

# 1 Abstract

## 2 Introduction

*But green's the color of Spring*

*And green can be cool and friendly-like*

*And green can be big like an ocean, or important*

*Like a mountain, or tall like a tree*

*It's Not Easy Being Green*, -Kermit the Frog

Green is the color of spring, but a keen observer walking the Eastern deciduous forests early in the season would readily notice that it is often the subtle reds and yellows of emerging tree flowers that are the first harbingers of the season. Why does spring flowering precede leaf development in some woody species, while in others, it is leaf expansion that occurs first? Flowering before leafout, a trait referred to as hysteranthly (), protanthly () or precocious flowering () has been a feature of temperate deciduous forest recognized and explained by botanists and ecologists for over a century (). Formulated generally, hysteranthly is classically explained to be an adaptation associated with wind pollinated tree species allowing for increase pollination efficiency(), as the leafless state minimized physical barriers to pollen transfer () and increases wind speeds through the canopy, expanding pollen dispersal ranges(). This hypothesis has been carried in the ecological literature several lines of compelling indirect evidence. (Find Whitehead papers on pollen flow: Tauber 1965). Milleron and colleagues demonstrated the prevalence of pollen interception by non-reproductive structures and the decrease in pollen dispersal distances after the return of and understory to a beech-oak forest following grazing exclusion. (perhaps expand this)

But hysteranthly increasing pollination efficiency should also be considered for entomophilous species as well. Janzen argues that hysteranthous flowering would increase flower visibility and reduce flight path impediments for insect pollinators. In fact, many of iconic flowering trees, such as the cherry blossoms and magnolias, are hysteranthous and insect pollinated.

–Hysteranthly cannot be separated from theory regard selection for early flowering in general, an extreme example. The foliate and floral phenology are independent, and flowering is less constrained by the risk of late season frost.

– Despite long history and increased interest in the study of phenology, timing of annual life cycle events, to our knowledge, there have been no empirical studies, largely because floral and foliate phenology have long been treated separately.

in this paper...

. We investigated the prevalence and trait associations of hysteranthous flowering.

Hypothesis: Associated with wind pollination, and height. Also will test other biological relevant traits and

the null hypothesis.

Alternative: Hysteranthly is an adaption for early flowering so fruit can mature and disperse. Flowers are less constrained than leaves by frost.

## 3 Methods

### 3.1 data

Data from Michigan Trees (Barnes and Wagner) and Michigan Shrubs and Vines (Barnes, Dick and Gunner).

Hysteranthly descriptions coded 1 or 0 before or before/with=1, with, with/after or after=0

pollination: wind or animal- include explanation of ambophilous assignment Tree or shrub coded based on 15 meters of highest height

flowers coded bisexual or unisexual

shade tolerance, collapsed to tolerant or intolerant

fruiting: Average fruit maturation for each species coded. then split early (before 8.5 ) or late (after 8.5)

Phylogeny obtained from Zanne et al, species added randomly to genus

### 3.2 statistical analysis

Baysian approach in brms, corrected for phylogeny

show model

## 4 Results

X/140 are hysteranthous X/140 hysteranthous or synanthous pollination syndrome and time of fruiting supported alpha value not strongly phylogenetically constrained

## 5 Discussion

Hypothesis is supported (both).

Classification may vary based on personal interpretation (eg silvics) or vary annually, or over population

Dont know what structures these patterns (external, internal) related through resources, genetic pathways?

and perhaps function (hysteranthly) What will happen when climate changes Phenology researchers need to consider flower and leaves together.

## 59 **6 Figures**

60 results table phylogeny graph like dans

## 61 **7 Suppliment**

full model with interactions *ppchecks?*