Differences in leaf and wood traits predict phenological sensitivity to daylength more than temperature

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Discussion

1. General summary of what we FOUND (with some of what we did)
   (a) Our study = one of the first to combine trait data with phenological cue responses for the same individuals and across species distributions
   (b) We found only three (out of six) traits showed a relationship with phenological traits, with two of those fitting our hypothesized aquis to cons paradigm in the spring.
   (c) Joint modelling approach = use sp-level estimates for traits to understand phenological cue responses and budburst timing suggested photoperiod may be most important to trait-phenology relationships ..
   (d) Includes plant communities in eastern and western deciduous forests of North America, and samples collected from multiple populations—modelling approach that accounts for variation across populations and transects
   (e) We found, however, generally low population-level variation in traits—usually even across the different eastern and western deciduous forests of North America, which was likely driven by species-level variation in traits
2. Population level variation:
   (a) generally traits did not change across population or with latitude
   (b) Only leaf traits varied with transect—patterns are in line with what you would predict given the differences in shrub vs tree spp in our transects
   (c) Predicted shrubs = acquisitive growth strategies = low LMA and high LNC
   (d) Western pop = more shrubs = did have low LMA and high LNC relative to eastern transect
3. Phenology in context of LES
   (a) Summarize whether fits with acquisitive-conservative predictions
      i. Partial support whether phenology = the same acquisitive to conservative gradient in growth commonly found for other traits
      ii. Predicted all traits to correlate with phenological cues = budburst timing—but found relationships with only one of our three cues
      iii. Ht and DBH both in line without prediction that tall, larger trees would have stronger photoperiod cues
      iv. But LMA showed opposite response to photoperiod than predicted—low LMA (acquisitive) spp more responsive to photoperiod

(b) Interesting similarities with previous studies

i. Traits have many functions—mitigate abiotic and biotic factors

ii. But trait research has found considerable variation in trait phenotypes across spatial scales (cite Gross 2000, Flecker and Jones 2003)—different responses for different traits

iii. In comparing plant traits across spatial scales, previous studies have found little variation across regional scales (comparing populations or sites) and more within-community variability (Messier et al 2010, Kang et al. 2014, Standen et al. 2023)

iv. But in comparing our results with a global meta-analysis of trait relationships with budburst cues = similar results for some traits

v. Found similar unexpected responses in leaf traits—high specific leaf area (the inverse of LMA) exhibited strong responses to photoperiod—suggests could be alternate underlying mechanisms shaping how species respond to photoperiod cues

vi. But also found strong temperature cues for most traits—not found in our analysis of North American forests

How traits shape species temporal niches

4. Correlations between traits and cues

(a) Individuals temporal niche = result of numerous and likely complex interactions across abiotic and biotic factors

(b) Our results suggest focusing on single traits—fails to account for interactions between other traits and cues

(c) Decades of research on budburst cues = primarily driven by temperature cues—but only photoperiod related to other traits

5. Suggests may be other physiological constraints or trade-offs selecting for other traits and shaping species phenologies

(a) Temperature—generally thought of as a strong environmental cue—but might not be strongest selective pressure in temperate forests

(b) Soil moisture = known to select for other types of tree phenology—radial growth and shoot elongation

(c) LMA can also vary with soil moisture—to reduce evaporation plants can reduce leaf area = high LMA in dry conditions (de la Riva, 2015)—could be driving the unexpected trend in LMA

(d) Later in the spring—longer photoperiods—less water high LMA would be favorable

(e) To gain a holistic understanding of species growth strategies and phenotypes require consideration of additional cues

Using functional traits to predict climate change responses

6. Impacts of community dynamics and forecasting

(a) Community dynamics with climate change

i. Results = novel insights on how other traits impact phenological sensitivities to environmental cues

ii. Relationships between budburst and photoperiod could limit the extent of spp advances in spring

iii. Photoperiod is fixed—unlike temperature cues = increasing with climate change—species ability to track temperature could be constrained

(b) Forecasting future forests

i. Our study is one of the first to model the relationship between phenology and other traits—but results simply tell us the associations—need to understand mechanism

ii. Phenology—cited as finger print of climate change—but other traits have been noted to change as well

iii. Across temperature and precipitation gradients—leaf size and shape also change—spp shift to conserve water and mitigate effects of transpiration with high high temperatures—cite de le Riva 2016 as example

iv. trait literature = explored how traits shift across environmental gradients—temp or precip—denoting trends leaf area and height

v. Important we continue to synthesize across phenology and trait research—better forecast the future impacts of climate change on communities