



Livatski Lushkijev
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SIVATOSH MOOKERJEE

(1926-1993)

Elected Fellow 1971

SIVATOSH MOOKERJEE was a man of cultural, academic and humanitarian magnanimity and the highest nineteenth century magnum of cultural heritage of undivided Bengal. Born on the 7th October, 1926, at Calcutta, Sivatosh Mookherjee was the second son of Late Rama Prasad Mookerjee and a grandson of Late Ashutosh Mookerjee, better known as the Royal Bengal Tiger.

EARLY SCHOOL AND COLLEGE EDUCATION

Sivatosh Mookerjee had his school education in the wellknown Mitra Institution of Bhawanipore, Calcutta, from where he passed his Matriculation. Thereafter, he had his college education from Presidency College, Calcutta, and passed his ISc and BSc (Honours in Zoology), and then MSc from University of Calcutta, in the year 1948. He was ranked First Class First, in both BSc (Honours) and MSc Examinations.

BEGINNING OF A FLAMBOYANT SCIENTIFIC CAREER

Upon acceptance from the then stalwart of Embryology Experimental/Embryology, CH Waddington, Sivatosh Mookerjee went to Edingburgh, worked at the famous Institute of Animal Genetics and received his PhD degree from the University of Edinburgh, in February, 1951. The title of his PhD thesis was "A morphogenetic investigation of the notochord cells in the Amphibian embryo".

During this period, his dominating personality outweighed the criticisms of some members who did not like the dominance of modern aspects of chemical and physical technologies in Biology, which already revolutionised Life Science studies all over the world. He could successfully introduce new papers in the syllabi of Zoology, in MSc at the Calcutta University. He introduced new special papers like Cell Biology and Developmental Biology. He also incorporated several changes in general curriculum of MSc syllabus



of Zoology. I believe, this was a period of Renaissance of Zoology in India in general and in particular, in Calcutta. Just during this time, I was fortunate to enroll myself in BSc (Zoology Honours) at Presidency College, and had the opportunity of being taught by this great personality and a great teacher, Professor Sivatosh Mookerjee. I was also fortunate in learning comparative Anatomy of Vertebrates from another great teacher of the time, Professor Jitendra Nath Rudra, for whom Professor Mookerjee had deep regard. Both Professor Rudra and Professor Mookerjee had love for Zoology and love for the students that is unfortunately rare among the teachers of the present generation. Professor Mookerji was glamorous and romantic, with clear conceptuality and comprehension on the subjects he taught, while Professor Rudra was highly provocative to impermeate thought and imagination into students, was also comprehensive and had a great command on the subjects he taught. We never saw either of them carrying any note or book, and never saw them dictating any note from book; both used to draw diagrams like an artist drawing a landscape on a canvas. Professor Mookerjee used to teach us Embryology, Cell Biology and Evolution, in three papers in BSc and MSc with projection slides whenever necessary. It is rather difficult to forget the dynamic description of how a sperm moves through the Zona Pellucida to the point of entrance into the egg, with all chemical reactions in the pathway. It is also difficult to forget the description of the interactions between fertilizin and antifertilizin, and the cortical reaction that prevents polyspermy and facilitates monospermy. It was really enchanting hearing the movement of cells during gastrulation, and the experiments of Spemann and of Vogt. His class lecture on Evolution will be ever remembered by the posterity. It was like viewing a Primaeval horse running on three toes, and then suddenly jumping on one single toe. It was like a dream of wandering through the Garden of Adam and Eve. It was like travelling with him on an excursion to the past over 50 million years. That was Sivatosh Mookerjee, the teacher. At that young age, he was very popular and friendly with all his colleagues, other teachers of Zoology and other Faculties, and office staff members including his subordinate staff. He created an atmosphere in Presidency College at that time so much so, that no staff or student or researcher ever thought of absenting or ever thought of leaving the department immediately after the duty hours.

He was instrumental in creating a friendly atmosphere and a friendly relation among students, among teachers, and among teachers and students. It was like a play-way school, one or the other teacher moving around the practical class or museum of the laboratory, just watching us doing something with the model or charts or with the museum specimens. And in between Professor Mookerjee would come just casually and would casually and wittily ask a question, a very pertinent one about something concerning the item (s) with which we were engaged. And we would answer with a great burst of laughter. This was the relation and atmosphere he created. In field trips and excursions he always used to accompany us despite all his busy schedule. In such excursions also, we learnt in the form of stories, about the stalwarts of Zoology, about Mendel, Darwin, about Morgan, Spemann, Aldous Huxley and his BRAVE NEW WORLD, about the pedigree of Methe-



Arnold and Julian Huxley, about CB Bridges, about Th. Dobzhansky, about Herman J Muller and his artificial transmutation, about Curt Stern and Cytological demonstration of crossing over, about Barbara McClintock and her colourful Kernels, that at a later period led to the pioneering discovery of jumping genes, about Miescher's discovery of Thymonucleic acid (now known as DNA), and the double helix of Watson and Crick, though famous paper came out just then in 1953. Thus, our basic training in swimming through love for Science vis-a-vis Zoology was virtually completed in Presidency College, and that was mainly due to Professor Sivatosh Mookerjee.

He was in Presidency College from November 1953 until June 1972. During these golden years he produced some brilliant scholars and students, *e.g.*, Dr Somesh Sanyal, Prof Asok Bose and Prof Bansidhar Hazra, Dr BB Ganguly, Prof Simananda Adhikari, Dr Arup K Sinha, Prof Sunil K Datta, Prof Samar Chatterjee to name a few. It was during this period he got elected to the Fellowship of Indian National Science Academy (1971), then was awarded the Sir Dorabji Tata Medal from Zoological Society of India (1962), and Joy Gobinda Law Medal of Asiatic Society in 1966.

He married the charming lady Dr Anjali Mookerjee on the 6th December 1957. Dr Anjali Mookerjee, a Nuclear Physicist turned Biophysicist worked at the Saha Institute of Nuclear Physics later joined as one of the faculty members in the School of Environmental Sciences of JNU. In India this was the unique institution to start Environmental Sciences curriculum at the University level. She was a brilliant scholar of Sanskrit as well. Frequently, we had the opportunity of get-together in his house, and during different trips as well, when Prof Mookerjee and Mrs Mookerjee would narrate interesting episodes about Calcutta of Sir Ashutosh era.

When in 1965, January-February, Prof CH Waddington visited India, he visited the laboratory at the Zoology Department in Presidency College, Calcutta. Prof CH Waddington wrote in the visitors' book : "It was of course a pleasure to renew our old friendship, but I was specially delighted to find how far he has progressed. He has developed quite new lines of work on Hydra, Sponges, Amoebae and other organisms, which are already making significant contribution to developmental biology, His enthusiasm, originality of outlook and devotion to biology are already admirable." (Sd.- CH Waddington, 2.2.1965).

In his Presidential address, given in January 1967, in the 54th Indian Science Congress Prof. Mookerjee made a history which on earlier addresses was never so much resplendent and endowed with so much facts. This was an address reading which any student or scholar working on Developmental Biology would derive new ideas and materials for future experiments. He started this address with simple philosophical remarks and then went on to intense embryological derivations. He started with the following notes : "Time is something elusive. Neither can it be seen nor touched. Nonetheless, we can feel the passing away of time. Our own life seems to bear the burden of its effects. Time is something in between happening of events similar and dissimilar....".



Then he went on : "Investigations carried out in our laboratory show that Hydra occupies a unique position in the nature of progressive determination".

At one point he mentioned that "Hydra be better called Cellular Hydra because most of its body cells behave as individual units rather than organized tissue organ system". Even long after this Address Prof Mookerjee maintained that idea which he enunciated in the sixties. His concept of the individuality of cellular units to organized tissue system and true multicellularity through evolution, the role of positional information and cell-cell contact in differentiation and cellular determination are some of the ideas which are hot spots of developmental biology as on today. Prof Mookerjee was a scientist who would strongly and rigidly come to a conclusion derived from the experimental results. He was a type of scientist who would strongly push his prediction until the point to which experiments would lead him to. He would not accept the outcome as simple serendipitous.

A NEW EPISODE IN THE JAWAHARLAL NEHRU UNIVERSITY, DELHI : CHALLENGING YEARS OF MOLECULAR BIOLOGY IN DEVELOPMENTAL BIOLOGY BEGINS WITH THE BLENDING OF THE CONCEPT OF POSITIONAL INFORMATION AND CELL CONTACT THEORY

In June 1972, Prof Mookerjee joined as Professor and Dean of the School of Life Sciences, at Jawaharlal Nehru University, New Delhi, where he spent about twenty years, until the age of 60, and thereafter, on extension for three more years. During the years in Jawaharlal Nehru University, he was instrumental for recruitment of learned and talented scholars into the Faculty of School of Life Sciences. It was during his time as the Dean of the School of Life Sciences, at JNU, eminent scholars like Prof Habibullah, the Immunologist, Prof Kesavan, the Geneticist, Prof Samar Chatterjee, the Developmental Biologist, Prof Sipra Guha, an eminent Cell Biologist, Prof Asish Datta, an eminent Molecular Biologist, Prof PN Srivastava, an eminent Radiobiologist, who later became the Vice Chancellor of JNU, and many others were recruited into the faculty of Life Sciences. It was his overwhelming personality and far-sightedness that brought JNU into the International limelight and to the forefront of International Academic Institutions. It was through his endeavour and sincere efforts that the School of Life Sciences was recognized as one of the SPECIAL ASSISTANCE CENTRES OF THE COUNTRY. Even after his term as Dean was over, he went on to encourage all his younger colleagues for better publications, for new funds and for attracting talented students. His farsightedness and intuitive attitude led him to create an atmosphere of excellence among his colleagues. He could foresee the development of science much ahead of time. It was this intuitive attitude of his mind he compiled with the help of his team of colleagues an academic calender of post-graduate and higher studies, something unique in the national context, if not in the international context. He was real lover of science teaching. He



was out and out a devoted teacher. His intimate association with the NCERT, of which he was the Director for long time is the documented evidence of his love for Science. During the period of his stay in JNU he produced nearly a dozen more PhD's and published nearly 100 papers on different aspects of cell biology and experimental morphogenesis.

Throughout his long scientific career he searched for the answers to the very fundamental and challenging question of Developmental Biology and Cell Biology, about which the scientists all over the world are still baffled and bewildered. And that question is what cascade or cascades of signals lead to unwind the genetic regulatory hierarchy of differentiation? For this challenging question he switched himself and his research area from amphibian to chick then from there to hydra and to sponge. He realized that cell contact and cell movement were the two very fundamental aspects of early embryogenesis, whereby most of the signal transfer and signal transduction required for ultimated information transfer in the higher order of tissues are established. For this reason, I assume, he shifted to Hydra and Sponge. Prof Sivatosh Mokerjee could readily understand how the evolutionary mechanism and natural selection might potentiate the requirement for the transformation from unicellularity to disorganized multicellularity and to the highly organized precise cell layer from sponges to coelenterates (that is Hydra) and then to the higher multicellular systems. In one paper he wrote "Nature's first coveted multicellular proposition has been the organization of sponges—a distinct step forward from the scheme of unicellularity to a level of multicellularity." (Mookerjee, 1989)

Prof Mookerjee realized that cell differentiation in eukaryotes is a consequence of several events directed by several sets or cascades of genetic and eqigenetic signals. The signals from genetic cascades are set as a linear array of epigenetic events. The epigenetic signals are superimposed over the epigenetic events directed by the genetic cascades. The interaction of the signals from series of signals expressed as what is now known as "Positional Information". This idea of Positional information and the role of cell-cell contact in cellular differentiation although at first appears to be philosophical is indeed an accepted dogma for differentiating systems as of today. (Hadorn, 1973, Bryant, 1982, 1987). In the paper on cytophotometric determination of different cell types of Hydra (Chatterjee et al., 1988) Prof Mookerjee postulated the role played by the state of DNA of differentiating genome in potentiating cells dynamicity for determining the downstream pathway of differentiation.

This concept of the cellular morphodynamics and cell contact and the idea of positional information were elaborated in his lucid eloquent lecture in the Presidential address of Zoology, Entomology and Fisheries section of The Indian Science Congress held at Hyderabad, in 1967.

Prof Sivatosh Mookerjee was a voracious reader of both scientific articles within his field and also beyond his own specialization, Embryology and Developmental Biology



as well as of popular articles including short stories, novels and travelogues written by eminent literateurs. In research and scientific thoughts Sivatosh Mookerji was always innovative. One of his teachers and the then stalwart of Embryology, Prof Himadri Mookerji, once said to some of his research students who had gone abroad and had come back, and subsequently started their scientific research career, that "what you people would be doing would be simply to make one single component of a machine or repeating what your supervisor had taught you to do, like a technical person in a Gramophone Manufacturing Company would make the handle by which the turntable is to be geared into rotation and only that, and nothing but that". Prof Sivatosh Mookerjee was an exception. He deviated from his guide Prof CH Waddington's or from his earlier teacher, Prof HK Mookerjee's classical embryology. He would think certain very fundamental questions pertinent to differentiation and development, and in order to answer those questions he would select the best organism that would be suitable for his purpose. And for that reason, from the Amphibian system he moved to Chick, and then to Hydra, to Amoeba, to sponges. The intent and purpose in selecting the system was specific that was only to suit his prediction and intuition.

During the period of his deanship of Life Science School and later, I had the opportunity of visiting him and his School on several occasions, once or twice as an examiner for conducting the PhD Viva of his student. I had the privilege of conducting the viva with Prof Sivatosh Mookerjee, with his jovial mood. Another time, I visited the School, as a member of the Special Assistance Committee, and again as member of the Research Advisory Board for the Special Assistance. On all these occasions, he would spend hours out of his time discussing the progress in different fields of Zoology, Life Sciences, in Developmental Biology, and in Molecular Biology and Genetics. He talked about the role of membrane in cell functions and differentiation. After going to his house in the JNU campus, he would discuss many scientific ideas, never thought in Molecular Biology, then he would talk about literature, about many renowned Indian writers and poets and many Bengalee writers, about several newer and newer vocabularies in Bengalee, about Indian historical relics and characters.

Whenever I visited the School he felt proud to show me around different laboratories, the culture rooms, the tissue culture set up. During his stay in JNU also, he produced more than a dozen of PhD's. He believed and practised the idea, that each PhD thesis must yield at least three good publications. I got that inspiration from him on this aspect. He used to say that unless the works of PhD do not come out as published articles the quality of the thesis cannot be assessed.

Prof Sivatosh Mookerjee's thirst for understanding the hierarchy of developmental regulation of differentiation was deeply rooted in him and he was determined to answer the question and went on doing experiments until his sudden demise in 1993. In early 90's, he with one of his research associates challenged the role of cell-cell type from another. For this he used Hydra as his specimen. Instead of using the conventional



embryonic cells, he took the cells from mid-piece tissue of *Hydra vulgaris*, and grafted them either to the hypostome, or near the basal disc. He demonstrated that when the tissue was grafted near the host hypostome, it differentiated to a basal disc and when it was grafted near host's basal disc, it differentiated to a hypostome with tentacles etc. Thus, he could demonstrate the existence of a positive cross-reaction between the organizing regions in the hypostome and the basal disc, and that there was a morphogen gradient which had the selective ability of inducing budding in Hydra. This remarkable demonstration of concentration-dependent induction of budding through establishment of morphogen gradient was indeed novel and attracted many scientists in the country and abroad (Sinha, S and Mookerjee, S, 1992, *Developmental Biology*, 154, 218-22).

All these years and during the eighties he devoted himself mostly to this challenge of differentiation. The challenge was deep in his heart. In 1985, in a Banquet meeting at Schloss Reisenberg, he presented a sonnet or a sonneric as he called, that is re-represented below.

*So many human hypostomes travelled for me thousands of miles,
Just to see how I sparkle when I smile
A tiny little piece of marvel, I am Nature's fiction,
My methods esoteric, I enshrine super sense of organization,
My daily business to undermine the classic law of determination.
My quizzical beauty dazzled first queer fellow called Tremley,
Who totally aghast, not sure, me a plant or who's my alley,
Exquisite my cell technology, baffles, easily a Darwin or Lamarck,
Not to speak of Tardent-David-Schaller or any holy Bismark,
Best one can envision that I am not a biblical myth,
All my feats of gradients lie deep in my cellular pith.
Evolved from austere minimalist into exuberant eclectic multicellularity,
Most consistently, imaginative highly stylised innately decorative,
Like a visual art shuttering between cerebral and the surreal,
I lay my head, like magician, between Scientist's scissors,
Again to spring forth like a Spheonix from their geysers.*

*Intriguingly yours
HYDRA*

*SCHLOSS REISENBERG
SEPTEMBER 26, 1985.*



PROFESSOR SIVATOSH MOOKERJEE AS A TEACHER IN A CLASSROOM AND OUTSIDE.

Prof Mookerjee started his teaching career in Presidency college, Calcutta. He used to come to the Zoology Department all week days, at 9.00 in the morning, and there was no specific time in the late afternoon for going back. This habit he maintained in Presidency College and also in the School of Life Science, at the JNU. His class lectures were indeed full of life, blending literature with science, sometimes facts with philosophy, but not with fiction. Outside the classroom Prof Mookerjee was a different man. He was very witty, humourous and would tell stories about his teachers or seniors and would like making jokes, imitate either unique voices or accent of persons, for which he would not spare his seniors and for that matter not even his Vice-Chancellor. But the spirit of his jokes was so intelligent and lively that no one would react to such jokes as insulting. And yet, depending upon the level of his audience, his jokes maintained the dignity of the relationship. He was as much friendly with his students in excursions or field trips, as with his colleagues and subordinate staff.

AS A MAN

I and some of my classmates of 1953-1957, have had the opportunity of mixing with Prof Mookerjee and his family with much closer intimacy than anybody else. We have had the opportunity of discussing major academic issues, many literary episodes, many political and non-political jokes. And on every occasion, the discussions would continue not simply on a cup of tea, but at least three to four items of food. He loved to eat and he loved to enjoy his students and friends eating at his place. I have never seen him in his own residence or outside to be miserly in spending money for a delicious dish. Whenever I visited his residence in JNU, I had to stay most of the time in his house. And on such occasions, sitting for dinner on the dining table, while his wife would arrange the table, he would direct us to take specific pieces of the meat preparation or of fish. This was Sivatosh Mookerjee, a man, a scientist, a teacher, a friend, philosopher and a guide.

His scientific contributions to Developmental Biology will be remembered for several decades to come. But Professor Mookerjee's friendly attitude towards his students, younger and older, will be always be remembered as an example for the posterity. He had a literary flair and his facid, sensitive and humourous pen entertained young and old alike. He had several books and a few hundreds of articles-science or non-science – to his credit.

It was hard to believe that a man, so flamboyant with ideas, so generous in his behaviour, so full of life and so sympathetic and appreciative about others' ideas, would be suddenly taken away from us when posterity had yet to achieve many more and much



more from him. He died on 6th of March 1993, at Santiniketan (Tagore's place) where he built a small house on retirement and was engrossed in gardening and literary pursuits.

It was a great honour for me to write this profile of Prof Sivatosh Mookerjee. In this context, I should mention that after his retirement whenever he was in Calcutta he would visit the Zoology Department of Calcutta University. And he would come to Prof Asok Ghosh's lab, and then either call me from my lab, or would come and sit in my lab. Once on one of these occasions he told me very affectionately, "Ardhendu, I shall write my obituary and give it to you, before I'd die". We have lost a great teacher and a scientist, — quite prematurely.

I am thankful to Prof (Mrs.) Anjali Mookerjee for her help in preparing this profile of Late Prof Sivatosh Mookerjee and to Dr Simananda Adhikari for many materials for this purpose. I also thank Prof Asok Ghosh and Prof JN Rudra for various discussions which have helped me in the preparation of this profile. I am thankful to Indian National Science Academy for inviting me to write this profile.

AS MUKHERJEE

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