Title: A Generalist-Specialist Tradeoff between Switchgrass Cytotypes Impacts Climate Adaptation and Geographic Range

Authors: Joseph D. Napier[1*+](Joseph.Napier@austin.utexas.edu)**,** Paul P. Grabowski[2+], John T. Lovell[2], Jason Bonnette[1], Sujan Mamidi[2], Maria Jose Gomez-Hughes[1], Acer VanWallendael[3], Xiaoyu Weng[1], Lori H. Handley[2], Min K. Kim[2], Arvid R. Boe[4], Philip A. Fay[5], Felix B. Fritschi[6], Julie D. Jastrow[7], John Lloyd-Reilley[8], David B. Lowry[3], Roser Matamala[7], Robert B. Mitchell[9], Francis. M Rouquette[10], Yanqi Wu[11], Jenell Webber[2], Teresa Jones[2], Kerrie Barry[12], Jane Grimwood[2], Jeremy Schmutz[2], & **Thomas E. Juenger**[1]

+Co-first authors

Institutions: [1]Department of Integrative Biology, University of Texas at Austin, Austin, TX, USA; [2]Genome Sequencing Center, HudsonAlpha Institute for Biotechnology, Huntsville, AL, USA; [3]Department of Plant Biology, Michigan State University, East Lansing, MI, USA; [4]Department of Agronomy, Horticulture and Plant Science, South Dakota State University, Brookings, SD, USA; [5]Grassland, Soil and Water Research Laboratory, USDA-ARS, Temple, TX, USA; [6]Division of Plant Sciences, University of Missouri, Columbia, MO, USA; [7]Environmental Science Division, Argonne National Laboratory, Lemont, IL, USA; [8]Kika de la Garza Plant Materials Center, USDA-NRCS, Kingsville, TX, USA; [9]Wheat, Sorghum, and Forage Research Unit, USDA-ARS, Lincoln, NE, USA; [10]Texas A&M AgriLife Research and Extension Center, Texas A&M University, Overton, TX, USA; [11]Department of Plant and Soil Sciences, Oklahoma State University, Stillwater, OK, USA; and [12]Department of Energy Joint Genome Institute, Lawrence Berkeley National Laboratory, Berkeley, CA, USA

Project Goals:

- **Explore the natural genetic and phenotypic variation found in octoploids sampled from across the geographic range of switchgrass**
- **Quantify differences in genetic diversity, habitat preference, adaptability, and fitness responses across climatic gradients between tetraploid and octoploid switchgrass**
- **Identify potentially novel combinations of genetic diversity present in octoploids that might be linked to climate adaptation and range expansion, which would subsequently represent a valuable breeding resource for enhancing the resilience and sustainability of switchgrass feedstock production**

Abstract Text:

Polyploidy is the result of whole-genome duplication (WGD) and can have pronounced ecological and evolutionary implications. Approximately half of all angiosperms are polyploids, and polyploidy is thought to be a major component of adaptation and speciation within this group. Quantifying how transitions to higher ploidy can generate shifts in fitness and adaptability

is difficult when comparing across taxa because the role of ploidy is hard to disentangle from the roles of other genetic changes that accumulated after taxa diverged. However, different ploidy levels, or cytotypes, can exist within a single species, which provides a natural experiment to test how ploidy variation alters genomic diversity, fitness, and adaptability.

Switchgrass, *Panicum virgatum*, is a widespread, perennial C4 grass in North America with multiple naturally occurring cytotypes, primarily tetraploids (4X) and octoploids (8X). The genetic and morphological variation present in 4X switchgrass has been closely studied (i.e. Lovell et al. 2021), but there has been considerably less focus on the 8X and little is known about how this shift to higher order ploidy has altered fitness, genetic composition, or niche breadth. Here we contrast the molecular and quantitative genetic diversity of 4X and 8X switchgrass across naturally-occurring genotypes and 10 common gardens to evaluate the basis of ploidy-associated shifts in admixture, adaptive potential, ecological niche, and fitness. Specifically, we discovered (1) recurrent and evolutionary distinct genesis of 8X populations containing novel combinations of genetic diversity, (2) similar morphological/ecotypic divisions within 4X and 8X cytotypes but divergent cytotype fitness clines indicating a generalist-specialist tradeoff, and (3) niche evolution between 4X and 8X linked to climate adaptation. Combined, our results indicate that mixed-ploidy systems can be used as valuable tools to bolster the resilience of natural and agronomic systems by providing insight on how ploidy variation enables niche divergence, fitness tradeoffs, and range expansion.

References/Publications

1. Lovell, John T., et al. "Genomic mechanisms of climate adaptation in polyploid bioenergy switchgrass." *Nature* 590.7846 (2021): 438-444.

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