Traitors intro

January 13, 2023

1. Forest communities contain diverse assemblages of species, the coexistence of which reflects both the ways in which species tolerate local environmental conditions and the outcome of various species interactions.
    (a) As a result of these selective pressures and species specific responses, plant species within communities often have diverse growth strategies, varying in their resource use and competitive abilities.
    (b) A major access of diversity is in the timing of plant life history events, ranging from spring ephemeral species that leaf out early in the season to later leafing tree species that alter habitat conditions with increased canopy closure.
    (c) Despite considerable efforts to study plant environmental cues and timing, why plants vary so much in the timing of their phenological events remains unclear.
2. The timing of plant phenological events define the partitioning of resources across species over time, and therefore their temporal niche (Gotelli & Granves 1996 - ch5).
    (a) Differences along this niche axis contribute to community assembly, defining the abiotic environment experienced during growth and biotic interactions – competitive landscape and pressures from herbivory.
    (b) Studies of woody plants show diversity in species temporal niche e.g spring budburst and variable responses to specific environmental cues (Laube2014, Flynn2018)
    (c) While these studies do draw links to key environmental cues, the combined influence of abiotic and biotic cues, as well as relationships to species growth strategies and adaptive potential remains unclear.
    (d) Developing such a holistic framework of the drivers of species temporal niches differences is increasingly important, given ongoing changes to environmental conditions and habitats with climate change, and the the magnitude of recently observed shifts in species phenologies
3. In many temperate forest communities, budburst occurs over the span of several weeks, reflecting differences in species morphology and physiology.
    (a) Species that bb in early in the spring = greater abiotic pressures, such as risk of false spring events and frost = affects early budbursting spp = potential loss of tissue, but benefit from more light and resource availability
    (b) Late spp have greater selection from biotic pressures = less light available and competition for resources
    (c) Differences in bb phenology within communities = important in shaping community dynamics including competition & herbivory.
    (d) But also the potential invasibility of a community, invasive spp tend to be early bb with the potential to fill vacant niche space early in the season.

4. Considerable research has been done to understand how functional traits relate to species growth strategies and competitive abilities — few studies include phenological traits.
    (a) But the timing of species growth is likely to be related to species functional traits and their responses to abiotic and biotic pressures
    (b) Shrub and other woody understory species tend to budburst earlier in the growing season when light availability is greatest— these species are shorter in stature, and may have leaf traits that are favourable to both early light availability with greater photosynthetic potential and leaf traits that infer the ability to withstand late spring frost events.
    (c) Canopy species budburst later in the growing season—inherently taller, requiring greater wood densities, but greater access to light throughout the growing season compensates for their slower overall growth rates.
    (d) But these later budbursting species must also be better competitors as they compete with more species than those that begin their growth early in the season.
    (e) Despite the intuitive nature of these trait associations, few studies to date have tested whether phenological traits follow similar gradients in growth strategies across diverse species
5. Many commonly measured leaf and wood traits do follow gradients in their trait values, having associations that range from acquisitive (fast) growth strategies to more conservative (slow) growth strategies.
    (a) Collectively, the responses of commonly measured leaf and morphological traits have lead to the development of the leaf economic spectrum and the wood economic spectrum.
    (b) These frameworks have been built into decades of research linking functional traits to species responses to abiotic and biotic factors and community assembly
    (c) However, traits themselves can be highly variable, both across and within spp — Violle paper 'viva la variability'—requiring studies diverse species across geographic scales.
    (d) trait ecology's goal = predict sp-level characteristics by traits alone — how well we can do this to highly variable and species specific traits like phenology is unclear
6. In this study we tested for possible relationships between budburst phenological cues and other commonly measured functional traits.
    (a) We predict that spp with traits associated with acquisitive growth (high SLA, high LNC, short heights, small seeds) will have cue requirements associated with low forcing, chilling, and photoperiod
    (b) Spp that are better competitors with conservative growth and later budburst, with low SLA and LNC, tall heights, and large seeds, will have phenological response associated with high forcing, chilling, and photoperiod requirements
7. Previous studies of budburst date in woody trees have shown 3 cues are most important for spp responses:
    (a) Chilling - the period of cold temperatures from late fall to late winter, releases buds from dormancy
    (b) Forcing - the occurrence of warm temperatures in spring that initiate bud development
    (c) Photoperiod - daylength
    (d) field obs of phenology are highly variable — but under controlled environments and set cues, bb is highly predictable

(e) Potential to use phenological data from controlled environment studies to identifying the relationship between sp cue responses and traits

8. Using available trait data from trait databases with bb data from controlled environment studies of woody plant species from the OSPREE database we test for associations between plant phenological responses to environmental cues and common functional traits

   (a) We focus on the effects of forcing, chilling, and photoperiod cues and four easy to measure traits — SLA, LNC, height, & seed mass

   (b) Our model attributes phenological variation (day of bb) to species' trait values while including residual variation from species (partial-pooling).

   (c) When traits explain a significant portion of the variation, spp will explain only a small amount — may be able to predict spp growth strategies and phenological responses from trait values.

   (d) Potential to use phenological data from controlled environment studies to identifying the relationship between sp cue responses and traits

Need to fit in into intro, not sure where:

1. Cues address phenological variability

2. Be sure to clearly set up acquisitive vs. conservative

Stuff we had, but could cut:

1. details of phenological responses - ectodormancy transition to endodormancy – Cutting this, too much other content

2. detailed definition of forcing, chilling, photoperiod

Fig 1: i) Can you confirm the slopes (when trait effect = 0) are constant across the top conceptual panels? If not, we should make them that way I think to minimize what changes across them? DLDec15: Yes they are, the betaChill slope is always -2, betaForceSp =5 and betaPhotoSp = 1 for each plot
ii) Make sure the figure in the Supp that is similar has the same y axis scale - DLDec15: I will fix that in the next draft for sure