Photosynthesis manuscript

Shifts in photosynthesis protein abundance over continental scale environmental gradients

Continental scale proteomics: how environmental gradients affect/drive protein amounts across functional categories

Keywords: protein amounts, stoichiometry, continental scale ecology, photosynthetic proteome, ecological gradients, dynamic, ecological strategy

The stoichiometry of photosynthetic proteins is dynamic across continental scales and ecological gradients

Plant ecological strategy is captured by the stoichiometry of photosynthetic proteins across continental scales

Environmental correlates of the photosynthetic proteome

Thrust of the paper:

Plant trait ecology is about using phenotypic measurements to make deductions about plant ecological strategies and their inherent associated trade-offs. Most commonly measured traits are ‘soft’ – i.e. easily measured but are proxies for ‘hard’ traits which provide direct information about what a plant is doing and how it is doing it.

* Protein amounts describe phenotype at the molecular level. We’ve used a novel proteomics approach to quantify euc photosynthesis protein amounts in wild plant leaves from three major Australian families at a continental scale. This allows us to directly describe ecological variation in the abundance of the complexes and enzymes involved in harvesting light energy and assimilating carbon. Moreover, the stoichiometry of photosynthetic proteins is intrinsic to tradeoffs in photosynthetic strategy (i.e. differential investment in functional categories of photosynthesis proteins associated with light capture vs carbon assimilation), since investment of resources in protein is zero-sum.

We can use this dataset to add mechanistic integrity to our understanding of how wild plants construct their photosynthetic apparatus. We are able to quantify investment in light harvesting vs carbon assimilation machinery, and map this along ecologically relevant environmental gradients in eastern Australia, including climate, soil composition and canopy structure to find environmental correlates of photosynthetic strategy.

We can further decompose molecular responses to light environment by looking at ratios between photosystem I and photosystem II, which are known to dynamically adjust their relative abundance in response to light conditions. While PSII tends to remain constant, PSI amounts vary according to the structure of the incident light spectrum, as recorded by the redox state of plastoquinone.

1. The plant trait literature to date has largely focused on leaf nitrogen content as a proxy for photosynthetic competence across environmental gradients. Leaf N has been shown to increase with aridity, to compensate for decreased stomatal conductance (and therefore lower internal [CO2]) under dry conditions. The assumption is that the majority of leaf N is comprised by the CO2 fixing enzyme rubisco. Since we are able to decompose the protein component of leaf N into individual protein abundances, we can provide a more satisfactory investigation of this assumption.