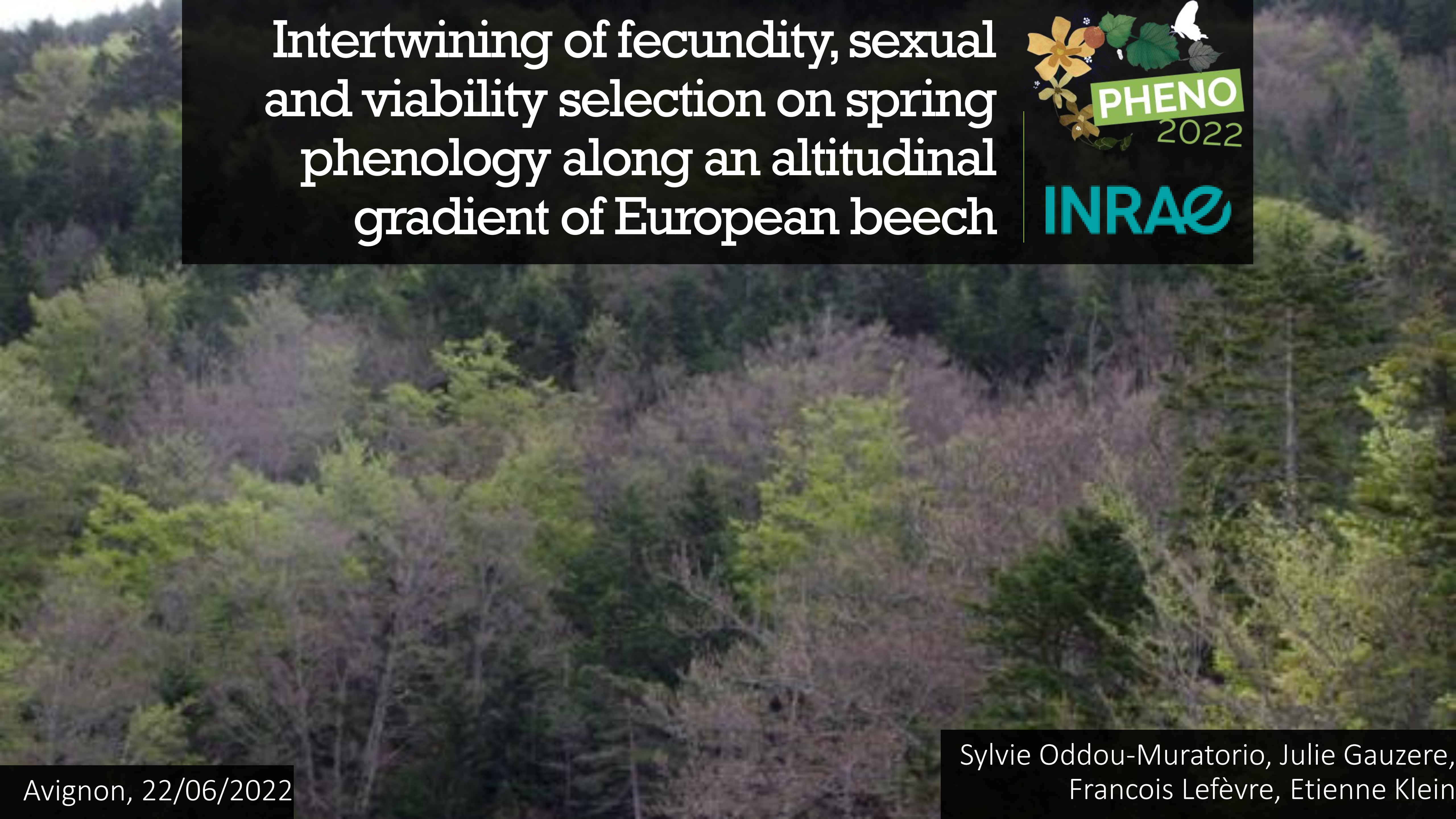
Intertwining of fecundity, sexual and viability selection on spring phenology along an altitudinal gradient of European beech

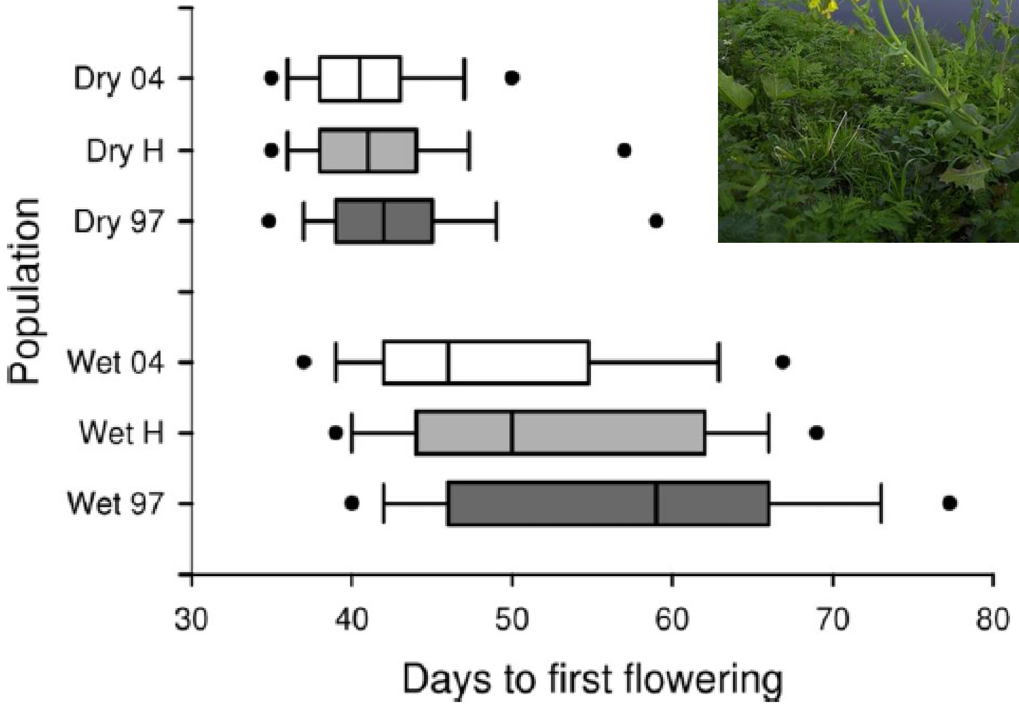


Sylvie Oddou-Muratorio, Julie Gauzere,
Francois Lefèvre, Etienne Klein

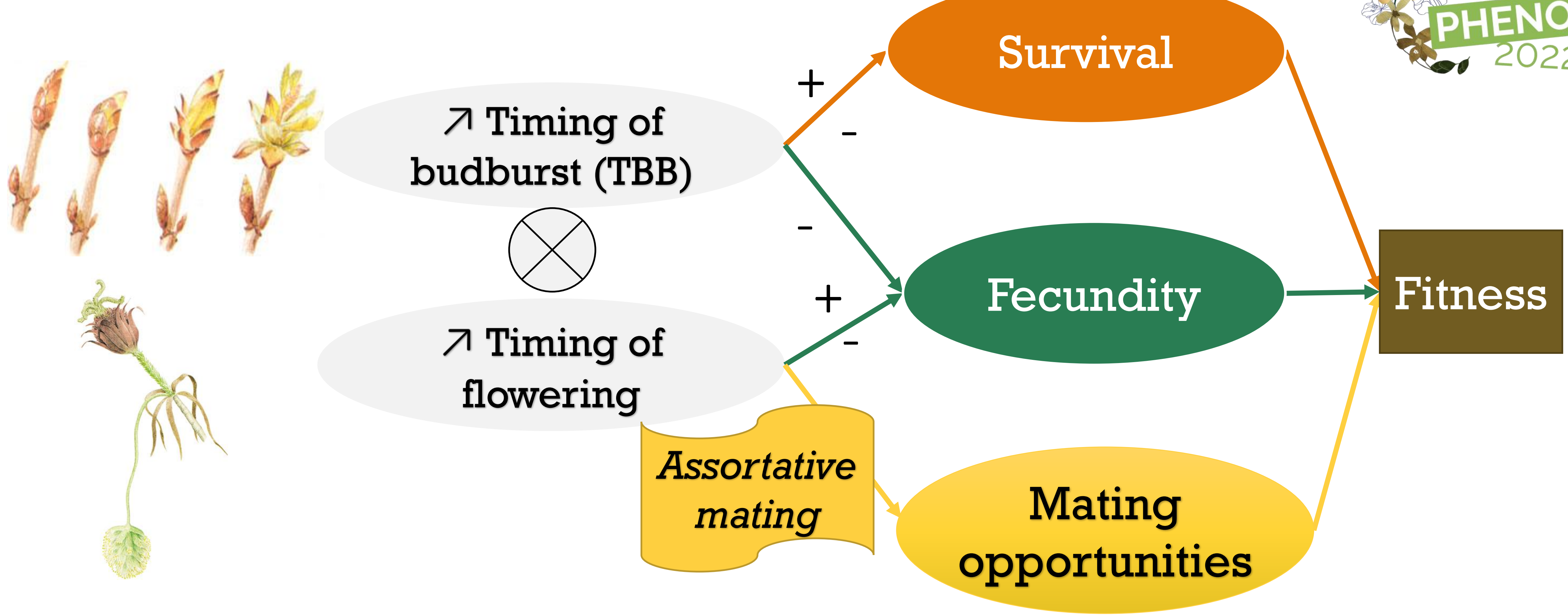
Avignon, 22/06/2022

Phenology, a key trait for the genetic adaptation of populations to ongoing climate change

- Significant advance in leafing, flowering and fruiting records in temperate plants (Menzel et al. 2006)
- Evidence for rapid evolution of phenological traits in response to selection (Franks et al. 2007, Hamman et al. 2018)
- To what extent microevolution may contribute to the response of plants' populations to climatic variation (Merilä and Hendry 2014) ?

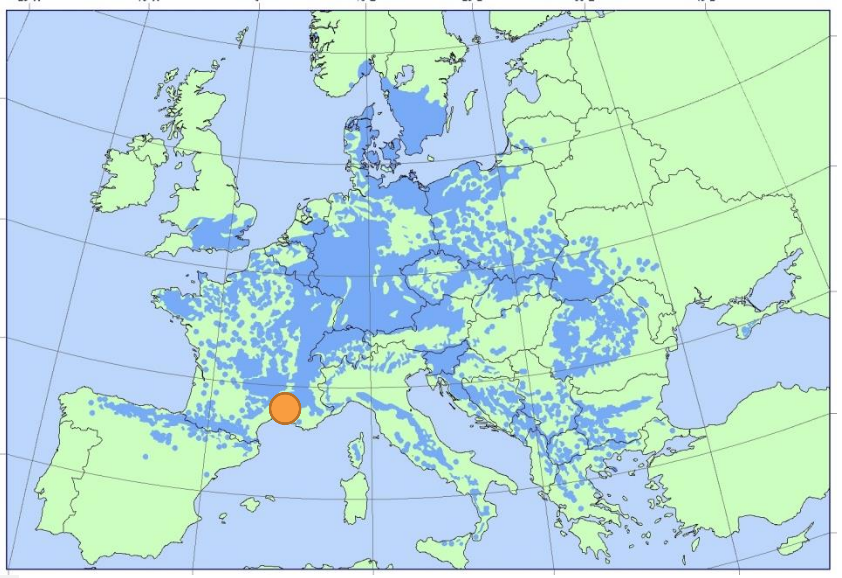


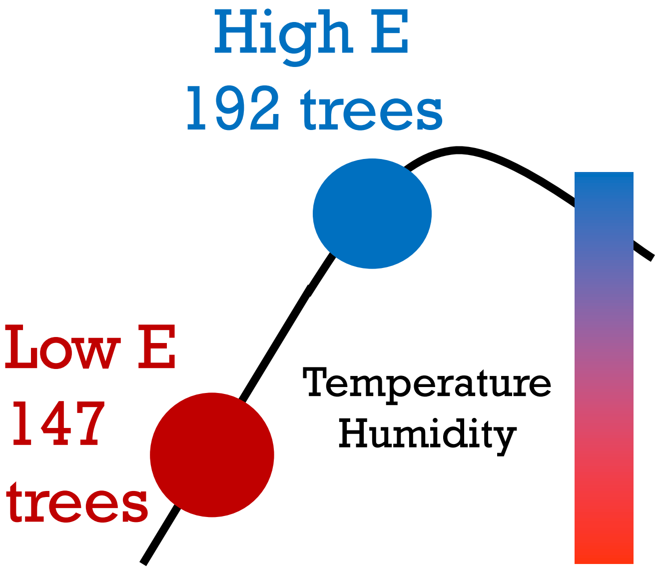
From phenology to fitness



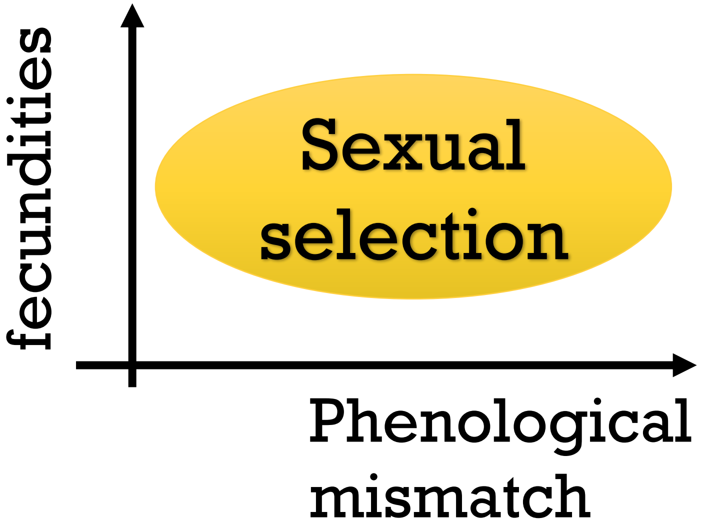
How can we disentangle/estimate the components of selection on beech spring phenology ?

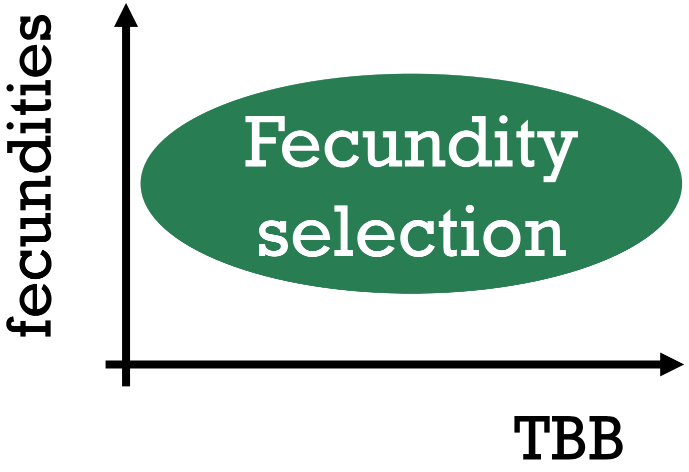
Material and methods: estimating selection *in situ* in the European beech *(Fagus sylvatica)*

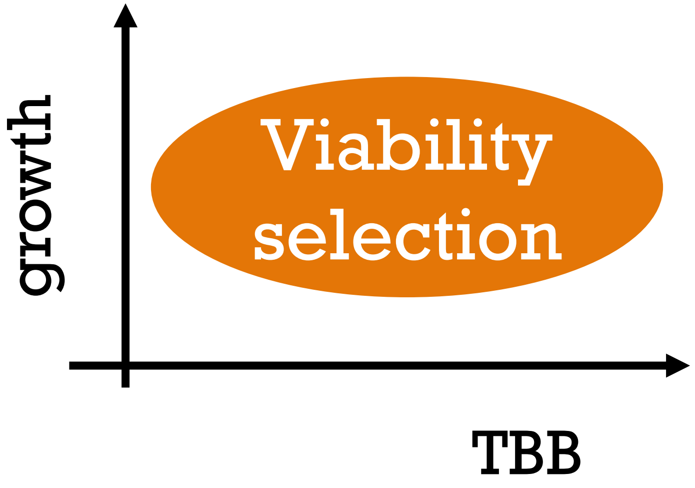




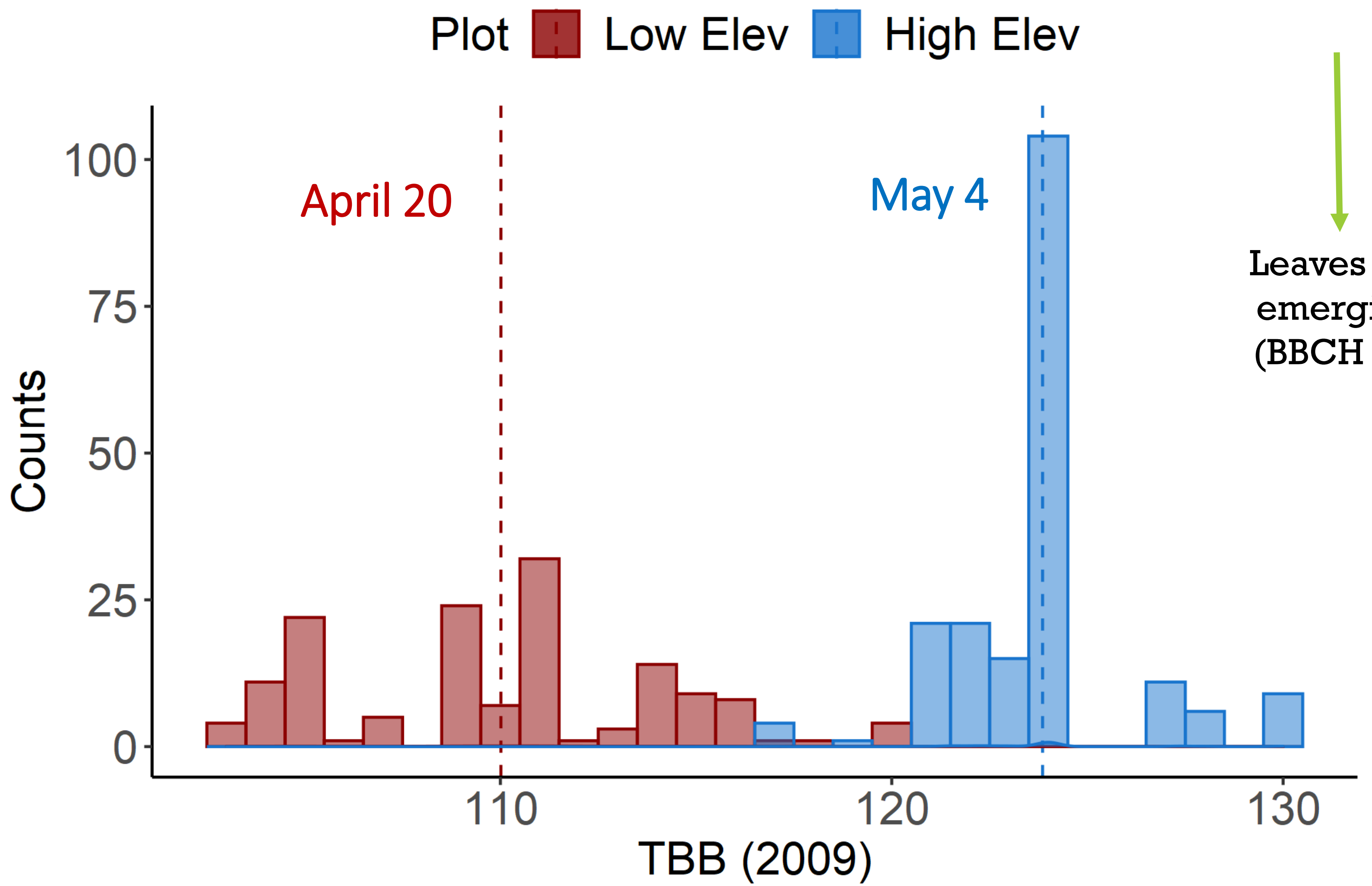
- TBB < Phenological survey
- ♂ and ♀ female fecundities estimated through paternity and parentage analyses







Distribution of TBB



Bud scales are broken (BBCH 07)

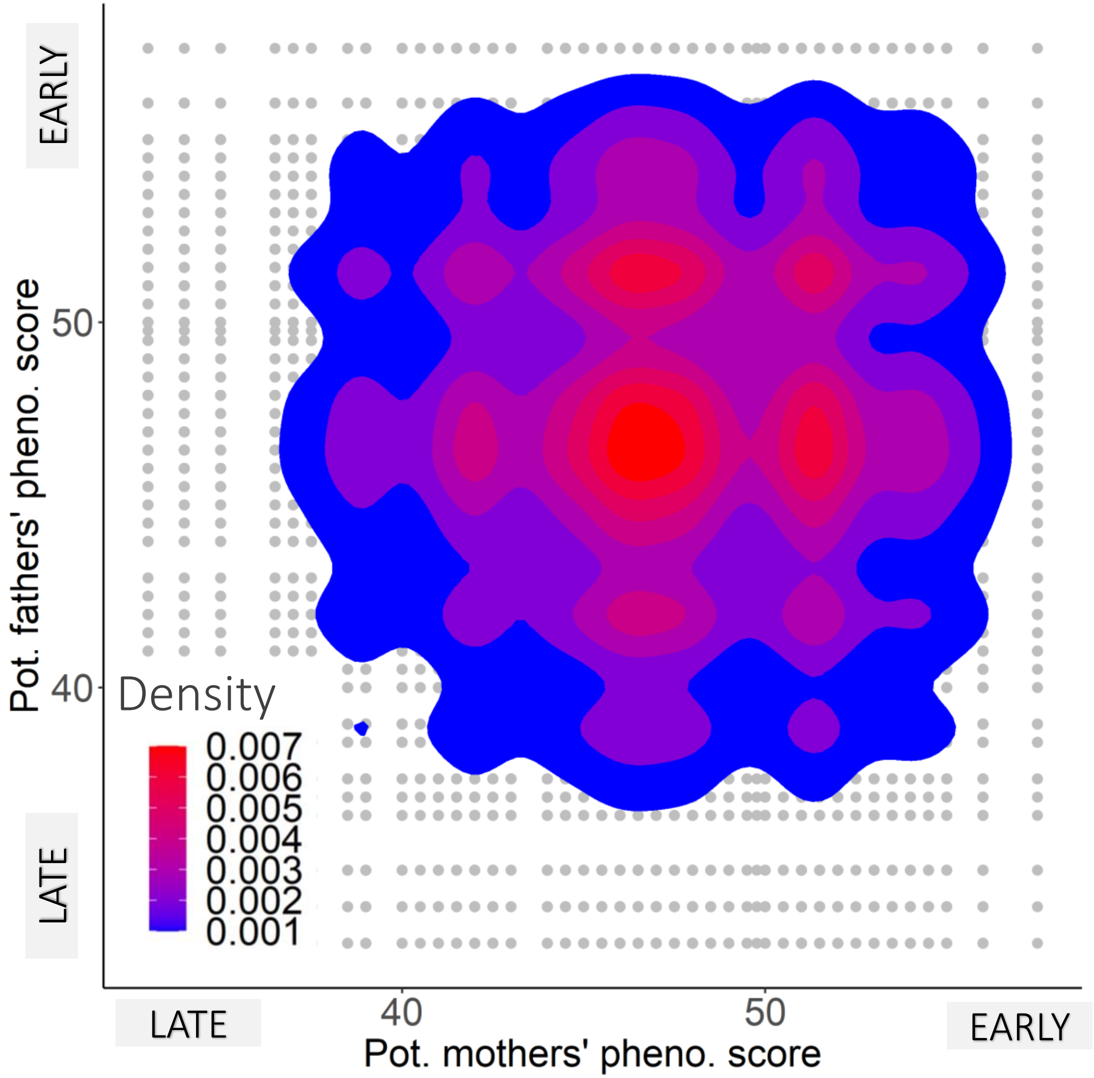
TBB

Leaves are emerging (BBCH 09)

Assortative mating

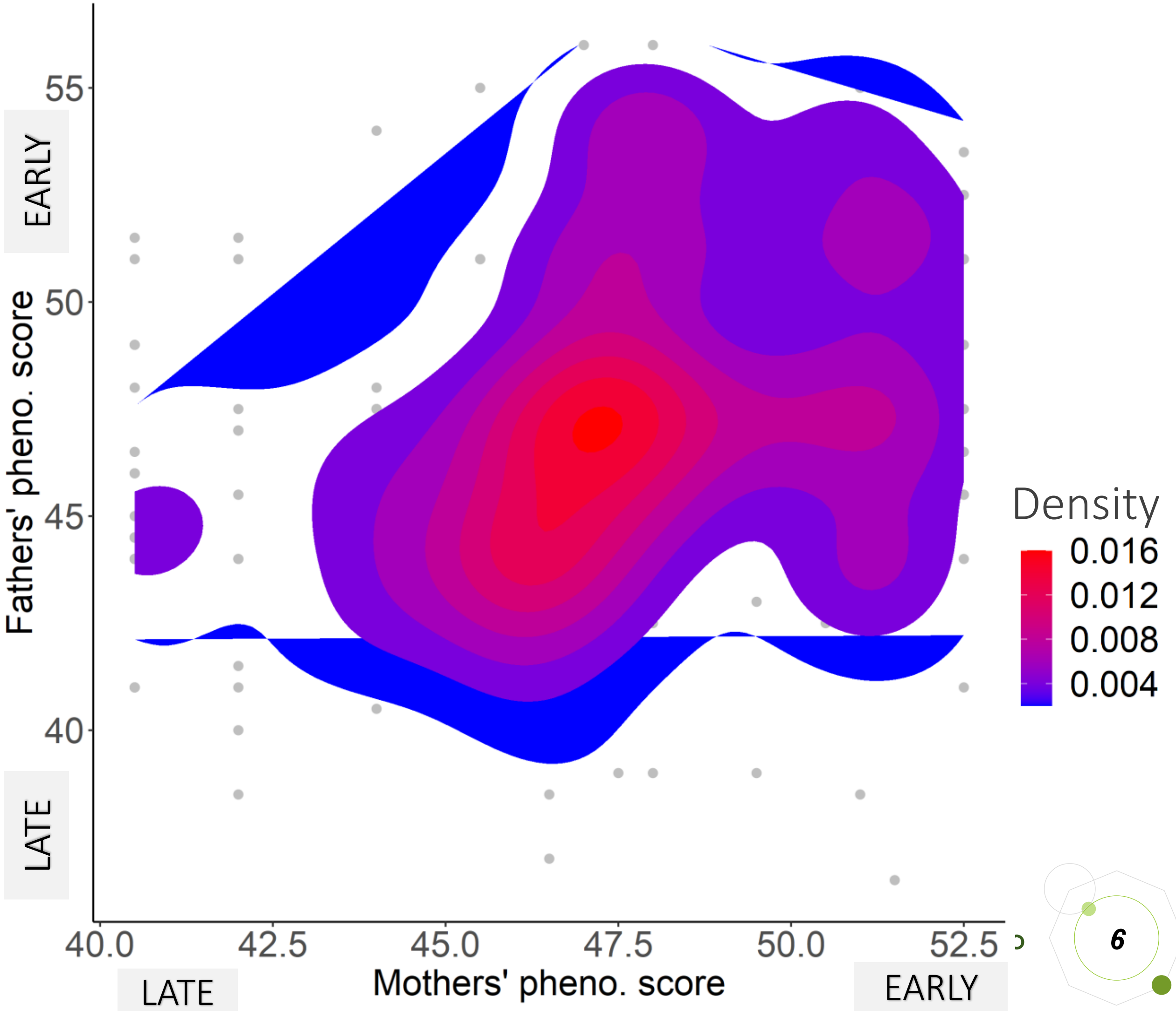
Significant correlation between mother and father's TBB at low elevation

Random mating, site low Elevation



Realized mating

ρ=0.19, p-val<0.001

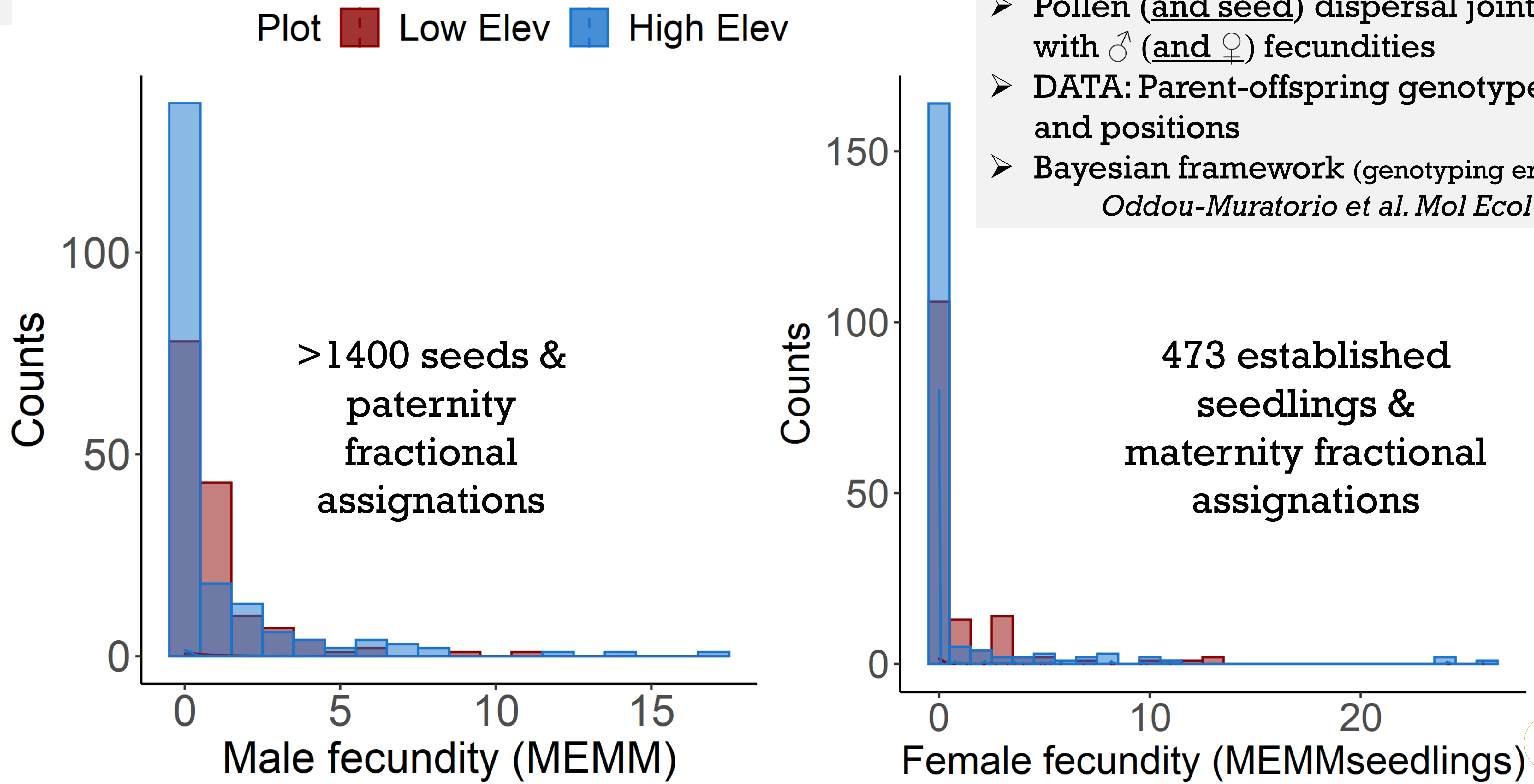


Distribution of ♂ and ♀ fecundities

MEMM & <u>MEMMseedlings</u>

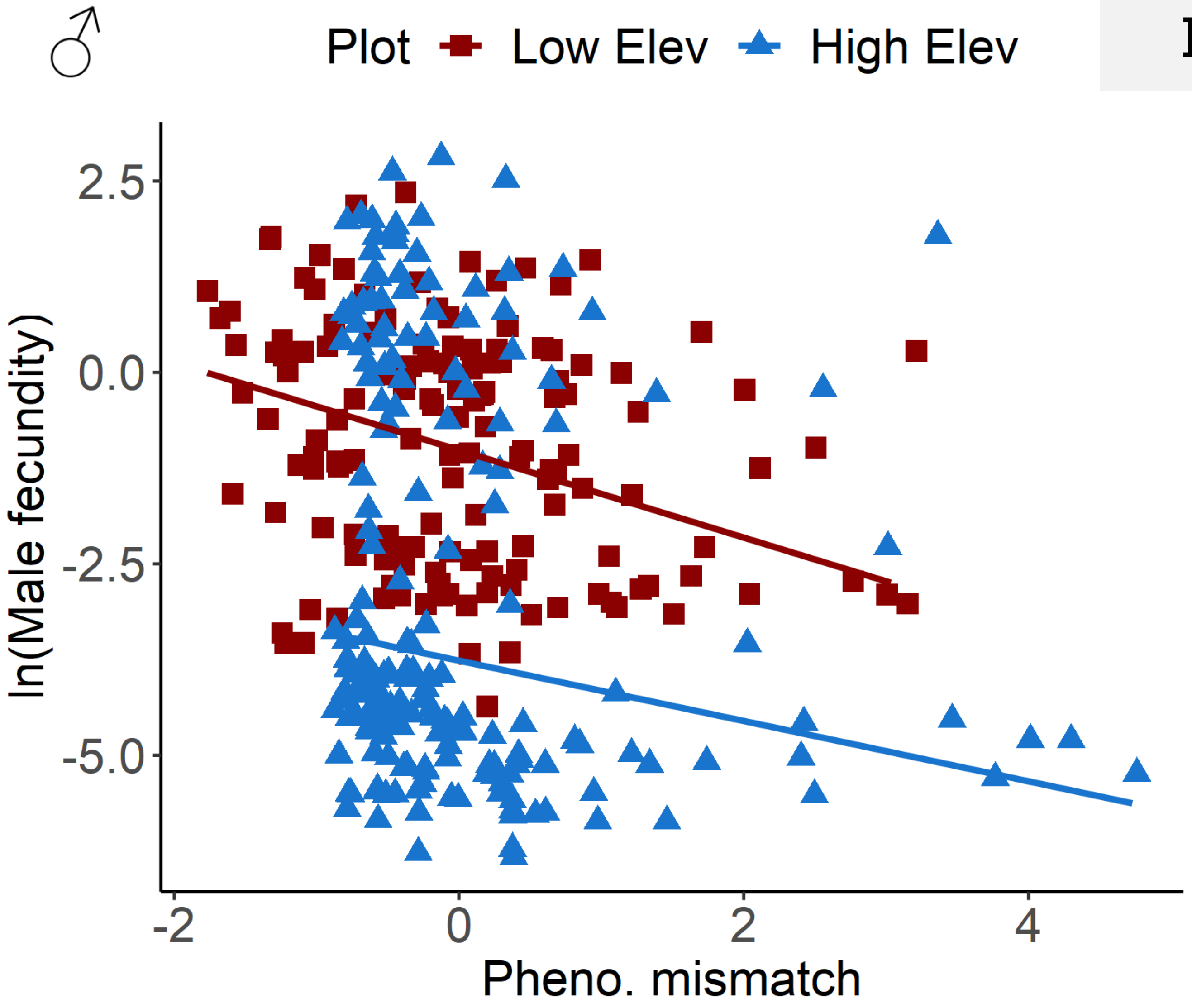
- Spatially Explicit Mating Model
- Pollen (<u>and seed</u>) dispersal jointly with ♂ (<u>and ♀</u>) fecundities
- DATA: Parent-offspring genotypes and positions
- Bayesian framework (genotyping errors)

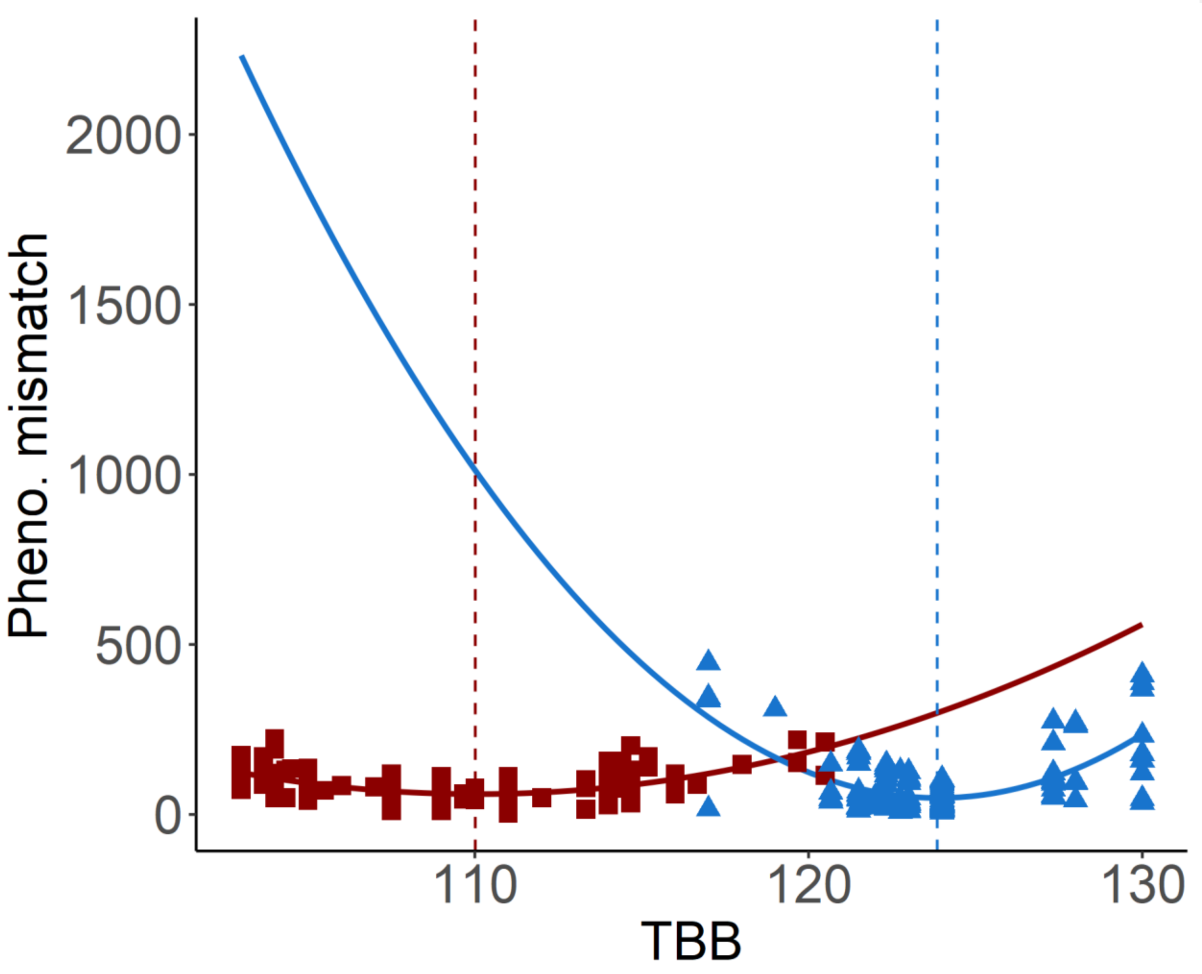
Oddou-Muratorio et al. Mol Ecol 2018



Sexual selection

- ♂ fecundity decreased with increasing phenological mismatch at both plots
- ♀ fecundity was not affected by phenological mismatch

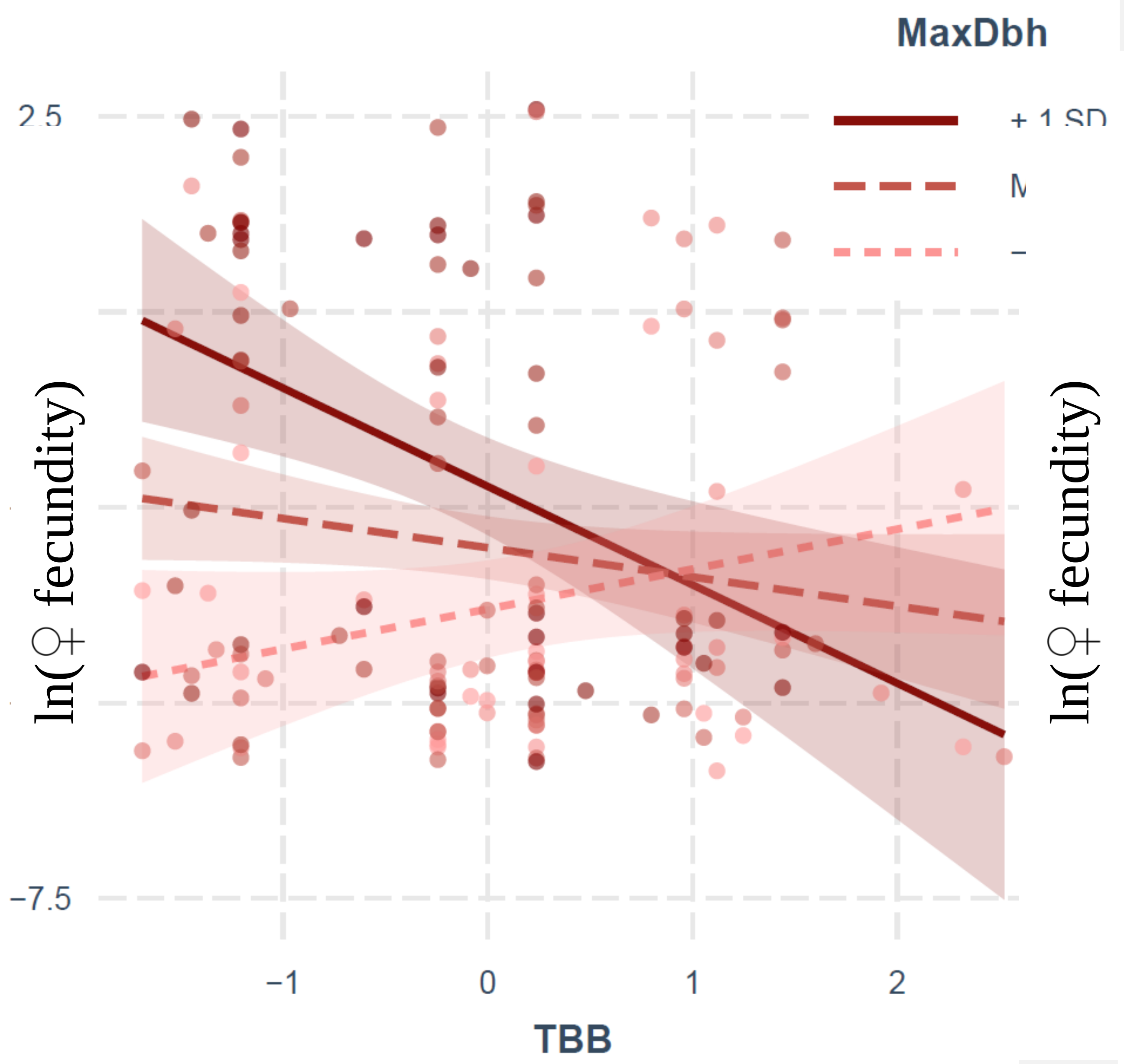


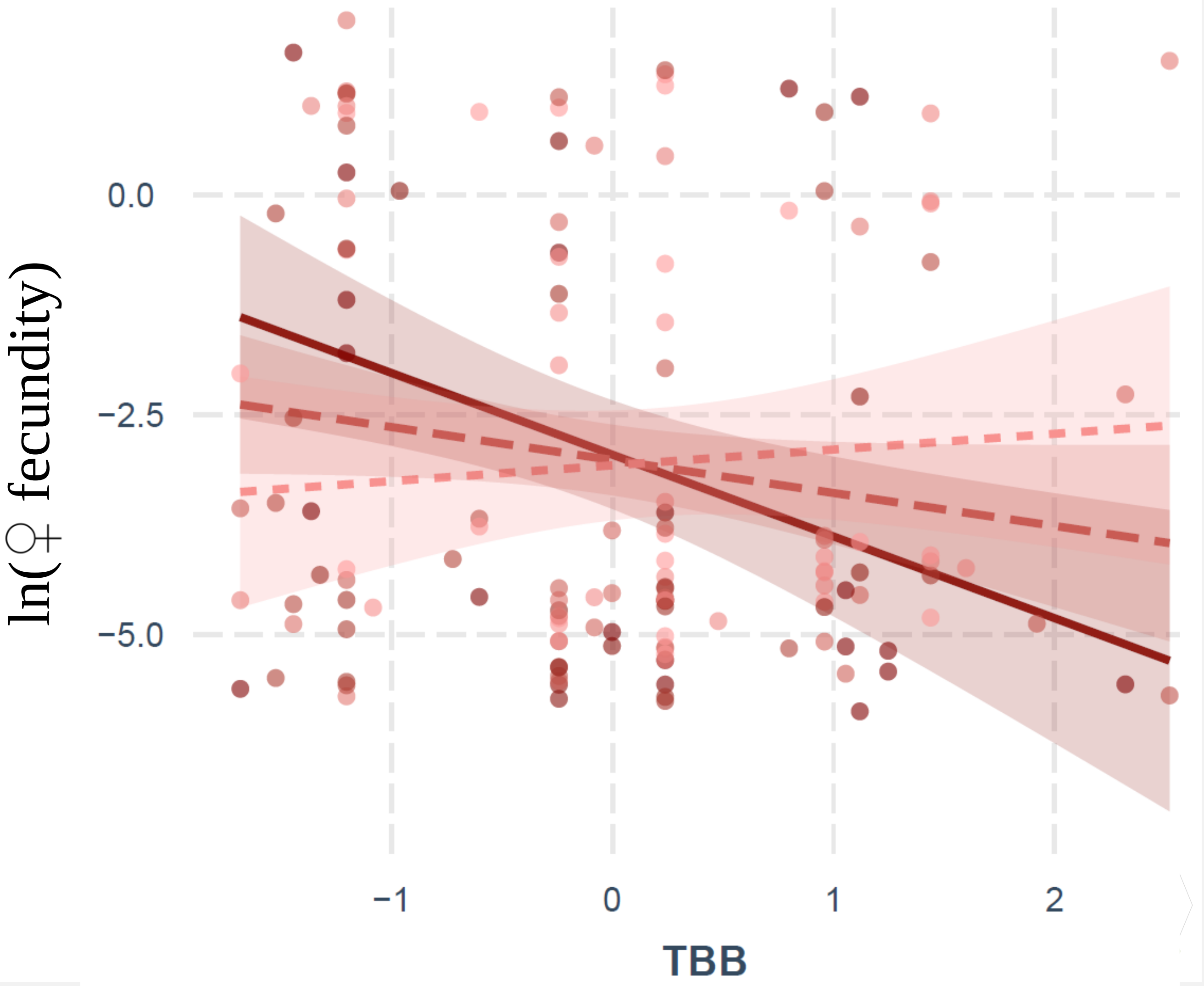


Fecundity selection

Low E

♀ fecundity of the more competed trees increased with increasing TBB

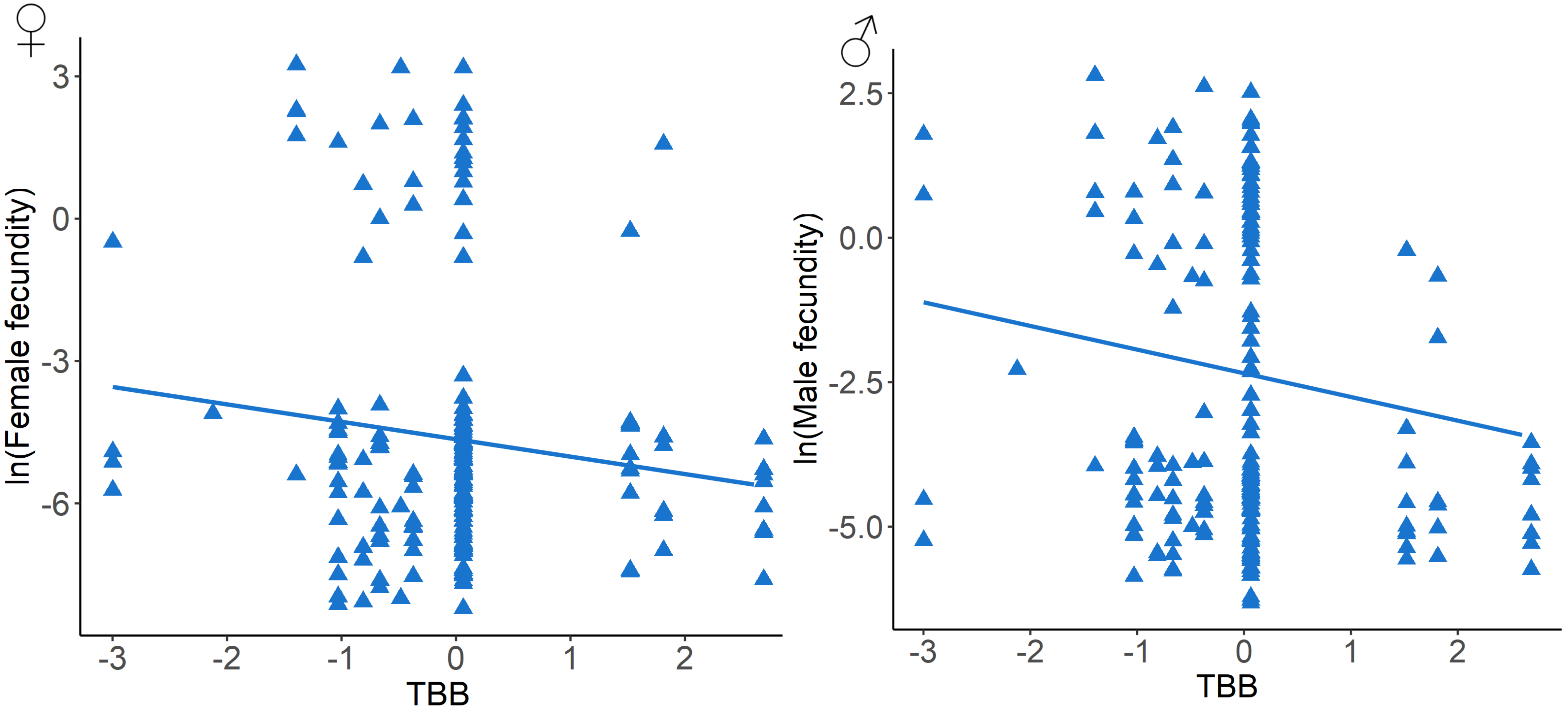




Fecundity selection

High E

♀ and ♂ fecundity decreased with increasing TBB at high elevation

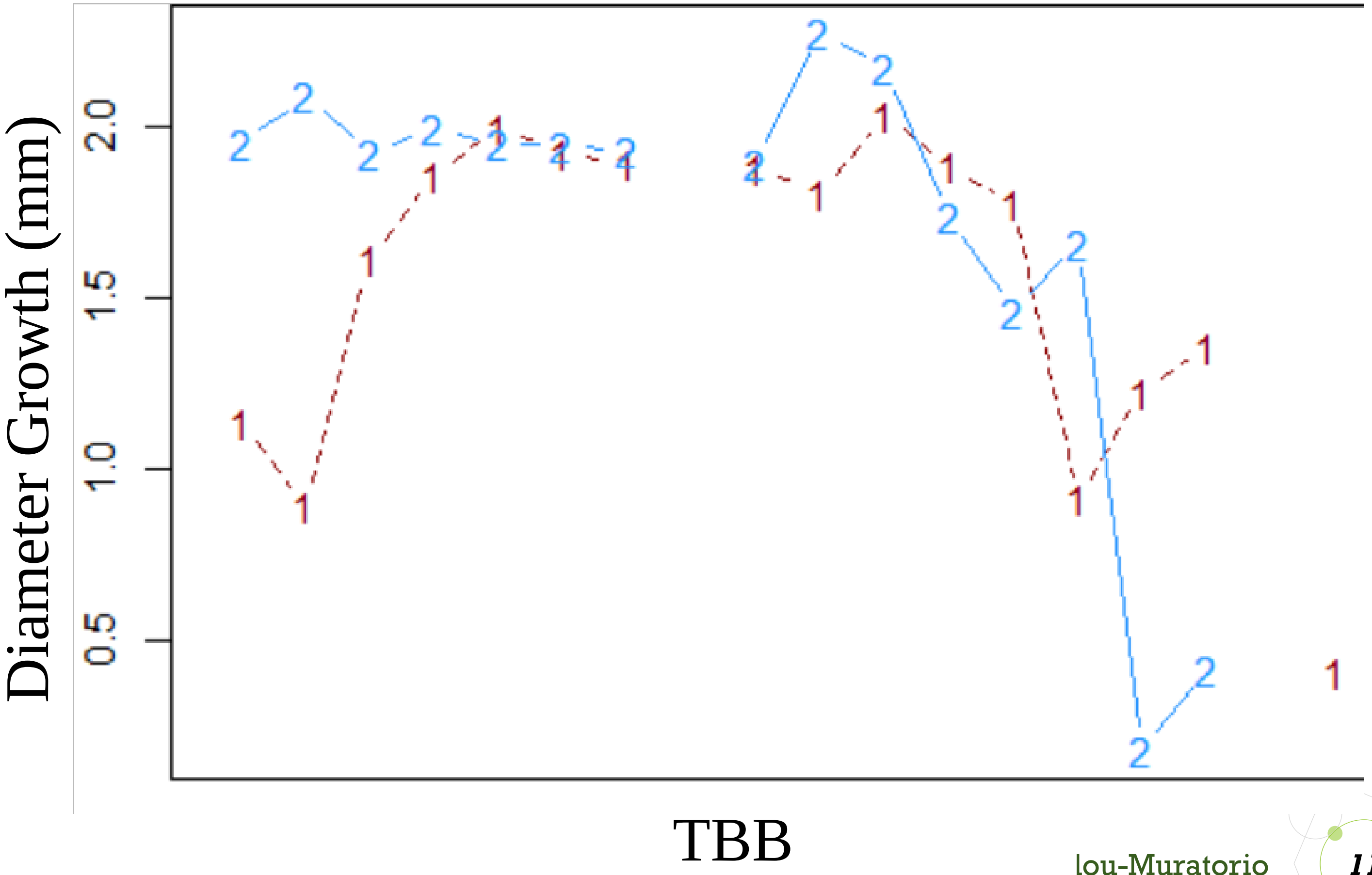


Viability selection

Diameter growth lower for:

- Seedling with late budburst at both plots
- Seedling with early budburst at plot N1

1= Low elevation 2= High elevation



Synthesis: components of selection on beech spring phenology

Stabilizing selection on TBB through ♂ fecundity at both plots

Directional <u>fecundity selection</u> for late budburst in small trees through ♀ fecundity at low E.

Directional <u>fecundity selection</u> for early budburst through:

- ♀ fecundity at both plots
- ♂ fecundity at high E

Directional <u>viability selection</u> for early budburst through growth at high E

Late ← TBB → Early

Synthesis: components of selection on beech spring phenology

- One of the first estimation of the strength of **assortative mating** in a tree species, and of **significant Bateman's gradient for ♂ fecundity**
- **Selection for earlier budburst** though ♀ fecundity and vegetative performance, consistent with the literature (Geber and Griffen 2003; Munguía-Rosas et al. 2011, Austen et al. 2017)
- Particularly clear **at high elevation**, in line with patterns of genetic differentiation for TBB in beech (Gömöry and Paule 2011; Gauzere et al. 2020)
- **At low elevation**, late budburst was adaptative for small trees: indicative of a **water-saving strategy** (delayed budburst → drought resistance), co-existing with a **water-uptake strategy** (early budburst) (Bontemps et al. 2017)

- Difficulty in estimating selection mediated by late frosts

Thank you for your attention

PHENO 2022

Avignon, 22/06/2022

Sylvie Oddou-Muratorio, Julie Gauzere,
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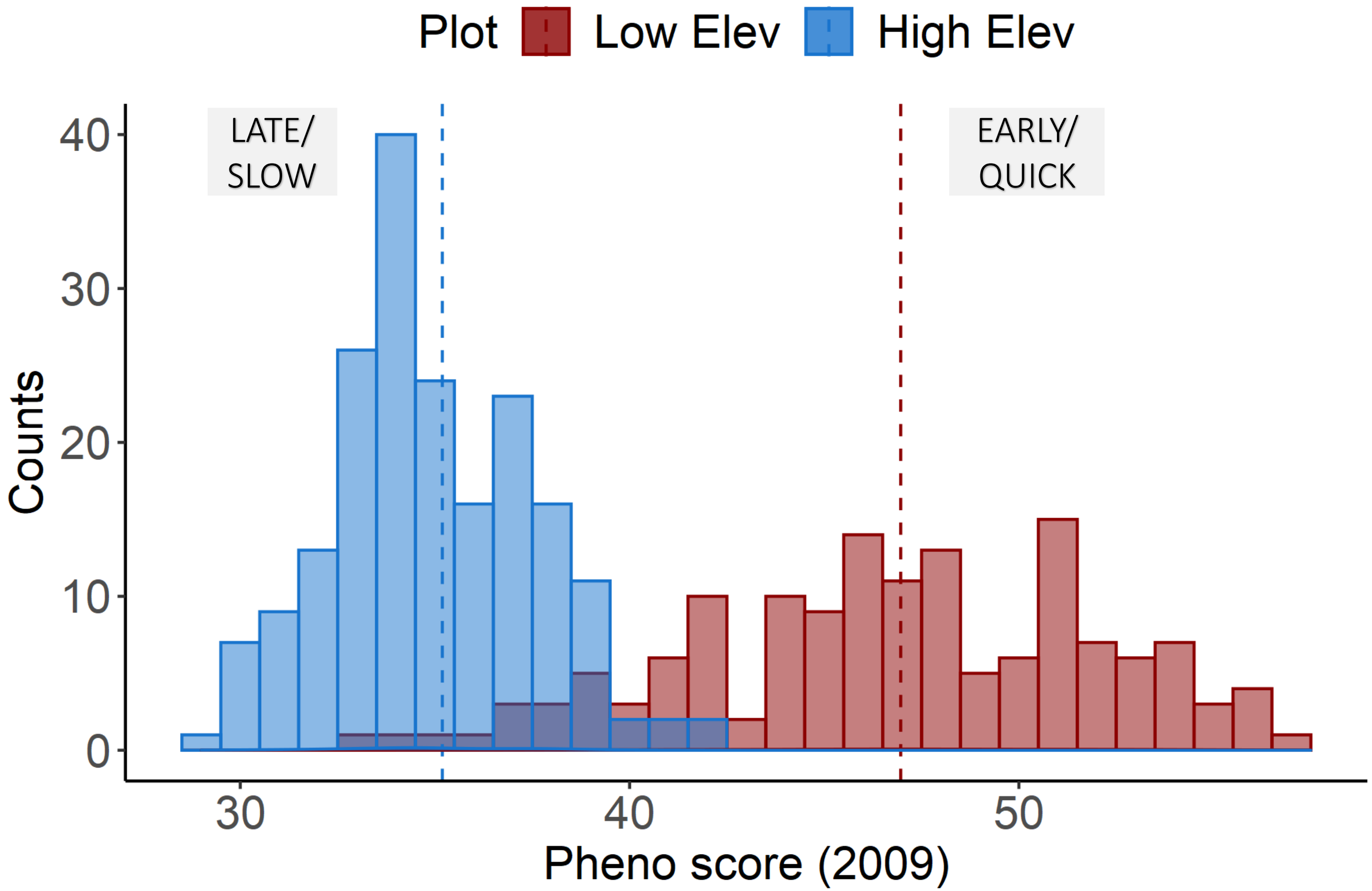
Distribution of phenological scores

- Low elevation: 15 dates of observations
- High elevation: 13 dates of observations



Phenological stages

1: dormant
2: swelling

3: Bud scales are broken

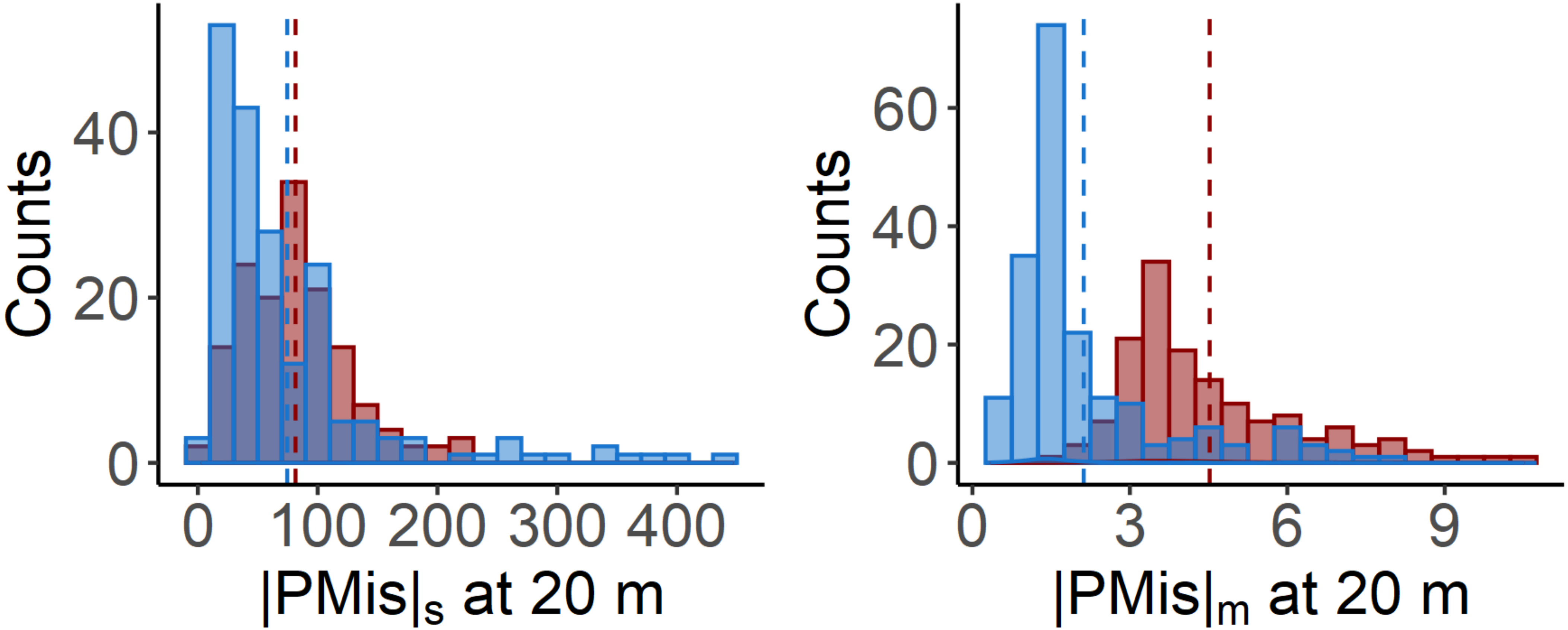
4: Leaves are emerging

5: Leaves are spread out

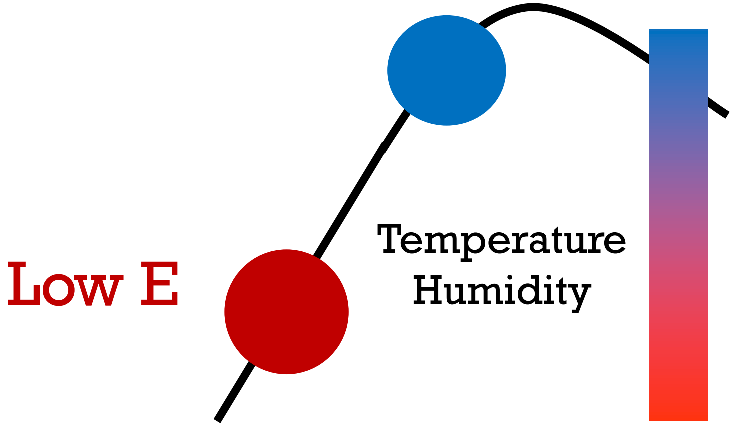
Distribution of phenological mismatches

$|Pmis|_s$ = sum of difference in TBB between the focal tress and its neighbors

$|Pmis|_m$ = mean of difference in TBB between the focal tress and its neighbors

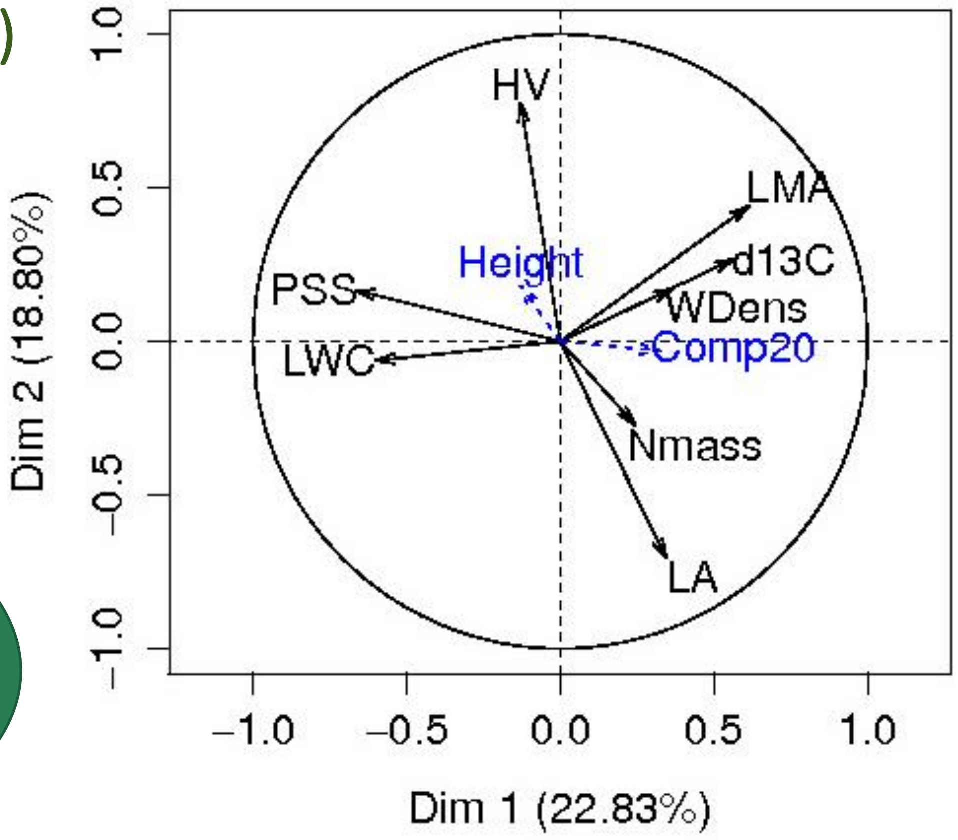


Distribution of phenological scores



Bontemps et al. 2017. Oikos

Early leaf unfolding (high PSS)
Low water use efficiency (d13C)
Low leaf mass per area (LMA)
High water content (LWC)



Late leaf unfolding (low PSS)
High water use efficiency (d13C)
High leaf mass per area (LMA)
Low water content (LWC)

water-uptake strategy

water-saving strategy

Genetic clines as the signature of local adaptation driven by the timing of budburst

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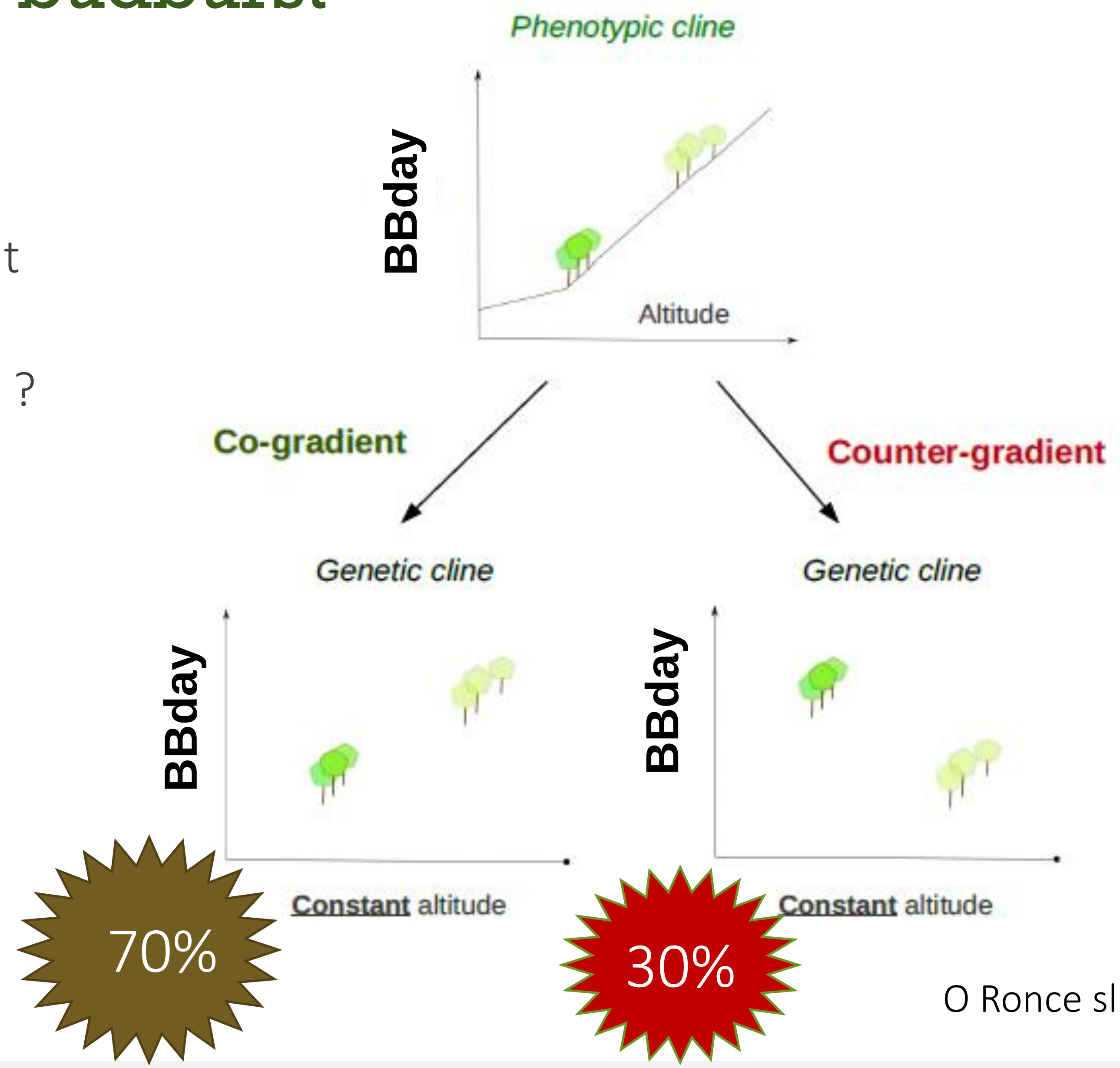
- Co-gradient versus counter-gradient
- counter-gradient ↔ maladaptive plasticity (Connover & Shultz 2003) ?



O Ronce slide