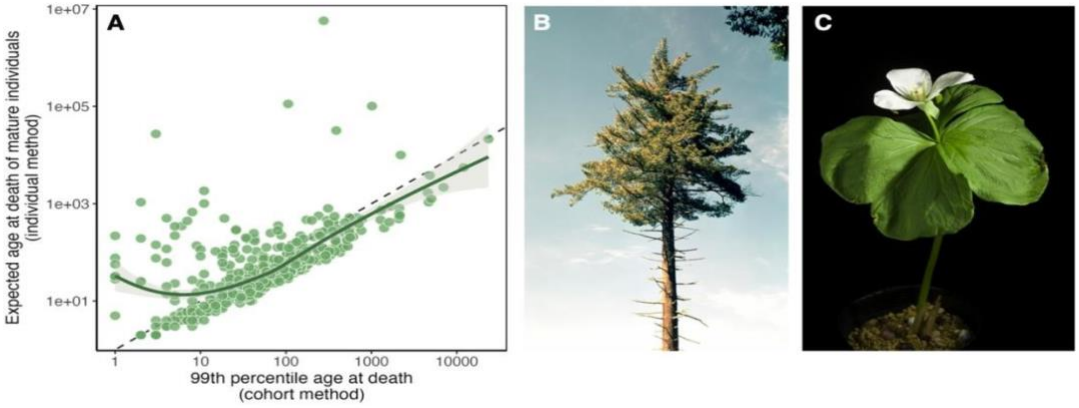
National Institute for Theory and Mathematics in Biology
Funded by the U.S. National Science Foundation and the Simons Foundation

Life History and Longevity in Perennial Plants

Dylan T. Simpson, Kieran Althaus, Amy M. Iler, Paul J. CaraDonna

How long organisms live is one of biology's most fundamental questions. This is because an organism's longevity is related to virtually all aspects of its ecology and evolution, from the ability to withstand environmental perturbations, to patterns of age-specific growth, survival and reproduction. Despite the importance of longevity, and for all its apparent simplicity, for many species it is unknown, imprecise, or misunderstood. We explore longevity in plants by asking a series of basic, yet longstanding questions: How long do perennial plants live? How best do we quantify plant lifespan? And what ecological and evolutionary factors contribute to variation in plant lifespan?



To answer these questions, we use a large plant demography database which includes several thousand matrix population models, allowing us to estimate lifespan for 498 plant species with diverse life histories. We aim to develop analytical tools that summarize key aspects of plant life history, with the goal of effectively and succinctly relating different life history strategies to longevity.

In our analysis, one pattern that emerges is a correlation between two common longevity metrics: the "cohort method," which estimates longevity from the 99th percentile of age at death, and the "individual method," which estimates the expected age at the time of death for mature individuals. These metrics are positively related, but they do not always agree. Some species fall far from the 1:1 line (A), making direct comparisons difficult and revealing how easily plant longevity can be oversimplified. For example, the long-lived tree, *Pinus lambertiana* (B), has an estimated longevity of 141 years. Meanwhile, the longevity of the herbaceuous perennial, *Trillium camschatcense* (C), depends strongly on how we quantify it. While less than one percent of these plants live past 11 years, some of the remaining one percent can live for nearly 1000 years. Such dramatic differences highlight that lifespan metrics can diverge sharply across species and that plant longevity is far more variable, and harder to quantify, than traditional approaches suggest.

This research was supported in part by grants from the NSF (DMS-2235451) and Simons Foundation (MPS-NITMB-00005320) to the NSF-Simons National Institute for Theory and Mathematics in Biology (NITMB) and NSF (DEB-2211721) to A.M.I.