A protagonist of plant sciences

An obituary of Frederic Campion Steward by H. Y. Mohan Ram

Professor Frederic Campion Steward, an outstanding plant physiologist of our time, passed away at the age of 89 in Tuscaloosa, Alabama, USA, on 13 September 1993. He was in poor health for many years. Steward was a unique individual, endowed with a rare blend of high intellect, unbounded energy and originality. The range of subjects in which he made substantial contributions was wide: cell physiology, ion uptake metabolism, protein synthesis, respiration, morphogenesis, growth and development.

He is best remembered for his work on cellular totipotency in plants. He grew pieces of carrot root consisting of fully differentiated cells, in specially devised glass tubes and flasks, in liquid medium containing nutrients and growth adjuvants. He observed that the tissue proliferated, and the peripheral cells that sloughed off into the medium exhibited the 'built-in capacity to grow', formed embryo-like structures and regenerated into fertile carrot plants. The recovered plants bore the typical crunchy orange-coloured roots!. This work was one of the earliest and the most impressive demonstrations of totipotency, vindicating the prophecy made by Haberlandt in 1902. This work was published in a series of papers in the *American Journal of Botany* in the late 1950s and the significance of the findings was conveyed to the scientific community by Steward through his electrifying lectures.

His research stimulated numerous workers around the world to take up work on plant cell and tissue culture. Totipotency of cells was reported from a wide range of tissues in diverse plants, including production of haploid embryos in the anther. The major outcome of these efforts was regeneration of full plants from cells, cloning and genetic engineering.

What distinguished Steward from other specialists in plant physiology was the breadth of perspective, which permitted him to understand the importance of relationships between the various disciplines in botany and chemistry.

Steward was born on 16 June 1904 in London. He graduated in 1924 with a first class Honours degree in Chemistry from the University of Leeds. He received the PhD degree in Botany from Leeds (1926) under the guidance of Professor J. H. Priestly, considered a maverick among plant physiologists of his time. Like his teacher, Steward dared to be independent and different. He often told his associates that a person *could* and indeed *should* be a 'majority of one' if his/her conscience and scientific convictions dictated it.

Steward spent two years at the Cornell University and the University of California, on a Rockefeller Foundation Fellowship (1927–28). He returned to accept the post of Assistant Lecturer in Botany at his Alma Mater. In 1929 he married Anne Temple Gordon, an American graduate student whom he met in the Department of Botany at Cornell University. After his appointment as Reader at the Birkbeck College, London, he visited USA again in 1934 on a Rockefeller Foundation Fellowship and was placed at the University of California and later at the Carnegie Institute of Washington. Steward was awarded the DSc degree from the University of London in 1938. During 1938–40 he served as Acting Head of the Department of Botany at Birkbeck College.

When World War II broke out, Steward plunged to serve his country of birth with patriotism. He worked in the Ministry of Aircraft Production, first with the rank of Administrative Principal and later (1941–45) with the rank of Director and Assistant Secretary. When the war ended, he sailed to the USA to accept the chair of Botany at the University of Rochester, which he held from 1946 to 1950. He then joined the Faculty of the New York College of Agriculture, Cornell University, and served there until his retirement in 1973 as Charles A. Alexander Professor of Biological Sciences.

It is during his long stay at this picturesque campus that Steward made his most significant discoveries along with his dedicated co-workers I had the privilege to work with Steward as a Fulbright and Smith-Mundt Fellow (Post-Doctoral) from 1958 to 1960. I could not have found a better laboratory to learn plant tissue culture and morphogenesis. Besides studying the developmental anatomy of the banana fruit and publishing the first detailed paper on tissue culture of the banana, I wrote a critical review with Steward entitled 'Determining Factors in Cell Growth' for the first volume of *Advances in Morphogenesis* (Academic Press, 1961)

His lectures in Advanced Plant Physiology, a two-semester course, were illuminating, instructive and stimulating. He developed his lectures with an historical approach and ended them by citing the most recent discoveries. His laboratory attracted a large number of graduate students and scientists from overseas. The education and training received under Steward have helped shape plant sciences in remote parts of the world.

Steward is credited with the discovery of the close association between the salt uptake, respiratory metabolism and protein synthesis. He was the first to subject the free and combined amino acids of plants to paper chromatography and to use this study for understanding problems of growth. He reported the presence of many previously unknown amino acids in plants and their significance in metabolism.

A monumental work of Steward was as editor and contributor to *Plant Physiology – A Treatise*, which runs into 10 volumes and 15 numbers published by the Academic Press, New York. These volumes have helped the scientific community in providing sufficient details and even extracts from the ever expanding literature in plant physiology. Steward has published hundreds of technical papers and has authored numerous books and reviews. *Growth and Organisation in Plants* (1968) depicts his personal approach to the understanding of the subject, matured through long experience gained from morphology, physiology and biochemistry. The other two books *Plants At Work* and *About Plants* have been widely read and enjoyed by undergraduate students In collaboration with his former student, Professor A. D. Krikorian, Steward brought out *Plants, Chemicals and Growth*, an authentic and excellent exposition of regulation of plant growth by natural and synthetic chemical substances.

A spellbinding lecturer, Steward was much sought after as a guest speaker or as a participant in scientific meetings in several parts of the world. Numerous honours came to him. He was elected a Fellow of the American Academy of Arts and Sciences in 1956. This was followed by his election to the Fellowship of the Royal Society of London (1957) and as John Simon Guggenheim Fellow (1964). He was honoured as Vice President of the International Botanical Congress (1964). Steward received the Merit Award of the Botanical Society of America (1961) and the Stephen Hales Award of the American Society of Plant Physiology (1964). The University of Delhi conferred on him the degree of D Sc *honoris causa* at a special convocation in February 1974. The Indian National Science Academy elected him a Foreign Fellow in 1981.

The following excerpt from a letter written by Steward to the Editor of *Cornell Sun* on the occasion of the cutting down of a gigantic oak tree bears testimony to Steward's concern and admiration for anything living. "The inexorable march of events has recently overtaken a long-time resident of the Cornell campus. No flags at half mast, no passing tears marked the end of two and a half centuries of gracious living in this community, for the resident was a tree. Although no single tree should obstruct a $9,000,000 enterprise, the sudden sight of that decapitated trunk, now mercifully removed from view, produced a physical sense of shock To paraphrase some hackneyed and familiar lines: 'Bombs are made by fools like me, but only God can make a tree'. There is however a lesson to be learnt. There is no material science more exquisite than that of the living state, no engineering more exquisite than that of a living cell."

The botanists of India found in Steward a true friend He was admired and respected. He first visited Delhi in 1961 to participate in the 'International Symposium on Plant Cell, Organ and Tissue Culture', and again in 1966. He was invited by the University of Madras as 'Sir C. V. Raman Visiting Professor' in 1974. A noted Indian botanist who attended the series of lectures was so enthralled by Steward's mastery of exposition that he named the event 'The Steward Festival'. Steward wrote a perceptive article on 'Trends in Botanical Research: In Retrospect and Prospect' (*Current Science*, 1974, **43**, 363–365). The distilled thoughts contained in this message to Indian botanists are relevant even today.

Motivation, utter dedication, tenacity, perpetual restlessness and obsession with excellence were qualities that propelled Steward's scientific accomplishments. There has been a general decline of teachers of his eminence and role models.

Steward's views on education were rather atypical: 'Universities cannot be wholly democratic. If they are, they cease to be Universities. A true University represents an oligarchy of scholarship based not only on tolerance but also on intolerance: intolerance of stupidity, intellectual laziness and sloppiness. Education is not only for the masses but also a privilege for those who can use it.'

Steward will be long remembered as a protagonist of plant sciences wherever plant growth and development will be studied. He is survived by his wife, son, daughter-in-law and two grandchildren.

The author, who is teaching in the Department of Botany, University of Delhi, Delhi 110 007, was a post-doctoral Fellow in Steward's laboratory at Cornell University (1958–60) Material for this note has been taken from an article by H. Y. Mohan Ram and I. V. Ramanuja Rao, published in Botanica (1976) and from correspondence with Professor A. D. Krikorian, Department of Biochemistry, State University of New York at Stony Brook, USA