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AT THE ROOTS OF PLANT NEUROBIOLOGY: A BRIEF HISTORY OF THE BIOPHYSICAL RESEARCH OF J.C. BOSE

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Sir J. C. Bose (1858-1937) is perhaps best known for his ingenuity and perspicacity in the field of microwave physics. Many of his inventions, including the first solid state semi-conductor diode, are now devices taken for granted in contemporary microwave technology. Bose turned his attention to the world of plants in the early days of the twentieth century, merging the boundaries of what had been quite separate disciplines, botany and physics, and establishing a nascent field of biophysics. The series of insightful experiments into life-processes of plants he began then would occupy him until his death, produce a prodigious body of published work, and see him transformed from a well-respected physicist into a controversial figure, a maverick, in the west. Seeking unifying principals underlying apparent disparities between animal and plant responses, Bose invented original and ingenious instruments that enabled him to simultaneously measure bioelectric potentials and to quantify very small movements in plants. Bose worked with touch-sensitive plants, including Mimosa pudica, with plants that perform spontaneous movements, such as the Indian telegraph plant Desmodium, as well as with 'ordinary' plants that made no obvious rapid movements.

The conclusions he drew from his experiments flew in the face of the emerging Victorian mechanistic materialist philosophy of science. Plants and animals share essentially similar fundamental physiological mechanisms. As do animals, plants co-ordinate their movements and responses to the world through electrical signaling. Rather than belonging to the category of passive automata, to which they had been consigned, Bose argued that plants are sensate, active, intelligent explorers of the world. He identified a fundamental physiological motif that interlinked measured pulsations or oscillations in cellular electric potentials with oscillations in cell turgor pressure, cellular contractility, and growth. All plants respond to the world and to other living things through this pulsatile motif, this electromechanical pulse.

Bose's conclusions that all plants possess a nervous system, a form of intelligence, and a capacity for remembering and learning, was poorly received by prominent electrophysiologists of the time. One hundred and fifty years after Bose's birth, concepts of kin-recognition, complex foraging strategies, intelligence, learning, and long-distance electrical signaling in plants are featured in the mainstream literature. Recent advances in both neurobiology and plant cell biology are uncovering some surprising similarities between plant cells and the neurons of animals. A relatively new discipline, plant neurobiology, now recognises plants as knowledge-accumulating systems that enact many of the same behaviours as do animals, despite lacking eyes, ears, or an obvious brain. Plant neurobiology now aims to understand how plants perceive, remember and process their experiences, coordinating their behaviours via integrated information networks, including molecular, chemical, and electrical levels of signaling.

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