Emerging functional roles for Chloroplast Sensor Kinase in land plants

Chloroplast Sensor Kinase (CSK) is an evolutionarily conserved bacterial-type kinase present in photosynthetic organisms. In cyanobacteria, the CSK homologue, Hik2, functions within a canonical two-component signaling system with its response regulator Rre1 to mediate transcriptional responses to changes in plastoquinone redox state. In non-green algae, the CSK homologue is thought to function with a homologue of the Rre1 termed Chloroplast Response Regulator (CRR). In contrast, CSK in green algae and plants has lost both the conserved histidine autophosphorylation site and the cognate response regulator partner. Nevertheless, CSK in these lineages retains the capacity to bind a 3Fe-4S cluster essential for redox sensing of plastoquinone pool. CSK is ubiquitously found in land plants, and a recent report shows selection for high CSK gene expression in modern cultivars of *Manihot esculenta* – a C3-C4 intermediate crop. However, the mechanistic basis of this broader functional role for CSK remains unresolved, apart from some earlier reports of altered plastid gene expression in CSK mutants. Furthermore, CSK knockout plants in *Arabidopsis thaliana* exhibit no visible phenotype under standard growth conditions. We hypothesize that CSK has evolved new functional roles within land plants by acting as an atypical serine/threonine kinase with phosphorylation targets across the photosynthetic metabolism. To investigate this, we are employing a mass spectrometry–based approach to define the CSK proxiome, proteome, and phosphoproteome using *Arabidopsis thaliana csk* mutants and wild type plants. Additionally, screening for photosynthetic phenotypes under high light and fluctuating light conditions will further unravel CSK's functional significance for C3 model and C4 crop plants.