

## **Isolation of NAC genes in green algae and *Physcomitrella*: origin and diversification of NAC gene family.**

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The shoot apical meristem in the sporophyte (diploid) generation is an outstanding feature of vascular plants, which enables indeterminate growth to have a large body and to produce many spores or seeds. In contrast, bryophytes form only a single sporangium and do not have a shoot apical meristem that proliferate organs in the sporophyte generation. Is this because bryophytes do not have homologues to the genes required for the shoot apical meristem formation in angiosperms? Or do have these genes, but the genes are regulated to form a single sporangium? *CUC1* and *CUC2*, which belong to the NAC gene family, are candidate genes that may have played a key role in the evolution of meristem, as they are essential for the formation of shoot apical meristem and define organ boundaries in *Arabidopsis* and their homologues are reported only in Angiosperms. We cloned 23 NAC genes in *Physcomitrella*, one gene each in *Coleochaete* and *Closterium*. Based on a phylogenetic analysis, NAC gene family originated before the split of *Closterium* (Zygnematales) and the land plants lineage, and diversified to at least four members in the last common ancestor of mosses and vascular plants. One of these descended to *CUC1* and *CUC2* in *Arabidopsis* and to a group of genes in *Physcomitrella*, which are highly similar to *CUC1* and *CUC2*. We expect that the *Physcomitrella* genes function in the sporophyte development and can play the role that *CUC1* and *CUC2* have in the shoot apical meristem formation.