950–51. By the early 1960s NMR was a critically important tool for structure determination in organic chemistry, with the hydrogen nucleus as the sole reported case of chemical environment. No chemistry department in the West would consider itself complete if it did not possess an NMR spectrometer (a condition that has now been reached in India also). Two problems, however, limited the range of NMR applications; sensitivity of detection of resonances and inadequate chemical shift dispersion in complex molecules containing large numbers of atoms. The introduction of Fourier Transform Spectroscopy in the late 1960s and the advent of superconducting magnets capable of providing high magnetic fields of requisite homogeneity allowed NMR to breach the barriers between chemistry and biology. Enhanced sensitivity now permitted detection of resonances from less abundant nuclei (^{13}C, ^{15}N), enhancing the information content of NMR studies. But more was to come. In the late 1970s following a suggestion by Jean Jeneer, the first two-dimensional NMR experiments were performed by Richard Ernst. Overlapping frequencies could now be resolved by spreading the information onto a frequency plane; more importantly correlations between coupled nuclei permitted identification of groups of spins characteristic of specific chemical groups. By the early 1980s there was a veritable flood of multiple pulse experiments; spectroscopists could now literally eavesdrop on intimate conversations between atomic nuclei in molecules. The convenient detection of nuclear Overhauser effects (NOEs) permitted identification of spatially proximate (< 4 Å) hydrogen atoms, providing finally a firm handle for the determination of three-dimensional structures of molecules in solution. NMR was poised by the mid 1980s to enter an arena which had till then been exclusively dominated by X-ray crystallography: the field of biological structure determination.

The first pioneering study of bovine pancreatic trypsin inhibitor, a small 58-residue polypeptide by Kurt Wuthrich and his collaborators at the ETH in Zurich, was quickly followed by a deluge. The size range of proteins that can be studied by NMR methods has steadily increased with the incorporation of stable isotopes (^{13}C, ^{15}N), permitting multidimensional spectroscopy. Advances in NMR have paralleled the revolution in molecular biology, which permits ready production of recombinant proteins; the fusion of the two areas now promises to provide remarkably detailed information on biological structures in solution.

In India too, the sophistication of the available NMR methodology has slowly increased with the TIFR now housing spectrometers that operate at 500 and 600 MHz for proton resonances. In this issue (**page 243**) P. K. Radha *et al.* describe a structural study of the DNA binding domain of a proto-oncogene product, c-Myb, from *Drosophila*. The analysis of the NMR spectrum of the 160 residue polypeptide and the determination of the structure of a dodecameric nucleotide containing the segment recognized by the c-Myb protein using multidimensional NMR methods are described.

P B.