How the synchrony between gypsy moth egg hatching and budburst of European species change under milder winters?

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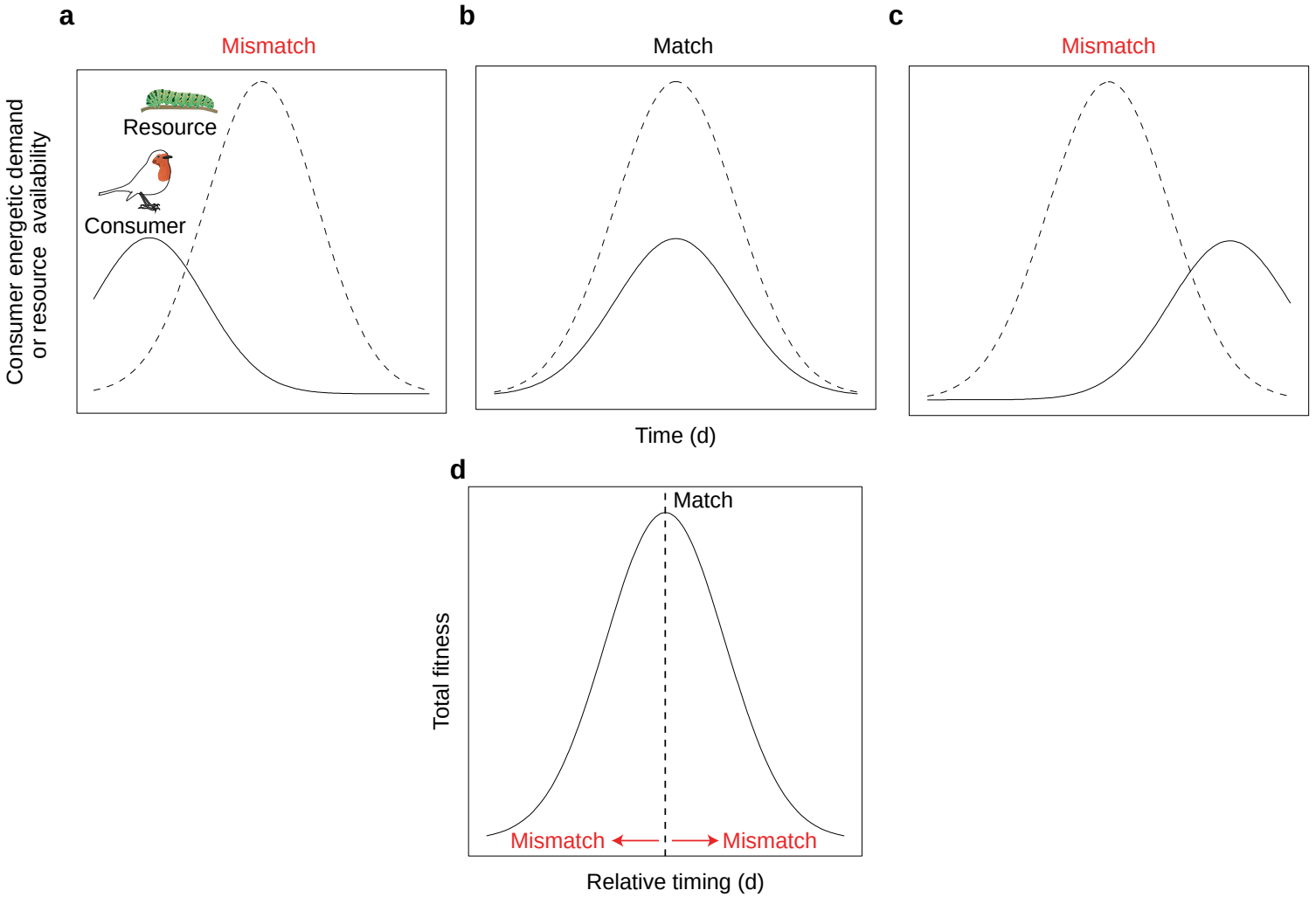
Cushing match-mismatch hypothesis

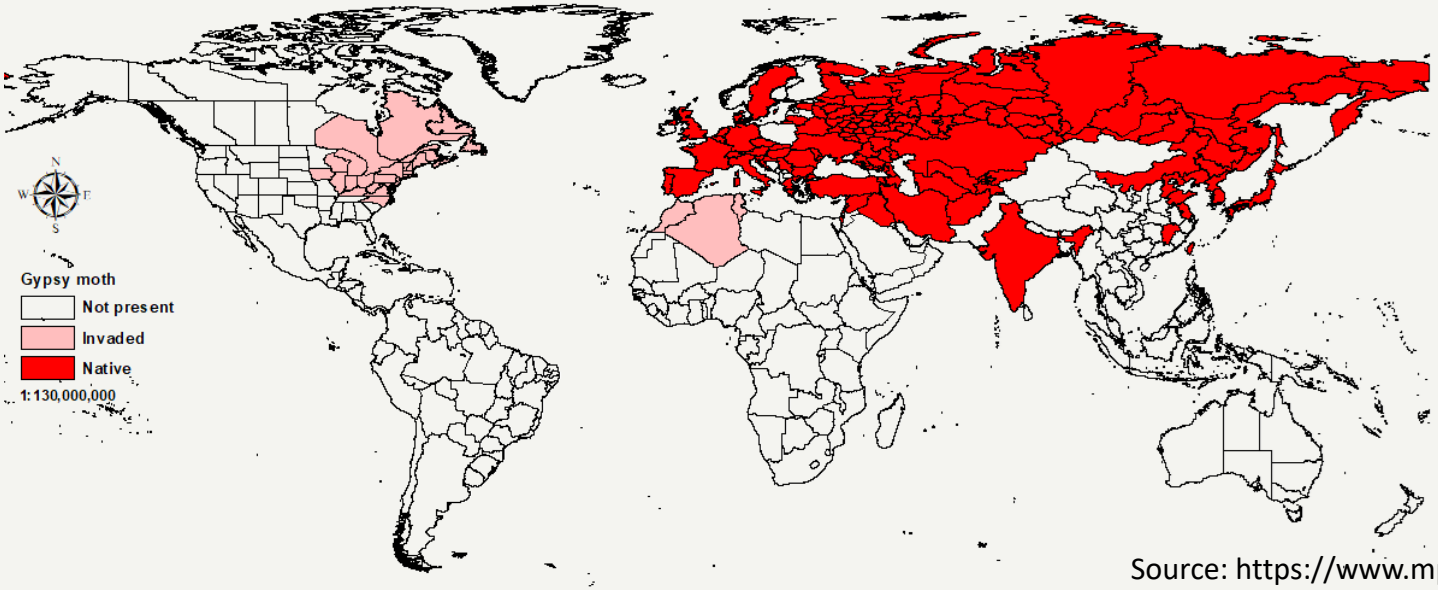


Kharouba & Wolkovich, *Nature Climate Change* 2020

GYPSY MOTH ?

– Lymantria dispar –

Generalist early-spring feeder, native from Europe, invasive in North America (introduced XIXe)



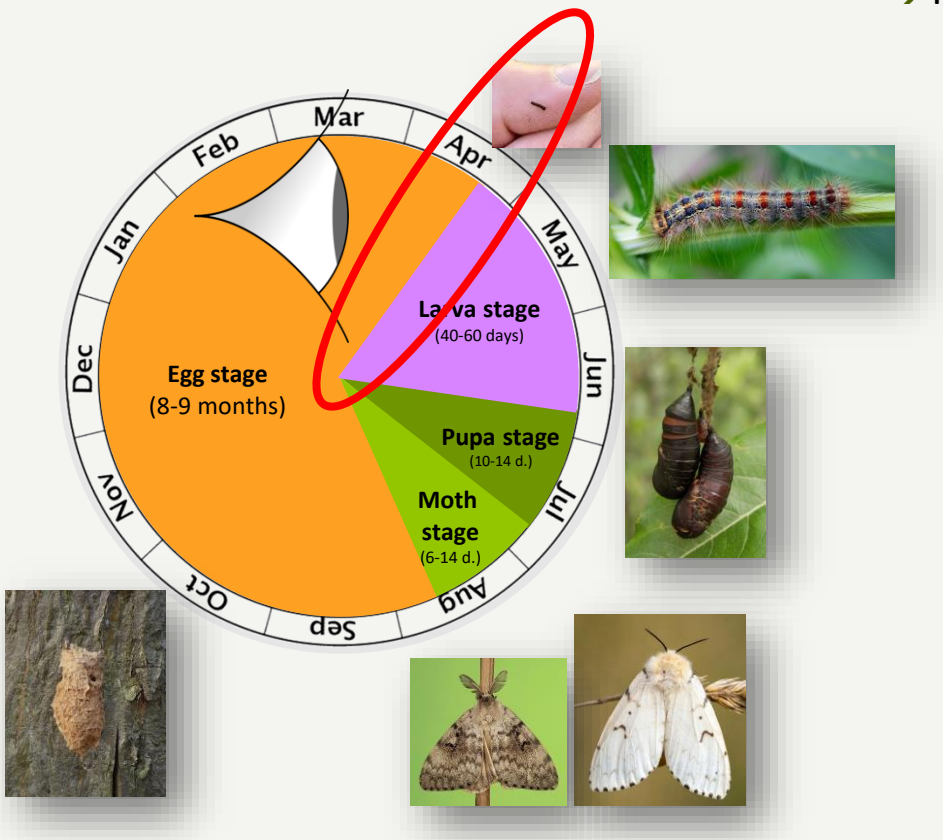
Source: https://www.mpi.govt.nz

Complete defoliation of oak and hornbeam trees in the North East of France.
Photos: A. Guerrier (CO DSF-CNPF, M. Mirabel (DSF)

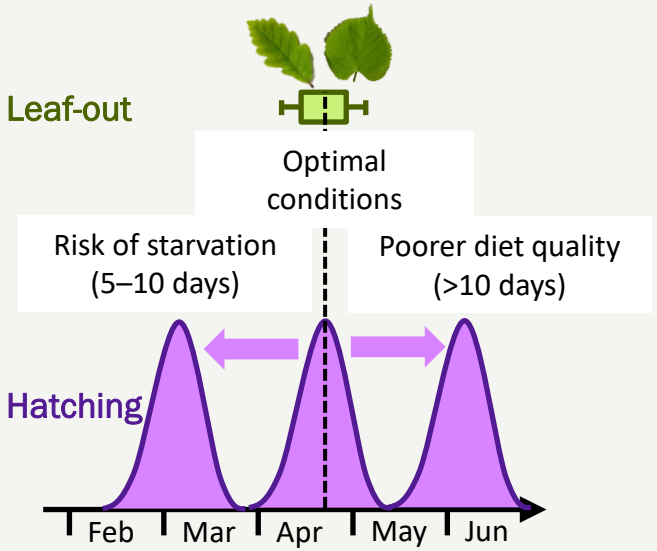
Complete defoliation of the chestnut in Southern Switzerland.
Photo: Swiss Forest Protection (WSL)

The importance of Synchrony with leaf-out

Annual cycle of the gypsy moth



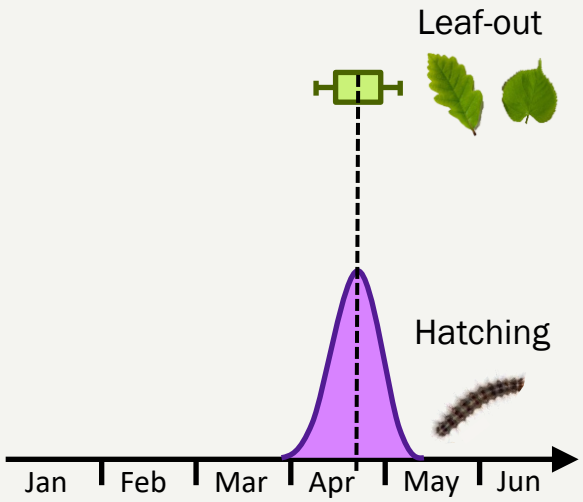
→ Hatch during bud-break and start to feed instantaneously on fresh young leaves



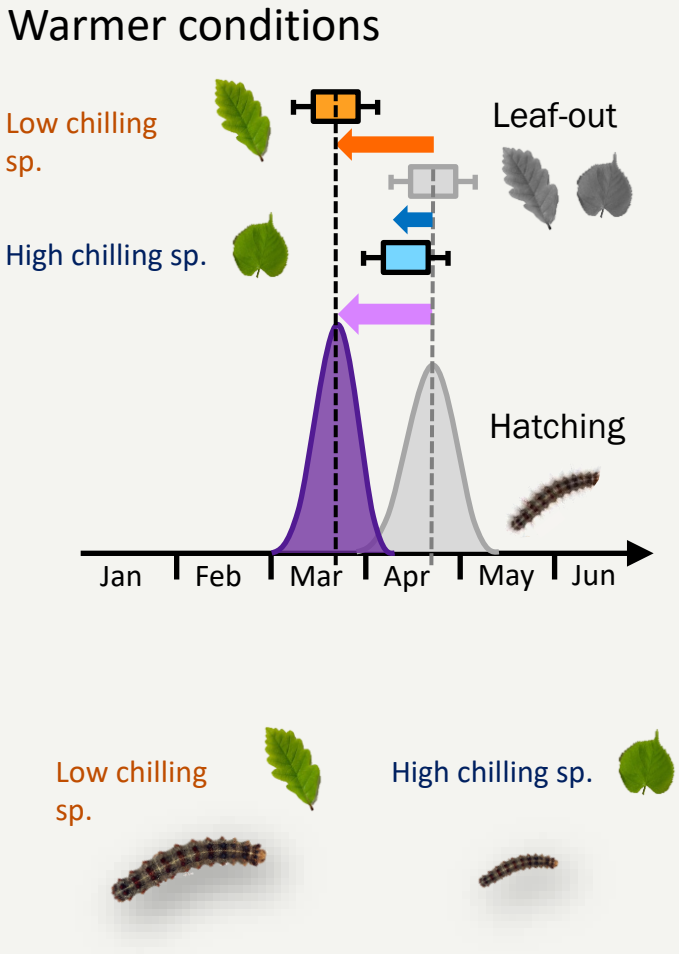
Hunter, *Oikos* 1993; Hunter & Elkinton, *Ecology* 2000

Hypotheses

Current conditions



Hypotheses



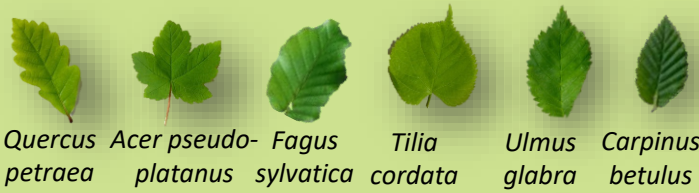
Hypotheses

- Hatching of the gypsy moth eggs is highly sensitive to spring temperature
- The gypsy moth might be more synchronised with tree species having lower chilling requirement and/or unsensitive to photoperiod such as Oak, hornbeam or Elm
  → EXP 1
- The gypsy moth larvae should be better adapted to these species with higher preference and fitness when feeded with their leaves
  → EXP 2

Experiment 1: Synchrony hatch/Leaf-out

Synchronisation between egg hatch and leaf-out under warmer winter conditions

Sampling Twig cuttings



Quercus petraea | *Acer pseudo-platanus* | *Fagus sylvatica* | *Tilia cordata* | *Ulmus glabra* | *Carpinus betulus*

- 6 species
- 5 replicates/Treat (trees)
- Total 120 cuttings monitored

Gypsy moth eggs

Egg mass

Eggs

First instar larva

- 5 replicates/treat (laboratory-reared moth egg masses)
- Each replicate consists of ~100-200 fertile eggs (~2800 eggs to monitor)

19 November 2019

Chilling

Winter conditions

No chilling
Tmin > 10° C

Moderate chilling
Tmin > 5° C

Realistic warming
OTC + 5° C

'normal chilling'
OTC ambiant

Greenhouses

Open Top Chambers

→ Monitoring egg hatch and bud development twice a week

Experiment 1: Synchrony hatch/Leaf-out

No chilling
Tmin > 10° C

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Tmin > 5° C

Realistic warming
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'normal chilling'
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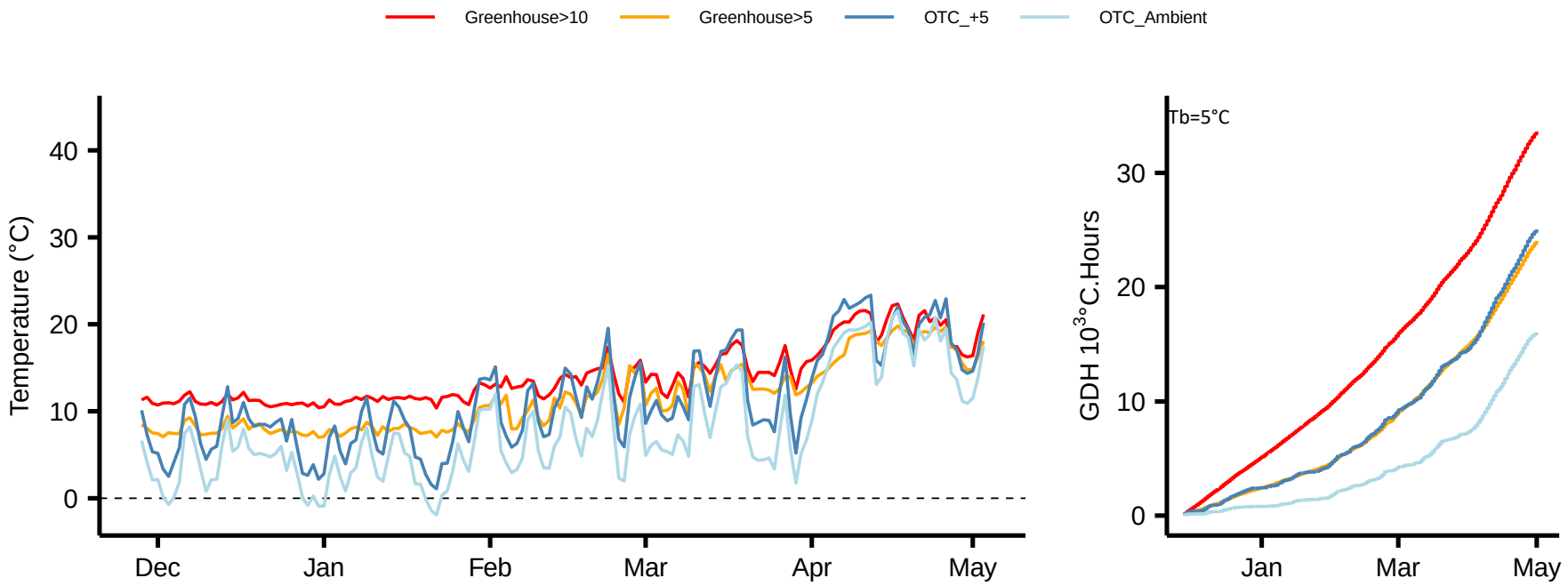
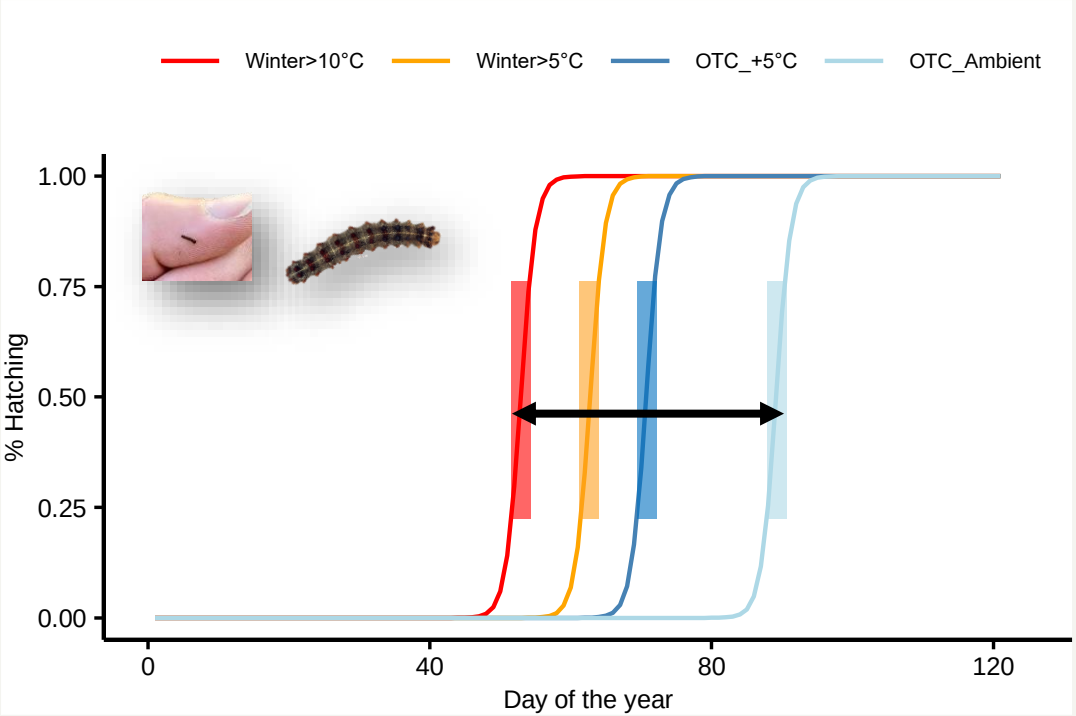


Experiment 1: Synchrony hatch/Leaf-out

Gypsy moth hatching

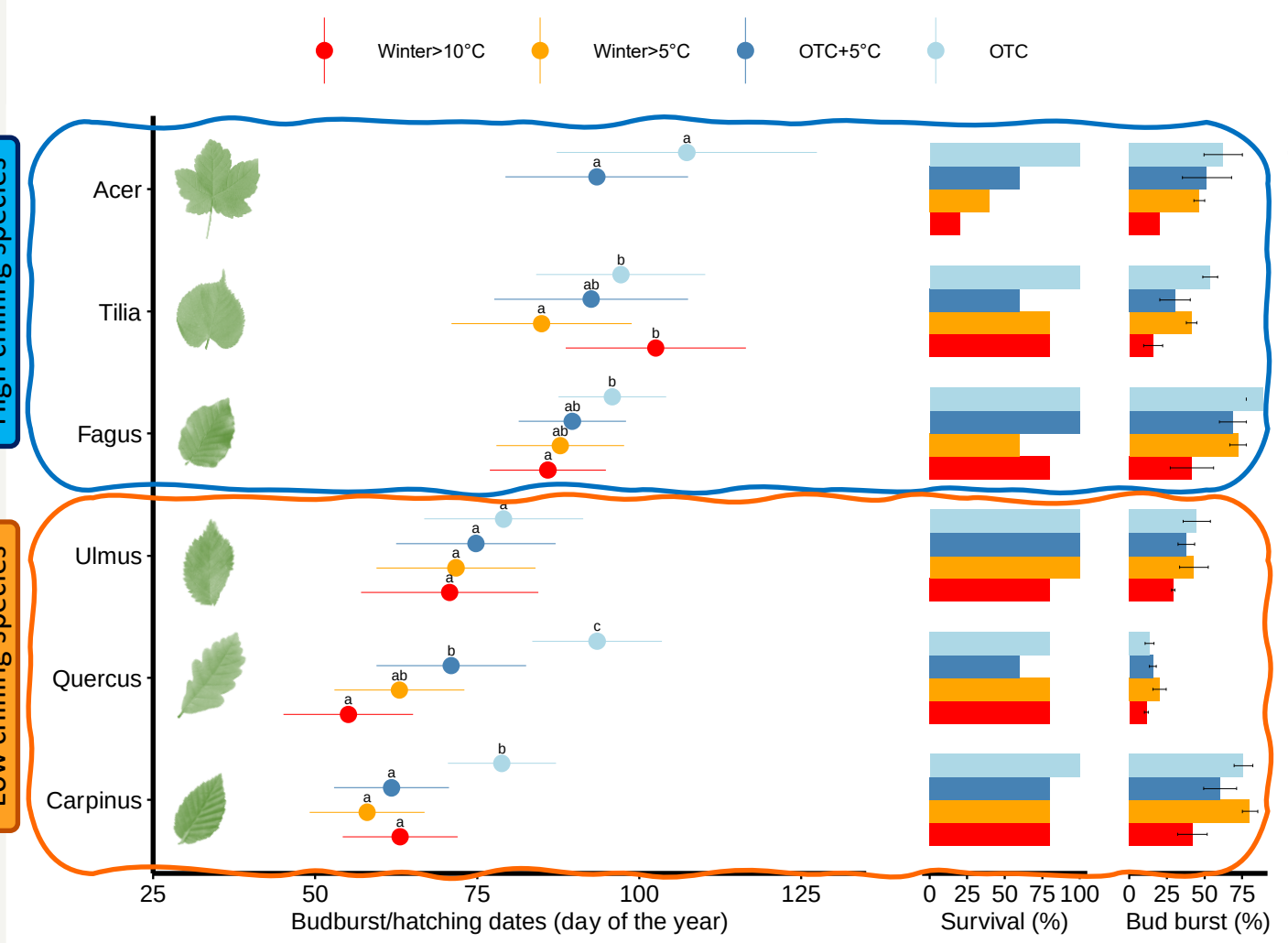


Hatching time range [25–75%]

Winter>10°C	DOY 50–58
Winter>5°C	DOY 62–66
OTC +5°C	DOY 68–72
OTC Ambient	DOY 84–90

→~34 days of difference between *OTC Ambient* and *Winter>10°C*!

Experiment 1: Synchrony hatch/Leaf-out

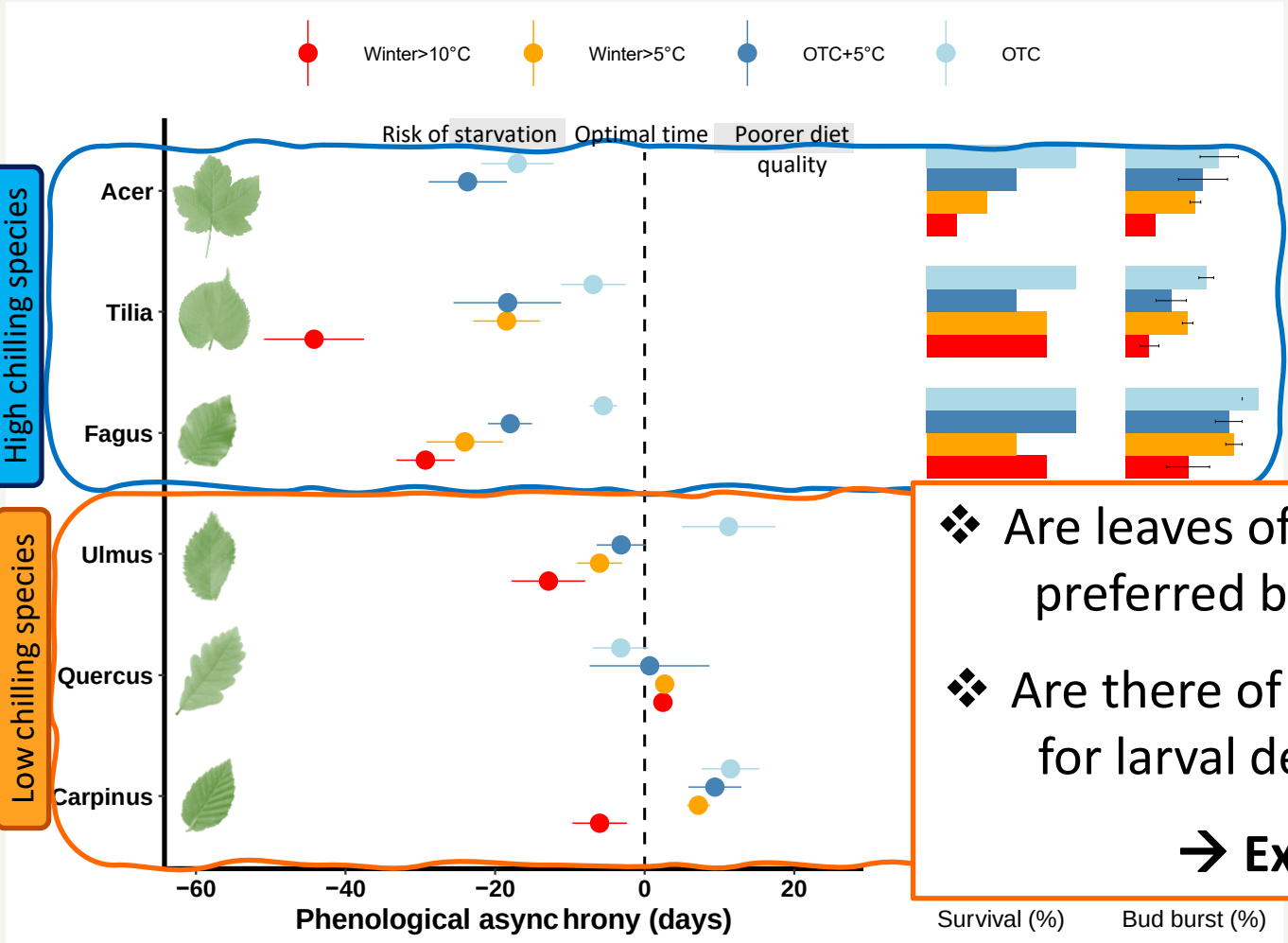


→ **declining survival and budburst success** under **lower chilling** and **smaller advance** in budburst to warming

→ **less affected** by lower chilling and better **synchronized with gypsy moth hatching**

Experiment 1: Synchrony hatch/Leaf-out

Phenological asynchrony = 75% hatching date – Budburst date



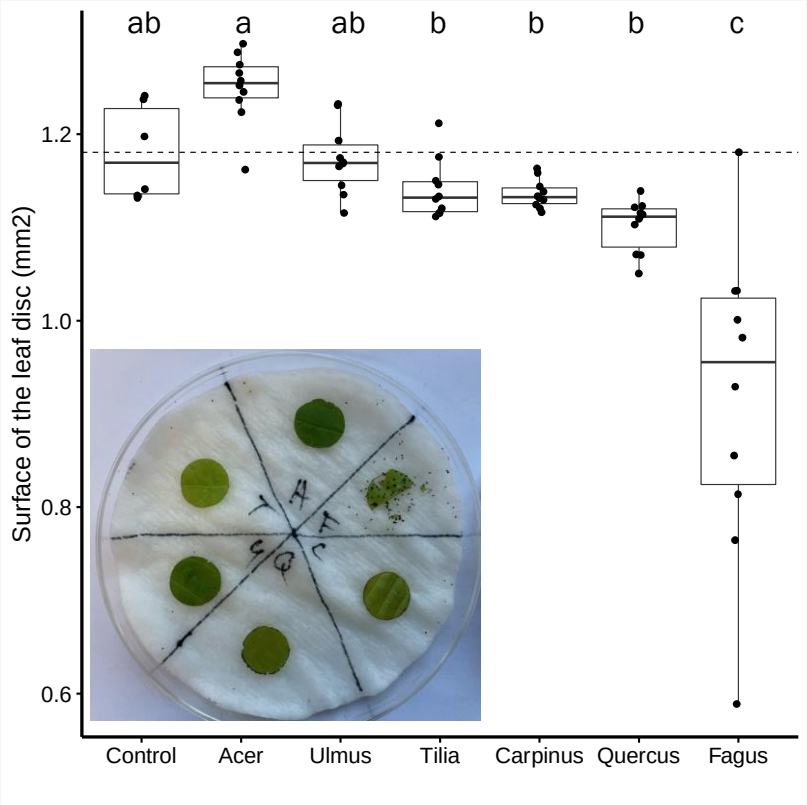
Synchrony moth/leaves under warmer climate

- Are leaves of these species preferred by the larvae?
- Are there of better quality for larval development?

→ **Exp 2**

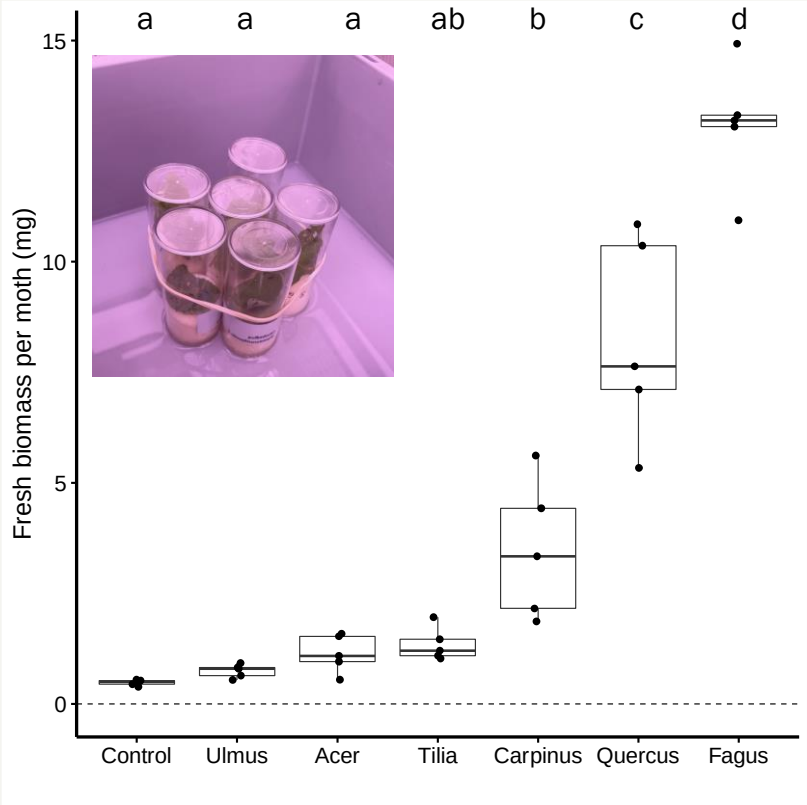
Experiment 2: Larvae preference and Fitness

Leaves preference (20°C, full light, 24h)



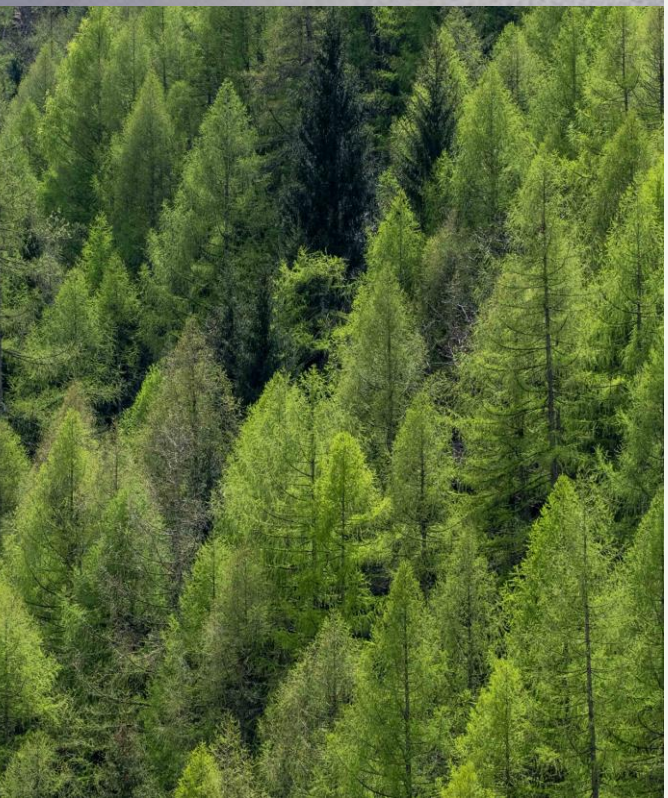
→ Fagus was clearly preferred by the larvae

Diet quality (20°C, full light, 7 days)



→ Fitness: Fagus >> Quercus > Carpinus > other species

Discussions / Conclusions



Conclusions

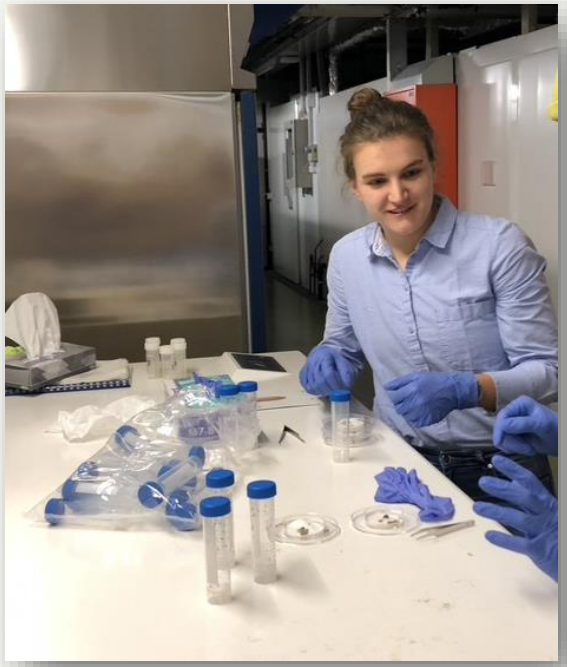
- Hatching of the gypsy moth eggs **is highly sensitive to spring temperature (~ –4.9 days/°C)** ✓
- The gypsy moth might be **more synchronised with tree species having lower chilling requirement** (Oak, hornbeam, Elm) ✓
- The larvae should be **better adapted to species with lower chilling requirement** showing higher **preference and fitness** when feeded with their leaves ✗ ✓

Discussions

- → **Window of opportunity**: temporal suitability of the host but also spatial availability ('ballooning' dispersal)
- → **Species composition:** beech-dominated stands might be better suited to the gypsy moth if the proportion of oaks were increased (as proposed today...)
- → **Natural ennemies**: complex interaction with phenology (pathogens, parasites, predators)→ to explore further!

Special thanks

Nora Pohl,
Master student



Frederik Baumgarten,
PhD student

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Thanks for your attention...

Questions?

"Life is about timing"

CARL LEWIS