

Remembering Panchanan Maheshwari – An eminent botanist of the twentieth century*

There are many great people in the world, but few become legends in their own lifetime. The late Panchanan Maheshwari was one such person. In physical appearance, he looked distinguished and in his profession he was a visionary, who transformed the botanical scene and did India proud by placing it on the world map. This year marks his birth centenary and seems an appropriate time to look back and recount the story of his life and contributions. I have had the fortune of knowing him both as a student and as a family member. This account centres around the period he spent in Delhi University (1949–66), where he was affectionately referred to as PM by his students and junior colleagues.

Panchanan Maheshwari was born in Jaipur on 9 November 1904. Panchanan, a somewhat unusual name, means an intellect of five brains in Sanskrit. As his life unfolded, the appropriateness of the name became apparent. Young Panchanan studied in the reputed Ewing Christian School at Jaipur and passed the Matriculation examination at the age of 13. His weak eyesight precluded entry into the medical profession as originally planned, but nevertheless he pursued a career in science. He obtained his Intermediate (1921) and Bachelor of Science (1923) degrees from the Ewing Christian College affiliated to Allahabad University, which was among the half a dozen or so universities that had been established in India by then. It was while doing his Intermediate that Maheshwari came under the spell of a remarkable American missionary teacher, Winfield Scott Dudgeon, a reputed botanist from the University of Illinois, Chicago, who was a Professor at Allahabad University. Young Maheshwari was exceptional in studies and this was noticed by Dudgeon, who took personal interest and guided and moulded his life and career. PM did his M Sc (1927) and D Sc (1931)

under Dudgeon's supervision on the morphology, anatomy and embryology of some angiosperms. After completing his studies, PM went to his mentor to offer him 'guru dakshina'. Quick came the reply, 'Do for your students what I have done for you'.

PM joined Agra College as Lecturer in 1930. This college was among the earliest established in British India. PM was a charismatic teacher and a dynamic researcher who attracted many students. Several enthusiastic scholars joined him and a

school of plant embryology was established. With meagre resources he acquired a microscope and a microtome and also worked at home during the night. Though his wife, Shanti had no formal education, she learnt microscopic techniques and assisted him by preparing slides like a professional. The surge of research activity in the small Agra laboratories was such that young Maheshwari was soon promoted to the position of an Associate Professor and was called a rising star of Indian botany.



Top, Panchanan Maheshwari in his office at Delhi University. *Bottom* (Left to Right) with B. M. Johri (Delhi), P. N. Mehra (Chandigarh) and V. Puri (Meerut).

*The article embodies the work of many of Panchanan Maheshwari's students, colleagues and associates whose individual names are not mentioned because of space constraint. However, I would like to mention the late Prof. B. M. Johri, who was not only his pupil but a long-time collaborator and himself a stalwart of botany.

To Germany and then to Dacca

In 1936–37, PM went to Europe and England – a visit which proved to be significant, as he made several valuable contacts. PM's discussions with a plant embryologist, Karl Schnarf at the University of Vienna and with George Tischler, a renowned cytologist at the University of Kiel, greatly inspired him and influenced his subsequent work. After his return from Europe, PM worked on temporary positions for some time at his alma mater, Allahabad University and at Lucknow University in the department headed by Birbal Sahni. In 1939, he was invited to join Dacca University as Reader and Head to develop a new biology department. At that time Dacca University had many illustrious names, including Satyen Bose of Einstein–Bose fame who was then the Dean, Faculty of Science. Meghnad Saha, the well-known physicist, who knew PM since his student days at Allahabad, is said to have remarked that Dacca University was lucky to have appointed a jewel of Indian science! PM served at the Dacca University for 10 years and established a flourishing school of botany. In 1947, after returning from a two-year study leave at Harvard University, he became a Professor and was also appointed Dean, Faculty of Science. However, the partition of India changed it all. Although PM was reluctant to leave a department that he had built with great care and the East Pakistan authorities also requested him to serve there, he could not turn down an invitation to join Delhi University from its Vice-Chancellor Maurice Gwyer (also the last British Chief Justice of India). In Dhaka, even today a part of his original office has been preserved and a plaque in Bengali commemorating his stay adorns the department.

Delhi University (1949–66)

In 1949, PM joined Delhi University as Professor and Head of the Botany Department. Then followed an eventful and productive period of his career, and already in the 1950s he was being called a legend. How did PM earn this epithet so early in life? His personal attributes spelt greatness and made an immediate impression. He was a strong, determined, forthright, unconventional person with boundless energy and drive, yet magnanimous, an outstanding scholar and teacher with the motto 'Work is worship'. He had a re-

lentlessly enquiring mind, was a perfectionist who had set high standards for himself and accepted nothing that in his opinion was second-rate. His promptness and punctuality were proverbial. He was open-minded and had the ability to enlist the interest of others and organize team work.

An Introduction to the Embryology of Angiosperms – his magnum opus

Soon after he joined Delhi University, PM shot into fame with the book, *An Introduction to the Embryology of Angiosperms*, published in 1950 by McGraw-Hill Company, New York, which then was the largest and the most reputed publisher in the world. The writing work had begun in Dacca, continued at Harvard University (1945–47) and was completed after his arrival at Delhi. The book, first of its kind, is considered a classic, has been reprinted several times and translated into several languages, including Russian. Indeed in an editorial in the 1980s Eugene Garfield (ISI) ranked the book as among the 20 biology texts most quoted in the century! With the current emphasis shifting now to reproductive structures, the last ten years have seen a resurgence in investigations on plant embryology using the powerful tools of modern molecular biology. His book continues to be cited even 50 years after its publication.

Botanical contributions

In research, a uniquely critical outlook was the hallmark of his phenomenal work. An all-embracing approach with characteristic thoroughness is seen in research as in all activities he undertook. His work embraced almost all branches of botanical science – he may be said to be among India's last 'complete' botanists. In the early thirties, the microscope and the microtome were the chief tools of research in biology. He started out with morphology, anatomy and descriptive embryology and moved on to comparative embryology. But in later years he explored experimental embryology at the interface of physiology and genetics and steered the department in the course of modernization. Just a glimpse of his research work will be given here.

His doctorate work was mainly on anatomy and embryology. He discovered anomalous secondary growth in *Boerhaavia* and *Rumex* (these plants have extra vas-

cular bundles) and traced their origin to protoxylary tissues. PM showed that sterility in the tree, *Albizia lebbek* was not in response to environmental factors as was earlier believed but due to the collapse of pollination mechanism and degeneration of male and female gametophyte brought about by internal (probably genetic) factors. Plant morphology and anatomy continued to interest him, e.g. scattered bundles in *Elatostema*, interxylary phloem in stem of *Leptadenia*, abnormal secondary growth in stem of *Tiliacora*, phellogen in *Paederaria*. But gradually, he focused on reproduction in plants. Several plants growing in aquatic habitats attracted his attention, *Hydrilla*, *Jussiaea*, *Butomopsis*, etc. Later, he extended his studies to *Ottelia*, *Vallisneria* and *Limncharis*. For the first time he described many embryological features peculiar to them. The world's smallest seed-bearing plant, *Wolffia* too attracted him. Mistakenly thought to be on the early steps of the evolutionary ladder, it was shown to have advanced embryological features and derived from aroids by retrogressive evolution.

After he came to Delhi and trained a larger group of students, more challenging work on lesser known families was taken up. Along with his former pupils (some of whom became colleagues), monumental work was done on the families Loranaceae and Santalaceae, which revealed the obscurities of parasitic life – bizarre embryo sacs growing through the style curving downwards after touching the stigma or the unusual haustorial extensions from the micropylar and chalazal chambers of the endosperm and much more. Haustoria of different types were found to grow from embryo sacs in many other families. In *Leptomeria*, pollen grains were found to develop into embryo sac-like structures. It is a record of sorts that between PM and his pupils, more than one hundred families of angiosperms were investigated from the point of view of comparative embryology alone! In the process several gross errors were detected and many dubious taxonomic assignments were corrected; for instance, *Exocarpos*, an angiosperm belonging to the family Santalaceae had earlier been misclassified as a gymnosperm. PM advocated the use of embryological features in conjunction with palynology, cytology, chemotaxonomy and anatomy to achieve vastly improved and finely tuned taxonomic classification of vascular plants. The comprehensive approach was adopted by taxonomists

(such as G. H. M. Lawrence of Cornell University in his textbook) and led, in the course of time, to the multidisciplinary approach in plant classification.

In the mid-fifties, PM turned his attention to gymnosperms. From the embryological point of view, gymnosperms are even more fascinating than the more evolved and dominant angiosperms. Special attention was given to *Gnetum* and *Ephedra*, which occupy a unique position as they link the group to angiosperms. The research culminated in the publication of well-illustrated monographs, where their fascinating life histories were detailed. A masterly treatment of all gymnosperms in the manuscript was ready for publication, but for his untimely death.

His interest in floristics and taxonomy is seen in a major accomplishment, an illustrated *Flora of Delhi*, compiled under his supervision (1963). *A Flora of India* (compiled in 1965 for the *National Gazetteer*) includes plants ranging from algae to angiosperms. In another comprehensive coverage of *History of Botany in India*, pride of place is given to plants described in the *Rigveda*, *Atharvaveda*, *Vrikshayurveda* and other ancient scripts. This reflects PM's deep knowledge of Sanskrit. In Delhi University, PM introduced economic botany as a compulsory subject, as he felt that every responsible citizen must have some familiarity with natural plant resources on which man depends.

He often wrote popular articles about plant power being as important as water power, sea power and atomic power. In his writings, PM always tried to bring out what he thought the younger generation should know. For instance, he wrote that Gandhiji's very first Satyagraha was in relation to the plant *Indigofera tinctoria*, a source of the indigo dye used in textile manufacture.

Emergence of Delhi University as a leading botanical centre

Encouraged by a world-class leader, many Indian botanists were attracted to venture into plant embryology and experimental botany. Indeed India emerged as a centre of botanical work and respect for PM rose by the day. Also contributing to his success was his mastery of the German language, which helped in interactions with German colleagues. His admirable command of the literature rendered accessible the enormous German contribution of the late 19th and early 20th centuries to Indian researchers.

Phytomorphology, The Botanica and a high school textbook of biology

To promote interest in morphology and accommodate the enhanced volume of contributions in the subject, in 1951 PM launched an International Society of Plant Morphologists with the journal *Phytomorphology* as its official organ. Under his stewardship many foreign botanists regularly sent their manuscripts to the journal. PM's concern was as much the undergraduate student as the research scholar. To foster writing skills of the undergraduates, he started *The Botanica*, published by the Delhi University Botanical Society. The magazine was an instant success as it carried lively and informative articles and had an impact in creating interest in botany among undergraduates all over India. At the request of NCERT, he undertook preparation of a textbook of biology for higher secondary schools. Written with a team of 40 professors and readers from all over India, it indeed filled a great need as an inspiring introductory text with examples from Indian flora and fauna – on the national scene many educationists consider this to be PM's most enduring and seminal contribution. Biology, which till then was not so popular, became the first choice of many students embarking on a career in science.

Seminars and research demonstrations and containing the threat of Lysenkoism

PM was first and foremost an outstanding teacher; even the ordinary classroom lectures were extraordinary and memorable. Under his chairmanship, student and faculty seminars became the lifeline of the department. Everyone looked forward to PM's wit and sense of humour. Even a rather dull talk was enlivened by his sparkling commentaries and penetrating questions. In keeping with his wide perspective, students were required to present seminars not only on their research work but also on topics in general botany and at least one seminar per year on a non-science topic. On many Saturday afternoons, he himself gave discourses on the *Ramayana* and recited shlokas in his mellifluous voice, interpreting them in the modern context. History of science was another passion of his. It was his strong conviction that every science student should be familiar with the method of science. His own knowledge of

history of science was wide and deep and this was reflected in the superb lectures that PM delivered to all science undergraduates at Delhi University. These lectures were highly popular, interspersed as they were with interesting anecdotes from the lives of great scientists, narrated in a captivating style. Students marvelled at his technique, as he spoke he wrote on the blackboard all the key words in his beautiful handwriting – a fine take-home resume appeared on the blackboard that students treasured.

In research, it was his fastidiousness that ensured high standards. He insisted on first-rate technique, instilled in students accuracy of observation and meticulous, and flawless presentation of work. To this end an activity he introduced was actual demonstrations of research work, an activity which forged team spirit and inculcated a critical approach to science. Demonstrations for scrutiny and criticism by research scholars and teachers were great events – a prerequisite for anyone ready to submit a thesis or a paper for publication was required to display all research material used. Every aspect was examined threadbare and under his watchful eye only quality work was accepted for processing for publication.

PM is also remembered for stopping the menace of fraudulent science and a distorted form of genetics inspired by communist ideology from taking root in our country. He crusaded almost single-handedly against Trofim Lysenko – a Russian plant breeder who advocated the inheritance of acquired characters.

Botany Department – A Mecca for botanists

The Botany Department at Delhi University was a vibrant place and already in the early fifties, it had acquired the reputation of a world class department. Many scholars from all over the world were attracted to come to work and learn. Several Fulbright research scholars as also foreign scientists from Europe and USA spent their sabbaticals. They enjoyed consulting PM's extensive personal collection of books, reprints, slides, photographs of botanists and rare plants, botanical specimens from all over the world, and botanical stamps, perhaps the largest collection owned by any individual botanist. His collection was not confined to books in botany, there were encyclopaedias, medical books, books by playwrights, on phi-

losophy, history, history of science, biographies of great men and women, on music, general science, books on humour, atlases and geography books to name a few. Books were freely available to users even outside Delhi. For students going abroad for postdoctoral work, PM's name was the password to warm and affectionate treatment in the Western laboratories. Many students of the department sent back messages exulting over the royal treatment they received from their hosts.

Experimental embryology

Ever vigilant about developments in botanical science, already in the forties he was familiar with the tissue culture technique being applied by P. R. White (USA), R. J. Gautheret (France) and J. P. Nitsch (France) to grow excised plant tissues and organs. He was greatly interested in the work of A. F. Blakeslee and Johannes van Overbeek (whom he visited soon after the Second World War), who had used the tissue culture technique, for instance, to rescue embryos of desirable crosses which would otherwise abort. Indeed the last section of his 1950 book has a chapter on experimental embryology which deals with these attempts.

Ever since the discovery of the first natural haploid plant in *Datura* by Blakeslee and colleagues (Cold Spring Harbor Lab) in 1922, experimental intervention was sought to increase their frequency and obtain them at will. For several decades geneticists had to make do with trial-and-error approach using temperature shocks, delayed pollination or X-rays, but as the results were erratic, they were by and large abandoned. In the fifties, availability of gibberellins and cytokinins (auxins were already in use) inspired a project on 'Chemical stimulation of ovary and ovule'. As is well known, haploids provide the means of obtaining homozygous pure lines of chosen crops in a single generation instead of a decade or more of tedious selfing normally required. My own Ph D thesis concerned investigation in aseptic culture of unpollinated ovaries and unfertilized ovules. Somewhat unexpectedly then, culture of unpollinated ovaries was possible and this merited publication in *Nature*. On PM's suggestion, I went a step further and cultured ovules; although unfertilized ovules could not be excised from the placenta and grown, they could be handled only when zygotes were already formed –

even this partial success merited publication in *Science*. It is only now after 40 years with vastly improved technology that investigators have been able to obtain haploids from unfertilized ovules.

However, at this point one must draw attention to the remarkable insight that PM had to suggest that anthers and pollen might be the right material to look for induction of haploidy. PM's prophetic words at the conclusion of a Plant Tissue Culture Conference organized by him in 1961, the very first in India, are worth recording: 'The pollen grain like the egg is a haploid structure. What makes these two haploid bodies behave so differently? The egg can often develop parthenogenetically into an organized mass of cells, the embryo. Is it possible to obtain something similar from pollen grains?' What a coincidence that just one year later in his own department haploids were discovered in *Datura*, welcomed by contemporary botanists as a landmark. The serendipitous nature of the finding led George Melchers, a leading German botanist to compare it with the discovery of America by Columbus! Work on haploids was enthusiastically picked up all over the world and many improved crop varieties were released.

The Botany Department became well known for conducting studies based on the aseptic culture technique. It was used to advantage in the investigation of flowering in *Wolffia* (sensitive to just one photoinductive cycle), of *Cuscuta* (a semiparasite), for *in vitro* differentiation of buds from leaves. Induction of polyembryony in nucellus and study of morphogenesis in endosperm were other achievements. In the early sixties, several bryophytes were investigated in artificial culture and many observations were made for the first time, e.g. formation of buds in total darkness in the presence of cytokinins. PM encouraged work on a moss, *Physcomitrium* which emerged as a model system for work on physiological aspects. Also done for the first time was investigation of fertilization under experimental conditions; *in vitro* fertilization was an important advance, crucial for overcoming barriers to crossability in plants.

This effort was recognized and given a fine tribute – in his preface to the *Advances in Botanical Research Vol. II*, Preston (1965) wrote 'One of the most remarkable developments of our time in plant science has been the way in which hitherto purely observational regions are progressively becoming experimental or even mathe-

matical. One case of the former is included here, in the remarkable developments in embryology at the hands of Professor Maheshwari and his colleagues and students ...'.

Growth of plant physiology and modern plant biology – His legacy

Finally I would like to enumerate PM's contribution to the development of plant physiology and plant biochemistry and many investigations which are now considered as belonging to plant molecular biology. It is his voluminous contributions to plant embryology that have tended to overshadow his contribution to the growth of plant physiology in India. PM was an outstanding teacher of plant physiology, his friendship with Fritz Went, James Bonner (Caltech), George Melchers (Tubingen), Lawrence Bogorad (Harvard), Arthur Galston (Yale), Harry Borthwick (USDA), Folke Skoog, Robert Burris (Madison), F. C. Steward (Cornell) – all icons at that time – helped him stay in touch with the advances in plant physiology. It is also to PM's credit that the first laboratory outline of plant physiology in the country was prepared under his supervision. He was also responsible for organizing the first National Seminar in Plant Physiology, which was deliberately timed to coincide with the visit of a leading plant physiologist, Kenneth V. Thimann of Harvard University in 1957. Prominent plant physiologists of the country were brought together for the first time and this opportunity was utilized to prepare a set of recommendations for strengthening research in plant physiology for adoption in the country. PM gave impetus to the growth of the subject by encouraging many of us to take specialized training in the best Western laboratories with eminent authorities in the field. It is worth recording that the Botany Department at Delhi University was among the first in India to let the students experience the thrill of watching DNA threads spool endlessly or watch colourful chromatographic separations. It may not be an exaggeration to say that the growth of plant physiology and later of plant molecular biology in Delhi University and perhaps certain other centers in the country owes largely to the vision of PM.

Additional responsibilities

PM was a member of the Science Advisory Committee to the Cabinet in the time of

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Nehru and Indira Gandhi, and counselled the Government through its various committees and bodies, e.g. of the CSIR, UGC and ICAR (of the Ministry of Agriculture) and helped with the selection of candidates for the administrative services. The United States Educational Foundation in India depended on PM for selection of Fulbright scholars and sought his advice on other programmes. He was Editor of Publications of the National Academy of Sciences. The additional responsibilities apparently did not weigh him down and many wondered how he was able to pack so much in a day and still be up to date in his academic pursuits. A prodigious photographic memory was certainly an asset and so was skillful management of time. Generally all his serious study was confined to the early hours of the morning.

Honours and distinctions

PM was a scientific citizen of the world and many academies were honoured to make him a Foundation Fellow or Corresponding Member. In 1947, he was made a Foreign Fellow of the American Academy of Arts and Sciences. During the same year he became a Foreign Fellow of the Botanical Society of America. He was President of the newly created Embryology Section of the Seventh International Botanical Congress in Stockholm in 1950, and Vice-President of the Eighth International Botanical Congress held in Paris in 1954. In 1959, he was decorated with the degree of D Sc *honoris causa* of McGill University, Montreal on the occasion of the 9th International Botanical Congress. He was elected Foreign Fellow of the Kaiserliche Deutsche Akademie der Naturforscher Leopoldina in 1959, the Deutsche Botanische Gesellschaft in 1961 and of the Royal Dutch Botanical Society in 1963.

Turning to recognitions at home, in 1934 he became a Fellow of the Indian Academy of Sciences, Bangalore. The Indian Botanical Society honoured him with the Birbal Sahni Medal in 1958, while the National Institute of Sciences of India, of which he was a Foundation Fellow since 1935, honoured him with the Sunderlal Hora Memorial Medal in 1964. In 1966, he was made an Honorary member of the Botanical Society of Bengal. He was President of the Indian Botanical Society in 1944. He was President of the National Academy of Sciences of India in 1964 and General President-elect of the Indian Science Congress Association for 1968, a role he could not fulfil on

account of his untimely death. He was elected Fellow of the Royal Society in 1965. It was typical of him that he did not disclose this even to his family members, who learnt about it only through newspapers.

The end

PM was so full of life and excited about many of his projects getting completed to his satisfaction that he ignored the illness which was gradually descending on him, an illness which started when he was returning from London after signing the Charter Book of the Fellows of the Royal Society. The end came on 18 May 1966 and with that the botanical community suddenly lost one of the most extraordinary figures of recent times. Men of his stature are rarely born, but leave behind them footprints on the sands of time.

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Remembering my guru P. Maheshwari

The year 2004 is special for me as it marks the birth centenary of my guru, Panchanan Maheshwari (PM), who had a significant influence in transforming my career and life. I pay my homage to him on this special occasion. There are several accounts on his life and work¹⁻⁴. The well-researched essay by Kapil⁵ sums up Maheshwari's major achievements and those of his students. A short biographical sketch of Maheshwari by Rangaswamy⁶ has appeared recently. Here I wish to bring out the qualities that made him an eminent scientist, teacher, builder of a great institution and as an ardent promoter of plant sciences in India. I would also recall the environment in which I grew up as a young teacher and the impact our guru had on the development of his students.

After obtaining the B Sc degree (1950) and serving as a demonstrator in botany for one year at St Philomena's College, Mysore, I proceeded to pursue my M Sc

degree at B.R. College (later R.B.S. College) Agra in 1951. Bahadur Singh, who was heading the department in that college



guided my M Sc dissertation on the embryology of Asclepiadaceae. He was a student of Panchanan Maheshwari, the leading plant embryologist of the world. Reading Maheshwari's book taught me the fundamentals of embryology and opened my mind to the enormous potential applications of the subject.

After securing my M Sc degree I went back to my Alma Mater in Mysore as a lecturer. In early October 1953, I received a call from the Registrar of the University of Delhi, asking me to appear for a Botany Lecturer's interview on 10 October. After arriving in Delhi I reached Jubilee Hall, a hostel for postgraduate male students. I took a stroll in the spacious garden around the Vice-Chancellor's office, which was formerly the Viceregal lodge.

The Selection Committee consisted of two experts – B. P. Pal (at that time Director of the Indian Agricultural Research Institute) and R. Misra (Head of the Department