First estimates suggest that more than 10% of fungi can be brought into pure culture

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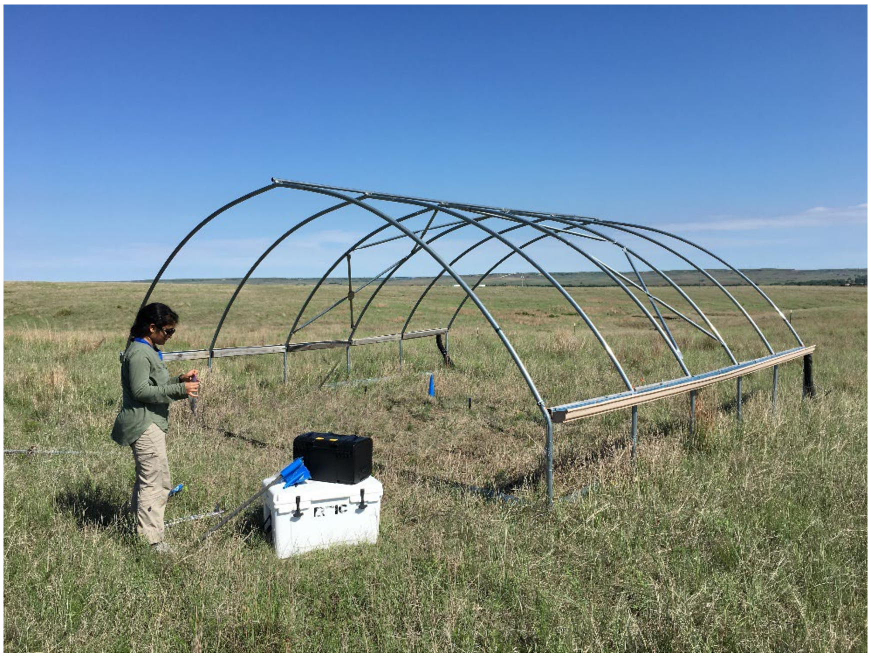


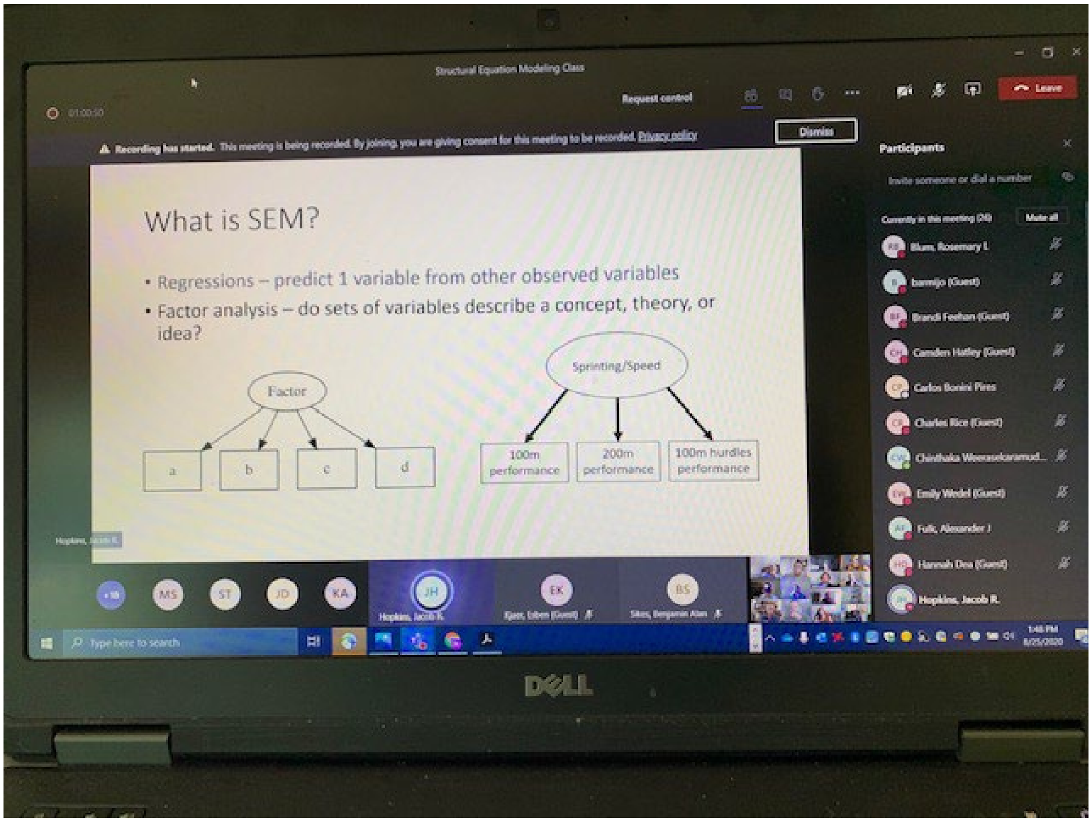
During summer 2020, a Research Experiences for Undergraduates (REU) program was funded by Kansas NSF EPSCoR. Participant Achala Narayanan conducted an experiment combining pure-culture and contemporary molecular analyses permitted estimating that more than 10% of all fungi and more than 20% of the soil-dominating ascomycetes are readily cultured. Such estimates have been available for bacteria for a long time but have been lacking for fungi.

In addition to providing the first numeric estimates for fungal culturability, these data suggest that generating pure-culture libraries of soil-inhabiting fungi can be more comprehensive than previously thought and that acquiring living representatives for physiological studies is quite feasible.

Estimates of culturable bacteria have been available for a long time, but such estimates have been lacking for fungi. In contrast to the approximately 1% of bacteria that may be cultured, these data suggest that more than 10% of all fungi and more than 20% of the soil-dominating ascomycetes are readily cultured. The combination of traditional pure-culture methods in combination with more contemporary molecular analyses that use DNA sampled from the environment (eDNA) permitted analyses of fungi from the very same samples providing thus a means to estimate the proportion of fungi that can be brought into pure culture as well as those that can only be detected from the eDNA.

New MAPS Multi-University Course

Ben Sikes, Associate Professor, University of Kansas



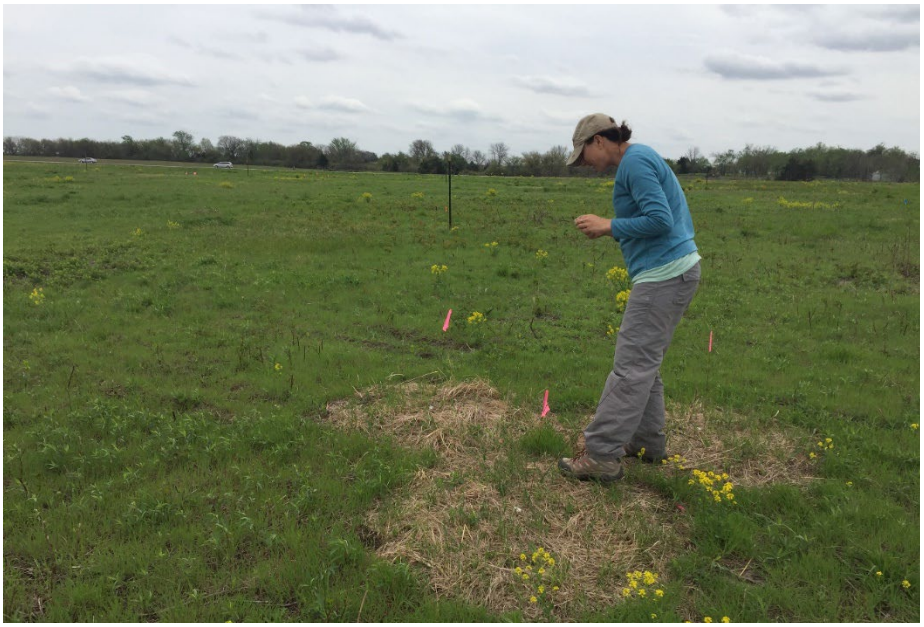
KU Associate Professor Ben Sikes developed and taught a new course titled *Topics in Structural Equation Modeling (SEM) for Biologists* in the fall of 2020. Nineteen students enrolled for the course (3 Universities, 6 Departments) and Jacob Hopkins, a 4th year MAPS Ph.D. student, served as the teaching assistant for the course. Faculty from four Kansas Universities also participated at different points. This educational collaboration was specifically designed for students to learn to apply SEM to their own research, much from the core MAPS projects, which stands for "Microbiomes of Aquatic, Plant, and Soil Systems across Kansas."

Students gained a foundational understanding of SEM, how to conduct SEM using R code, and then applied these to their own data and questions. Discipline specific analyses allowed students to solve SEM challenges such as sample size and data structure, while advanced several topics from swine microbiome to nutrient flows from land to water. Given its versatility and ubiquity, students can apply SEM to many other topics in their future research.

Structural Equation Modeling (SEM) is a scientific framework that combines multiple regression, factor analysis, and graph theory to build and evaluate hypotheses about cause-effect connections in systems. SEM allows for the use of conceptual "latent" variables that are unmeasurable (e.g. intelligence, fitness) and analysis of complex networks of relationships. It is widely used in business, sociology, and increasingly to assess biological systems.

What's so positive about positive feedback? A nucleation framework for ecosystem transition and recovery

Theo Michaels, Maarten Eppinga, and James Bever, University of Kansas



University of Kansas doctoral student Theo Michaels coauthored a paper in *Ecology* in which she outlined a theoretical framework of nucleation to address the problems of alternative stable states. In addition to providing this framework, Michaels also described how nucleation can be applied to ecosystem resilience and leveraged for ecosystem recovery.

The description of nucleation in Michaels et al. prompted debate within the ecological community. This led to Michaels and Bever organizing a symposium for the 2021 Ecological Society of America conference to facilitate further discussion about nucleation theory and application. Michaels will also present at the symposium.

The theory of alternate stable states has been an important framework for understanding ecosystem degradation and recovery. Recovery requires overcoming resistance thresholds. In this paper, Michaels and co-authors show that resistance thresholds can be lowered, and transitions between states can be catalyzed, by initiation of patches of a desired state at sizes larger than a critical radius. The process of patch growth, called autocatalytic nucleation, facilitates ecosystem transition. We use geometrical principles to derive a critical patch radius necessary for nucleation: a spatially explicit, local description of an unstable equilibrium point. This insight can be used to derive an optimal patch size that minimizes the cost of ecological restoration. Application of nucleation provides a promising way forward to boost the effectiveness of future management interventions related to alternative states that arise from anthropogenic disturbances. We are testing predictions of the nucleation model in research supported by NSF EPSCOR.