Professor S. P. Ray-Chaudhuri (1907–1994): An architectural scientist

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I consider myself to be very fortunate to have had Prof. S. P. Ray-Chaudhuri, Ph D (Edin) FNA, as my primary mentor. He inspired me not only to study animal chromosomes, but also taught me to be honest in scientific pursuits, develop humane qualities and work to the best of my capabilities. He inspired students who came in close contact with him to mould their future. Ray-Chaudhuri was a great scientist and scholar with many virtues. All of these qualities made him a 'rare specimen'.

Most modern scientists could be considered as bricklayers who help to build the scientific cathedral. Ray-Chaudhuri, by contrast was a rare architect in the field of biology. He conducted research in diversified fields of biology and I have no hesitation in calling him the 'father of cytogenetics' in the Indian subcontinent.

Sachi Prasad Ray-Chaudhuri was born on 15 September 1907, in a small village of Kulkathi in East Bengal (now Bangladesh), received his early education in Calcutta and finished his master's degree in Zoology from Calcutta University in 1930. In 1937, he went to the Institute of Animal Genetics, University of Edinburgh, for his Ph D degree on silkworms under F. A. E. Crew, then Director of the Institute. Crew advised Ray-Chaudhuri to join H. J. Muller, who was to join the Institute from Moscow, for his Ph D. Muller came to Edinburg and started a lecture series in genetics (on *Drosophila*) for new students. After Muller's presentation, students were supposed to come up with a project for their research work. Ray-Chaudhuri and Muller became good friends. Ray-Chaudhuri started a Ph D project under Muller's supervision. In 1939, Ray-Chaudhuri was awarded the Ph D degree. Muller, while delivering the Nobel Prize lecture in 1956, quoted results from Ray-Chaudhuri's work.

After returning to Calcutta, it was not possible for Ray-Chaudhuri to have a *Drosophila* research laboratory, so he took training in cytogenetics under P. C. Koller. Ray-Chaudhuri formed a small group of students in the Zoology Department, Calcutta University and pioneered research work on chromosomes of grasshoppers, ladybird beetles, dragonflies, spiders and Indian heteropteran insect species. His group mainly focused on the structure and behaviour of chromosomes in natural populations of these insects, sex-determining mechanisms, cytotaxonomy, effect of radiation and chemicals (mitogenic, carcinogenic and antimitotic) on animal chromosomes, radiation genetics using *Drosophila* as experimental material and chromosome cytology of malignant human tissue, especially from the cervix. His group also started evaluating the chromosome structure under electron microscopy.

In 1960, Ray-Chaudhuri was appointed Head of the Zoology Department, Banaras Hindu University (BHU), Varanasi. At the time, I was an undergraduate student at BHU. Though botany was my favorite subject, I could get admission only in the Zoology department at BHU. I clearly remember the first motivational talk given to our class by Ray-Chaudhuri. That very first lecture changed my life and chromosomes have become my life-long source of joy as well as my 'bread and butter' since then. While doing my master's degree, I not only learnt about animal genetics, but also learnt the art of teaching from Ray-Chaudhuri who was an ideal teacher. He introduced modern branches such as genetics, cytogenetics and biochemistry at BHU.

When Ray-Chaudhuri moved to BHU, he continued to study chromosomes of grasshoppers, walking stick insects and *Drosophila* salivary gland chromosomes; but he also wanted to study the chromosomes of vertebrates, including humans, with modern techniques. Ray-Chaudhuri accepted me as his Ph D Student. I was to study the chromosomes of Indian species of bats from bone marrow samples, since at that time the laboratory did not have tissue culture facilities. One of Ray-Chaudhuri's senior students, who had undergone such training, provided me with the procedure for bone marrow preparation (no actual demonstration). I honestly and faithfully followed each step of the procedure. We were to use a trypsin solution for dissociation of clumped cells without actually knowing the function of trypsin. I was using a massive dose, as suggested in the procedure. I worked day and night, seven days a week, for almost 10 months without seeing a single metaphase spread. It was evident to me that there was something wrong in the procedure. One day in the summer of 1964, I was examining my slides when Ray-Chaudhuri came by and asked, 'Pathak, are you satisfied with your progress?' I answered, 'No sir, how can I be satisfied about not seeing a single metaphase spread after 10 months of work?' I was informed that Ray-Chaudhuri had received a complaint that I was not working hard enough and that there was nothing wrong with the procedure.

That summer, G. K. Manna, a former Ph D student of Ray-Chaudhuri, visited BHU. While sitting in the cytogenetics laboratory, Manna asked me what I was working on. I explained my project to him as well as the problem I was facing. He suggested that I reduce the concentration or completely avoid using trypsin because that might be destroying the cell nuclei. Late that afternoon, after modifying the procedure, I saw for the first time metaphases on the very first slide. I was so excited that I could not sleep that night. The next morning I showed my preparation to Ray-Chaudhuri. This metaphase spread was the first preparation done with the 'modern technique' on vertebrate chromosomes in the cytogenetics laboratory and probably in India. Ray-Chaudhuri asked me to describe the technique step-by-step, and I described to him the modification suggested by Manna. Since then, the modified bone marrow technique has become a standard procedure for the preparation of vertebrate chromosomes.

Ray-Chaudhuri was an excellent teacher. One day in 1962, when I was a master's degree student, he came to teach us *Drosophila* genetics and described a phenomenon. Before he could name the phenomenon one of the students sitting in the back row of his class named this phenomenon. Ray-Chaudhuri appeared surprised and asked, 'Who said that? Yes! Come on, tell me'. Nobody in the

class was ready to utter that name again until he said, 'Yes, it is right'. This shy student who was sitting on the back seat raised his hand thinking that his teacher must be mad; but actually he was not. I was that student. From that day onward, I was being noticed in the class and his favorite words, 'Very good, very good', remained with me forever.

After receiving my Ph D in 1967, I was working as a senior fellow of the University Grants Commission, in the Zoology Department. Naturally, I wanted to proceed to the USA for further training. I wrote for a fellowship to a professor in Texas who was working on bat chromosomes at the time. I was prompted to do so by one of Ray-Chaudhuri's senior students, for whom I had great respect. The US professor did not write anything about the fellowship, but wanted my chromosome data on bats from the Old World to combine with his data on bats of the New World for publication. After receiving his letter I was very happy and thought that it would be nice if I could publish a paper with him. I, therefore, went to Ray-Chaudhuri's office to show him this letter. After reading this letter he got upset but finally, he cooled down and told me, 'Pathak! You belong to a poor country (India), and this professor belongs to a rich country (USA). As far as the quality of chromosome preparation is concerned, yours is in no way inferior to his. Write to him that you will not send your chromosome data to him and you will publish your own paper'. I did write to him accordingly. Before I came to Texas for post-doctoral training, Ray-Chaudhuri told me that my anxiety would vanish once I got to USA and saw that the chromosome research work done in India was of equally good quality. I could not believe how right he was until I compared my Ph D thesis with that of the American scientist who wanted my data. As a matter of fact, I taught all banding techniques to this scientist in T. C. Hsu's laboratory in the early 70s, and since then we have become great friends.

Sometime in the mid 1960s, six lecturer's positions were advertised in the Zoology Department of BHU. There were seven internal applicants, including myself. Everyone, was sure that I will be appointed. To our surprise, all the other six applicants were selected and I was not. It certainly made me sad, but I never asked my teacher why I was not appointed. One day six months later as we were walking together, Ray-Chaudhuri asked me, 'Pathak, you never asked me why you were not appointed despite all your positive qualifications'. I told him, 'Sir, you must be having some reason for not appointing me and because of this, I decided not to ask you about it'. Then he told me, 'Pathak, I knowingly sacrificed the candidacy of my student because I wanted to make my colleagues happy by appointing their students for teaching. I wanted you to spend more time in research'. Later, I was lucky to go to Houston to T. C. Hsu's department and work on cancer-related problems.

After his retirement in 1971, Ray-Chaudhuri went back to Calcutta. However, in Varanasi, he not only established an active *Drosophila* research laboratory, but also expanded chromosome research from insects to reptiles, birds, mammals, and humans. His relentless pursuit of excellence, continued desire for exploring new research areas, and humane qualities inspired many young biologists and students. Although his administrative and educational responsibilities significantly reduced his own research time, he considered it necessary for the future of biological sciences in general, and genetics in particular, in India. I would like to quote a few lines directly from his handwritten letter that I received from Kurukshetra, India, where he was a Visiting Professor, in November of 1978. He wrote, 'I am trying to emphasize the molecular approach to cytogenetics to the staff and students of the Zoology Department here. This is the 5th University where I am visiting and doing the same thing. I have to visit several other universities, and at each place I stay for a month. I am very much distressed to find that all these people are still in an archaic era. I know this. I do not know if I am able to make an impact on the post-graduate students at least. Some of them are very bright, but are always kept starved by their teachers. Maybe some of them are finding me useful'. This shows his desire to help, encourage and motivate young students. Ray-Chaudhuri continued such efforts until a ripe old age after returning to the Zoology Department at Calcutta University.

Ray-Chaudhuri was a great patriot and did not believe in brain-drain. Sometime in 1977, when I was already working at the University of Texas M. D. Anderson Cancer Center at Houston, he wrote me a letter from Calcutta University where he was working as Emeritus Scientist, encouraging me to apply for a Cytogeneticist position at Punjab University, Chandigarh, India. He wrote, 'Retiring Prof. G. P. Sharma would, strongly support your candidacy. If you feel that you can come and have a mind to serve your country, here is an opportunity'. I did apply for this position, but was not appointed.

In 1980, Ray-Chaudhuri visited USA. He was invited to our University, and presented a talk on 'Heterochromatization and differentiation of the sex chromosomes', which was well received. After this lecture, I took Ray-Chaudhuri to Galveston, and while we both were walking on the beach, Ray-Chaudhuri

From left to right: S. P. Ray-Chaudhuri, T. C. Hsu and S. Pathak. Photo taken in Houston in 1980.

asked me why I was studying cancer chromosomes? I gave him my detailed reply and then he told me, 'Next time when you visit India, I want you to give a talk in Chittaranjan Cancer Center in Calcutta and tell them why the study of cytogenetics is so important in the diagnosis, treatment and prevention of cancer'. He and his student G. K. Manna were the first in India to start a cancer cytogenetics laboratory in this hospital in Calcutta, but received minimal enthusiasm from local physicians. Ray-Chaudhuri was a pioneer in starting not only animal cytogenetics, but also cancer cytogenetics in India.

During his trip to USA Ray-Chaudhuri visited many cities and delivered a series of talks. While returning to India, he stopped to visit his students in Europe. After returning to Calcutta he wrote to me a letter on 3 June 1981 about his trip from which I am quoting directly. He wrote, 'You can imagine how pleased I was to see you people so well-liked and respected in your place of work'. What else can a 'true teacher' ask for from his students?.

Ray-Chaudhuri knew the technique of planting young seeds of scientific inquiry in the minds of his students. I personally feel very lucky and blessed to have had the opportunity to learn not only animal cytogenetics, but also human qualities from him. Some of Ray-Chaudhuri's students have become authorities in their respective fields of research and administration, but he was not fond of administrative responsibilities. Once he told me, 'Never become Chairman of the Department. You will become a glorified clerk'. Because of their achievements, some of his students are worthy of mention here: G. K. Manna is Professor Emeritus in Kalyani University, T. Sharma is Professor Emeritus in BHU, P. G. Kale is still active in teaching and research at Alabama Agricultural and Mechanical University in Normal, Alabama and Lalji Singh is currently Director of the Center for Cellular and Molecular Biology, Hyderabad, India.

Ray-Chaudhuri was a positive thinker. During a conference at New Delhi sometime in the mid 1960s he was having dinner with several other delegates. One of the guests, who was then Chairman of Zoology in Delhi University and also a former classmate of Ray-Chaudhuri from Calcutta University, started a conversation regarding his recent trip to USA. He started speaking about how scientists in USA were criticizing Muller's hypothesis and his published papers. The intention was to humiliate Ray-Chaudhuri in front of other scientists. Someone asked Ray-Chaudhuri to respond. Instead of becoming angry Ray-Chaudhuri said politely 'I am grateful to you Professor ... for bringing such good news about my mentor (Muller). It shows that scientists are very much interested in Muller's research and that the field of genetics is making tremendous progress in the right direction. But what happened to your Professor's field of research? It appears that what you and your mentor worked on has not changed in the last 30 or 40 years. Your science is at a standstill because no one is interested anymore in that direction'. This unexpected response of Ray-Chaudhuri made everyone burst into laughter and the dinner became more enjoyable. What a classic illustration of his positive thinking!

I hope I have succeeded in describing some of the contributions made by this great teacher and scientist, Prof. Ray-Chaudhuri, in the field of animal cytogenetics and showing his humane qualities by narrating some personal episodes. Without any hesitation, I would like to call him 'The Father of Animal Chromosome Research' in India.

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Errata

Species diversity and relative abundance of lichens in Rumbak catchment of Hemis National Park in Ladakh

Hans Raj Negi and D. K. Upreti

[*Curr. Sci.*, 2000, **78**, 1105–1112]

On page 1108, 2nd column, the following equation was missing:

$$J_{xy} = \frac{C}{(A+B)-C}.$$

We regret the error.

Soft condensed matter physics

[*Curr. Sci.*, 2000, **78**, 661–663]

The meeting report on 'Soft condensed matter physics' which appeared in the 25 March issue, was incorrectly attributed to Gautam I. Menon and K. R. Rao. The authorship should be credited to K. R. Rao.

Edited and published by P. Balaram and S. Ramaseshan, Current Science Association, Bangalore 560 080.
Typeset by R D Typesetters, Bangalore (Ph: 3405672). Printed by Lotus Printers, Bangalore (Ph: 3209909).