NUS National University of Singapore | Department of Biological Sciences, Faculty of Science

SEMINAR

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Evolution of efficient root gravitropism during conquest of land by plants

By **Jiri Friml**

Professor, Institute of Science and Technology (IST), Austria.

The ultimate conquest of the dry land by plants started at the Late Devonian period (about 382.7 million years ago) when the early diverging seed plants underwent dramatic evolutionary radiations and became the dominant group in most habitats, including the dry environment. The evolution of seed organs has been thought to be the key evolutionary innovation for the adaption to dry land since it allowed plants to break their dependence on water for reproduction and embryo development. Another, largely overlooked key adaption during colonization of land by plants is the efficient gravitropic growth of roots, which enabled to reach water and nutrients and firmly anchor plants in ground.

Here, we provide first insights into evolution of root gravitropic mechanism of the seed plants. Architectural innovation with root tip-constrained gravity perception along with a novel, shootward transport route for the phytohormone auxin appeared only at the onset of the seed plant advancement. Interspecies complementation and protein domain swapping revealed positive and later purifying selection-driven, two-step functional innovation within the family of PIN auxin transporters leading to evolution of gravitropism-specific PIN2. The PIN2 unique apical, subcellular localization was the major evolutionary invention that enabled connecting the anatomically separated place of gravity perception and growth response by the mobile auxin signal. Because of these evolutionary innovations of not only above-ground but also below-ground parts of the seed plants, they were able to overcome the past environmental restrictions and successfully colonize the dry land where their predecessor failed to arrive.

Artwork by Ann Nee, DBS, NUS