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From Seed to Species

FROM SEED TO SPECIES

A journey through botanical research at Washington State University's School of Biological Sciences (Pullman) parallels the physiology, ecology, and evolution of a plant itself. As a seedling emerges from the soil, it starts to photosynthesize, becoming autonomous from its seed reserves. As a young plant begins to assimilate CO_2, it must also acquire nitrogen and other mineral nutrients from the soil to build more photosynthetic capacity. Professor Asaph Cousins and his lab focus much of their work on CO_2 assimilation using innovative techniques and approaches. Gas exchange combined with isotope discrimination analysis is a key technique of the Cousins lab. After measuring isotope discrimination during photosynthesis under various conditions, the Cousins lab then rigorously fits this empirical data to the latest mathematical models to quantify these metabolic processes and parameters in our most important crops.[1,2] Professor Mechthild Tegeder and her lab are leaders in deciphering the complex networks underlying plant nitrogen metabolism. In soybean, the Tegeder lab upregulated nitrogen export from root nodules, positively feeding back and improving soybeans ability to convert and assimilate atmospheric nitrogen, improving growth, biomass, and bean yield.[3] Currently, the Tegeder lab focuses on amino acid transport and the dynamic interplay between nitrogen sources and sinks.[4]

As a plant grows, it must coordinate transport of carbohydrates from CO_2 assimilation and nitrogen rich protein building blocks (amino acids) via phloem tissue. Professor Michael Knoblauch and his lab work on phloem structure and function, shedding new light on the longstanding Münch hypothesis of phloem transport.[5] Over the growing season, a plant will likely face one or more abiotic stressors such as salt stress. The Knoblauch lab has also done seminal work on the transport processes and signaling involved in salt tolerance.[6] Professor Hanjo Hellmann picks up on abiotic stress tolerance research at WSU Pullman, focusing on anti-oxidants and protein turnover. A plant produces anti-oxidants to help deal with oxidative stress from drought, high light, or adverse temperatures. These anti-oxidants include vitamins and other compounds which are beneficial to human health, such as vitamin B_6 in potatoes.[7] Other recent work from the Hellmann lab shows how one group of proteins involved with stress tolerance helps an enzyme target another protein for degradation, incidentally speeding up the time to flower.[8] When a plant makes it to flowering, the evolution of its floral structures can influence whether or not it self-pollinates or outcrosses. Professor Andrew McCubbin studies heterostyly, where a plant species has two or three floral structures or morphs. Recent work from the McCubbin lab has revealed the genes responsible for heterostyly in the genus *Turnera* and how one of these genes interacts with an important hormonal pathway in *Arabidopsis*.[9,10]

As a plant reproduces, its genes can recombine to form new traits and phenotypes. Professor Omar Cornejo and his lab have recently revealed that genetic differentiation and intrinsic genomic features influence where and how frequently recombination occurs in *Theobroma cacao*, the tree that gives us chocolate.[11] Understanding how recombination works in *T. cacao* can provide insight into how these trees can adapt to increasing abiotic stress and disease pressure from global change.[12] Plants that can adapt and persist in new environments may become reproductively isolated and eventually form new species. Understanding how species are related to each other can be challenging. Professor Eric Roalson and his lab work with the incredibly diverse genus of sedges *Carex*, and are leaders in the Global Carex Group, using the latest molecular techniques to best organize this complex genus.[13,14] Finally, professor Jeremiah Busch and his lab study how lineages become reproductively isolated, and how populations form new species. Central to these questions is understanding is how and where species are moving and what their range limits are.[15] One recent study used our LTCB-19 chambers to re-create the climate gradient of *Mimulus bicolor*'s range across California to test predictions of its distribution model.[16] Great research starts with high quality plants. BioChambers (formerly Enconair) is proud to have partnered with Washington State University's School of Biological Sciences, with over 25 years of service.

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