Genetic variation in annual height growth of Latvian Norway spruce OP families

Darius Danusevicius, ASU, LT

Aris Jansons, Silava, LV

INVESTMENT IN YOUR FUTURE
Funded by the European Union

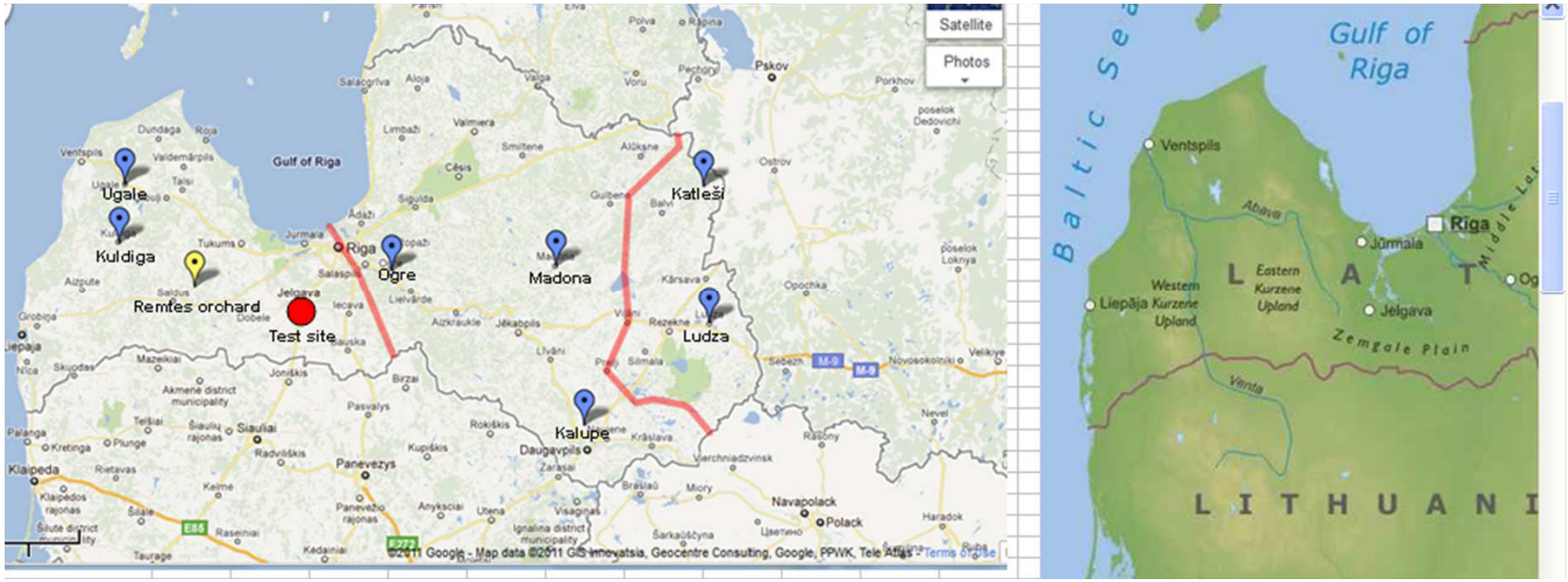
Objectives

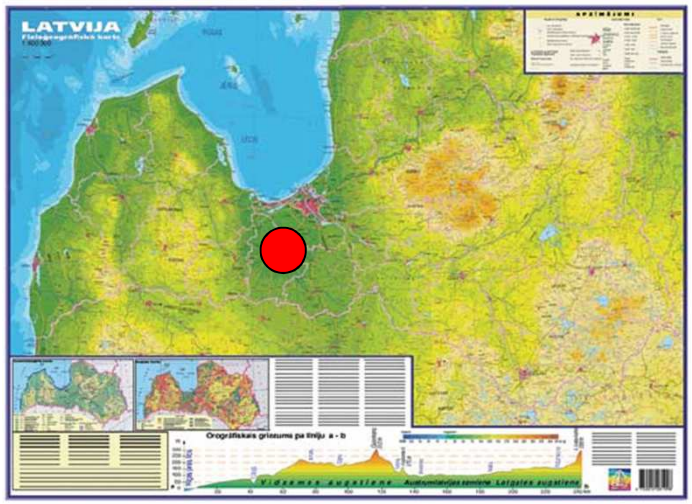
- Assess H growth to reveal adaptive environments and transfer effect within LV
- Patterns of genetic parameters during the growth period

Funded by the European Union

INVESTMENT IN YOUR FUTURE

Material

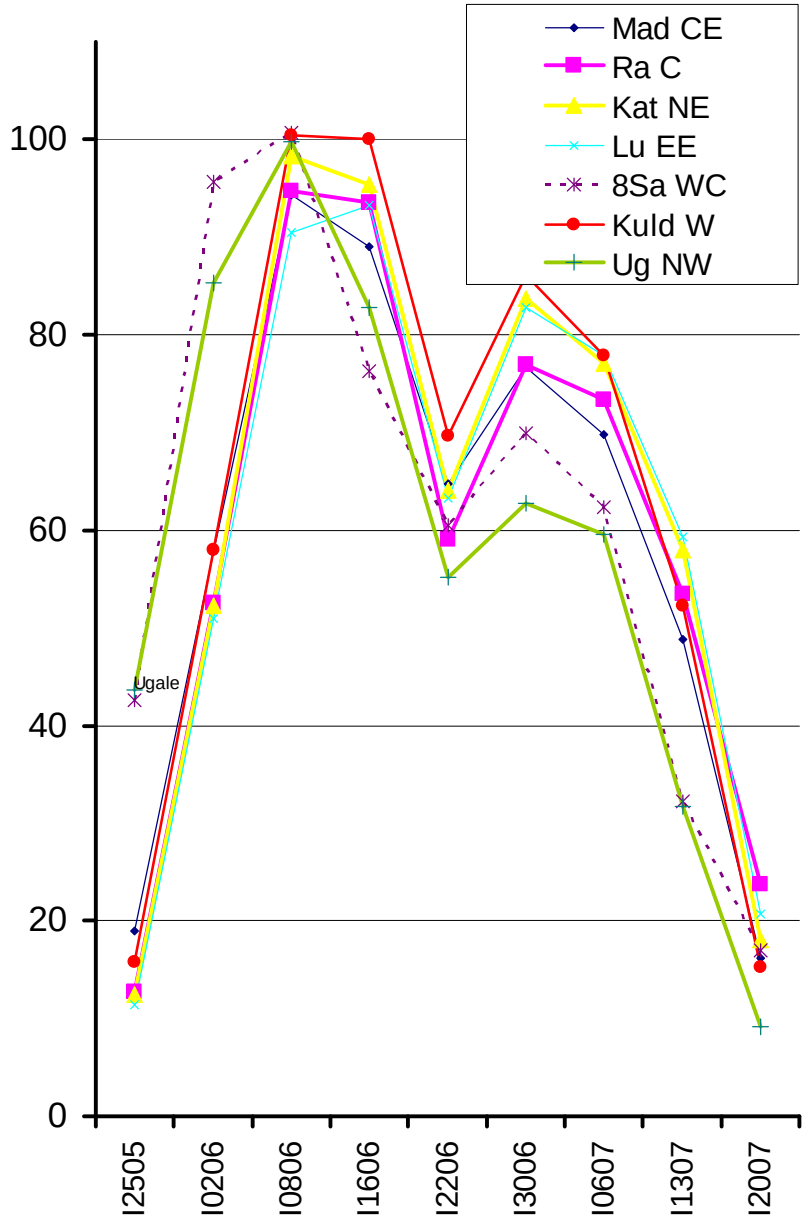




- 56 OP fam.s from 8 pop.s from 3 zones
- All moved from “cooler” to warmer (see altitude)
- 3 pop.s moved from CONT to MARITME

Funded by the European Union

INVESTMENT IN YOUR FUTURE



Funded by the European Union

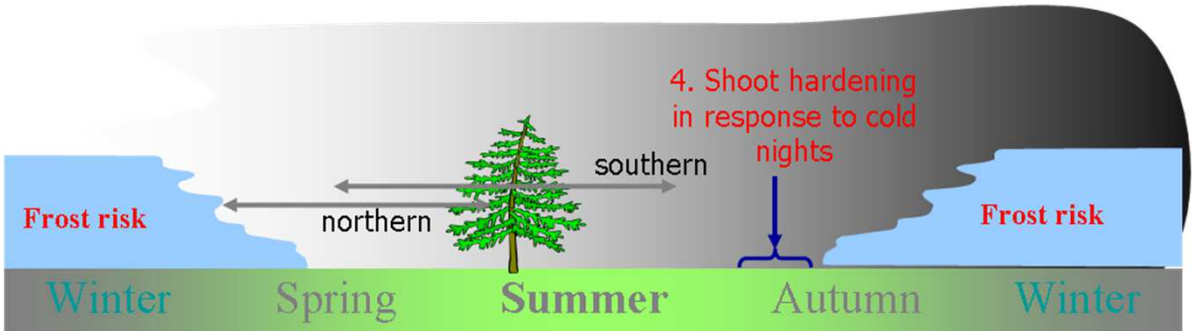
INVESTMENT IN YOUR FUTURE

Basic theory

Funded by the European Union
INVESTMENT IN YOUR FUTURE

3 major components of shoot length

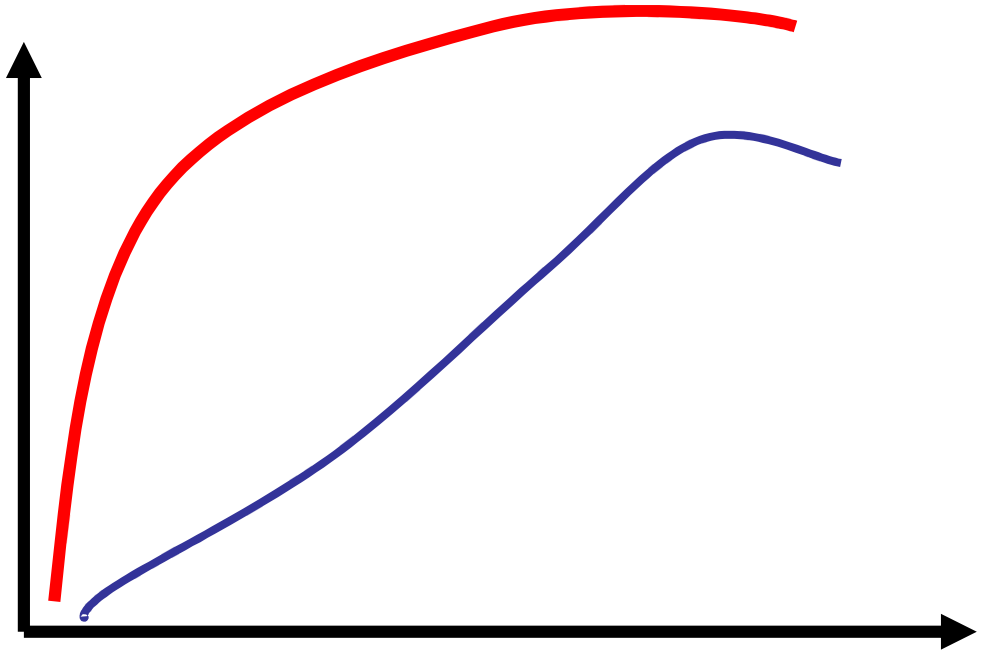
1. Transfer effect = growth rhythm



May be connected?

2. Growth vigor (fam effect)

3. Free growth (sea –continent)



Damage

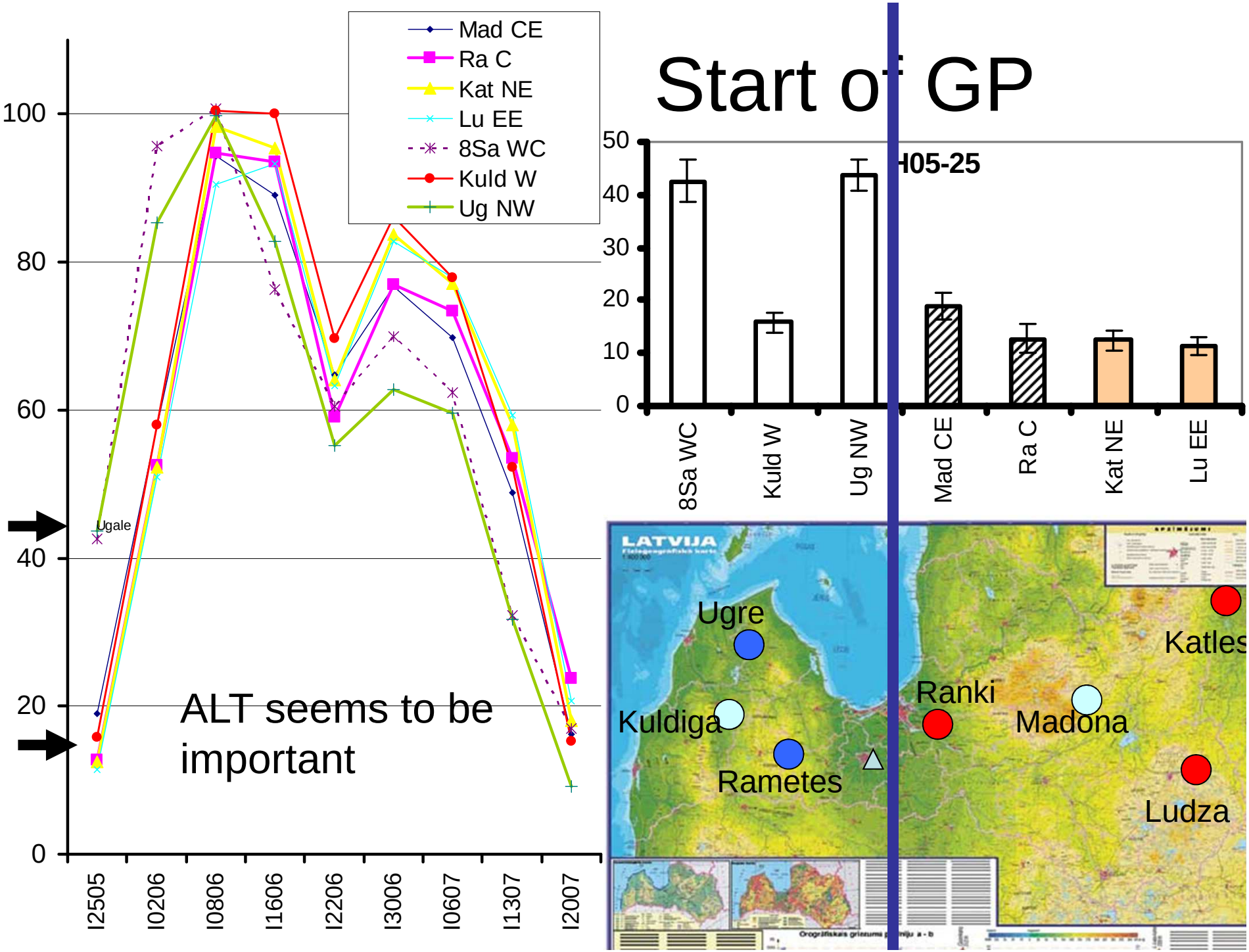
INVESTMENT IN YOUR FUTURE
Funded by the European Union

Results

- Population and transfer effect
- Correlations (early start means early end?)
- Genetic parameters and genetic variation at various stages
- Response to stress in June

Population (transfer) effect

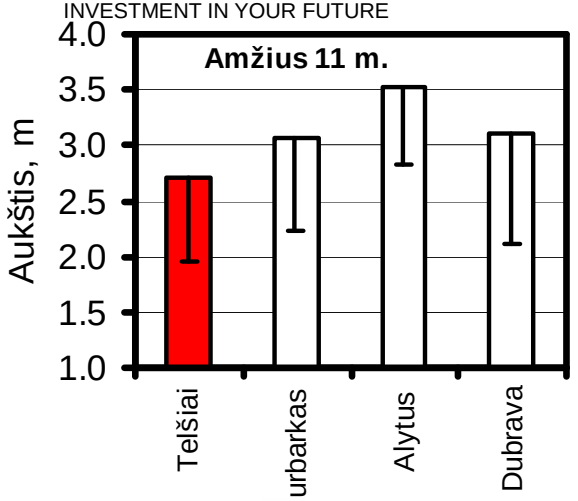
Bandomuosiuose želdiniuose

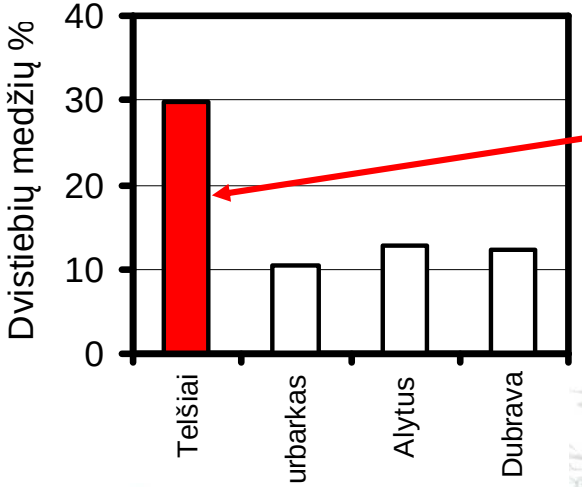

Mad CE
Ra C
Kat NE
Lu EE
8Sa WC
Kuld W
Ug NW
100
80
60
40
20
0
Ugale
ALT seems to be important
I2505
I0206
I0806
I1606
I2206
I3006
I0607
I1307
I2007
Start of GP
50
40
30
20
10
0
H05-25
8Sa WC
Kuld W
Ug NW
Mad CE
Ra C
Kat NE
Lu EE
LATVIJA
Ugre
Kuldiga
Rametes
Ranki
Madona
Katles
Ludza

Funded by the European Union

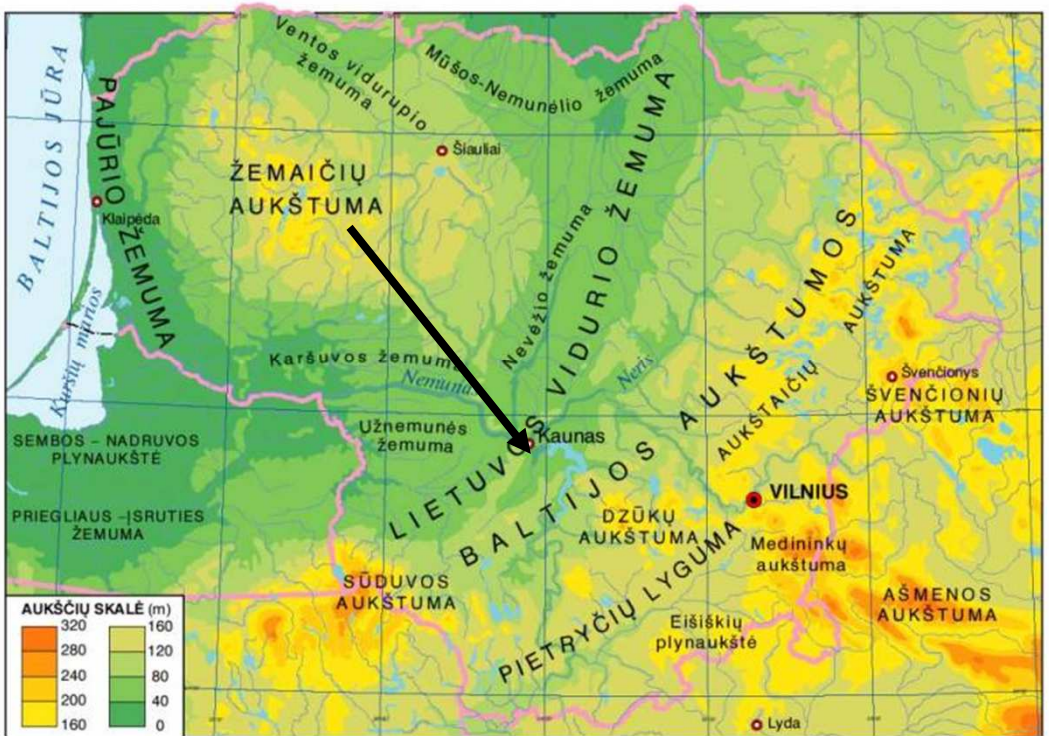
INVESTMENT IN YOUR FUTURE

Transfer effects in LT

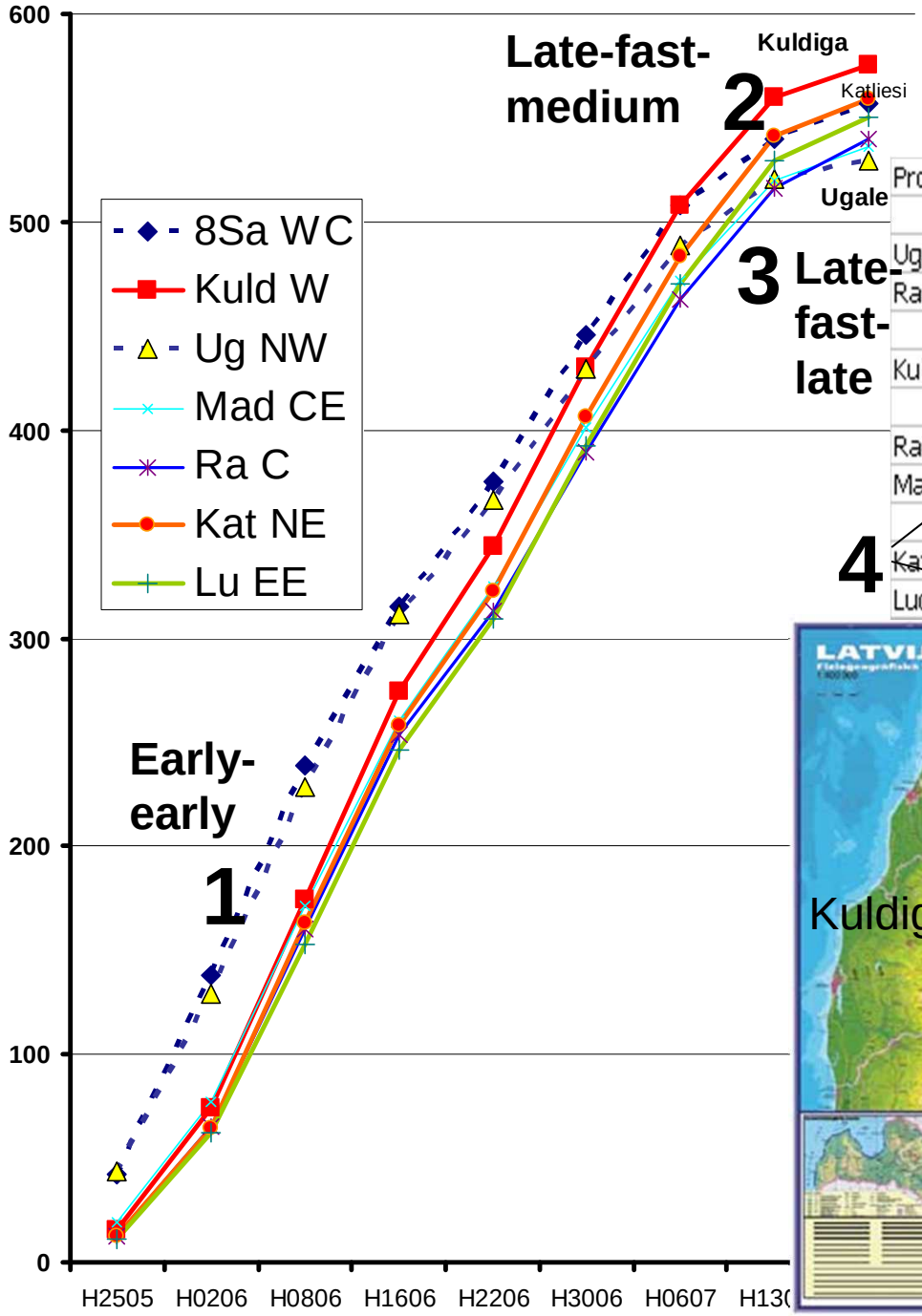




Esminis Lietuvos populiacijų perkėlimo efektas (pvz. iš Telšių į Kauną rajoną)

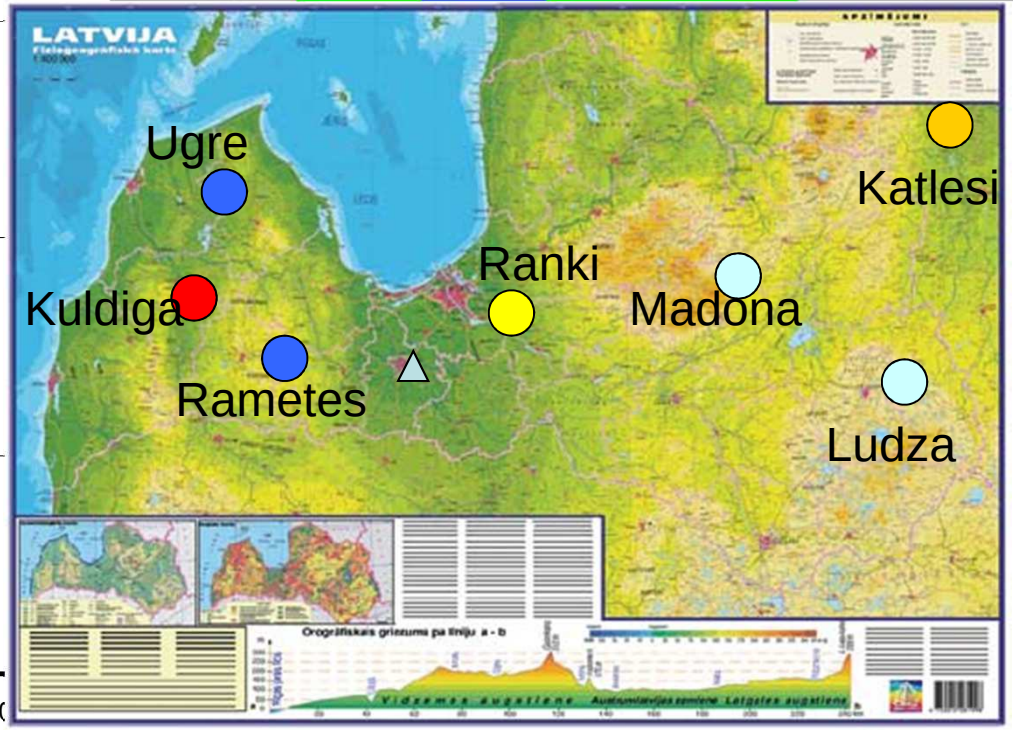


Growth pattern= 4 groups of populations

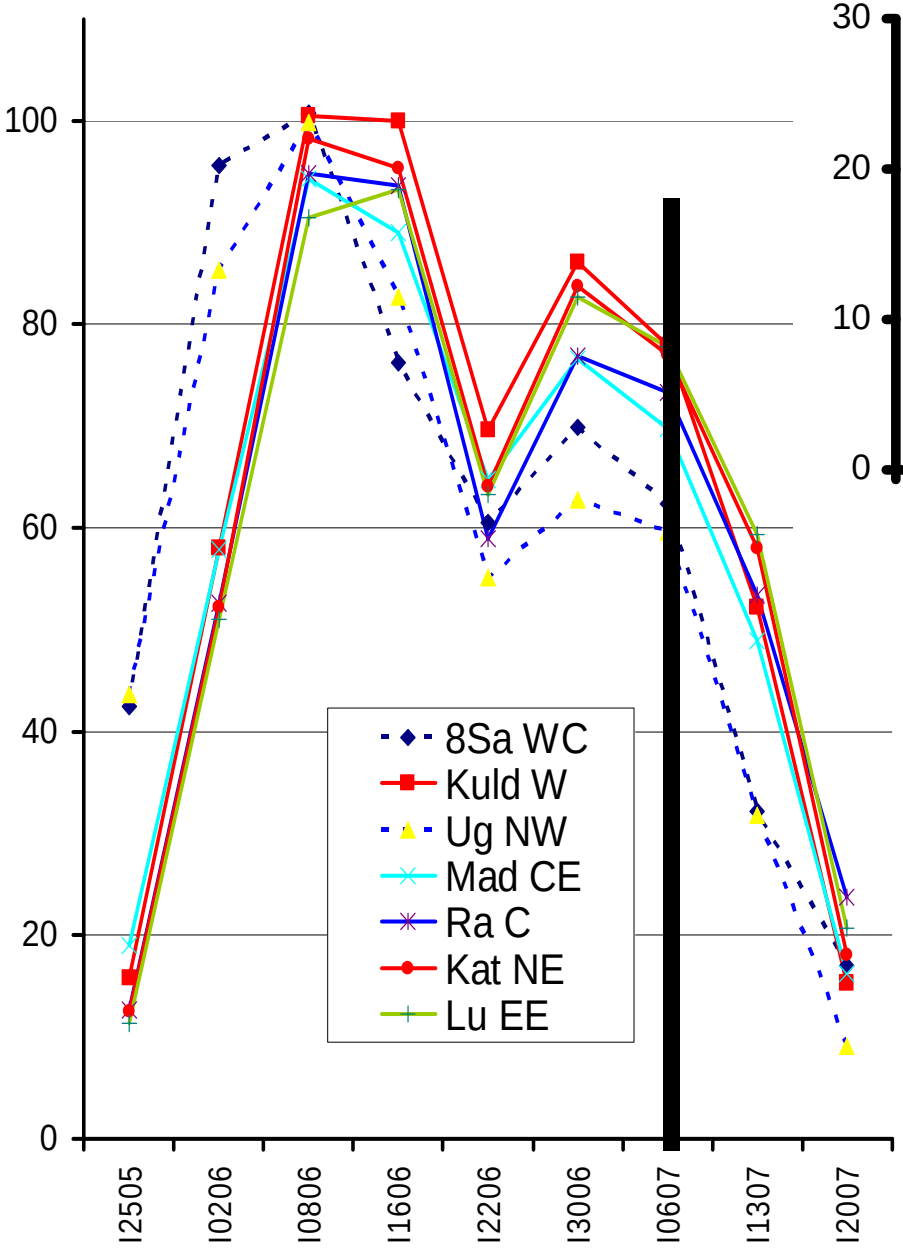


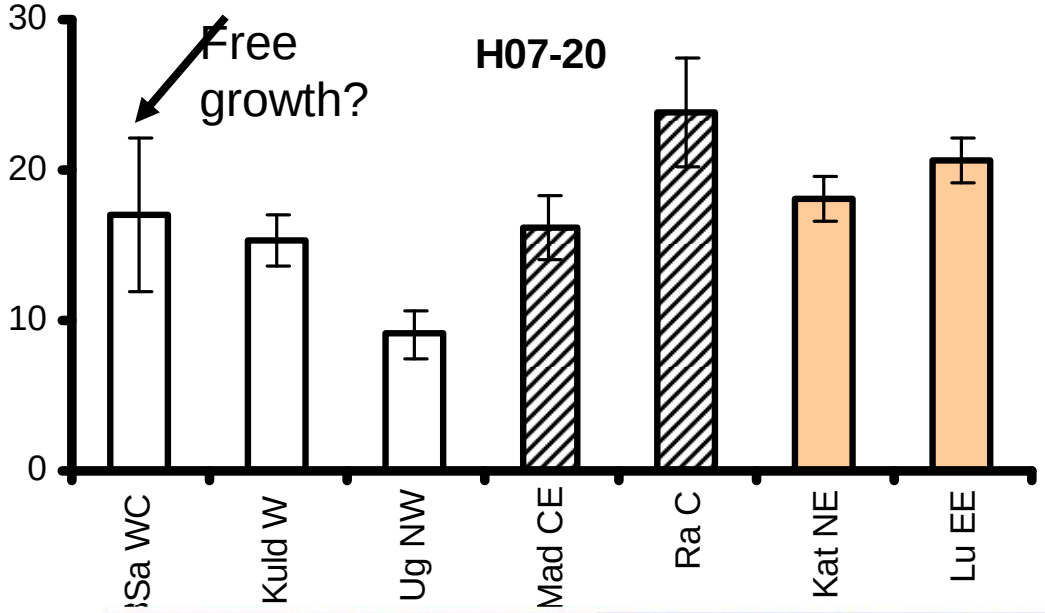
Prov	Zone	Start	Vigiuor Begin	End	Cessation	H rank of 7	
Ugale NW	W	Early	Hight	Lowest	Earliest	4	Free growt
Ramtes orc	W	Early	Hight	Low	Early	6	
Kuldiga	W	Late-	Hight	Hight	Medium	2	ws 1st rank
Ranki	C	Late	Low	High	Latest	1	Typical sou
Madona	C	Late-	Medium	Medium	Medium	5	
Katliesi	E	Late	Low	High	Late	3	most cotine
Ludza	E	Late	Low	Medium	Late	7	most cotine

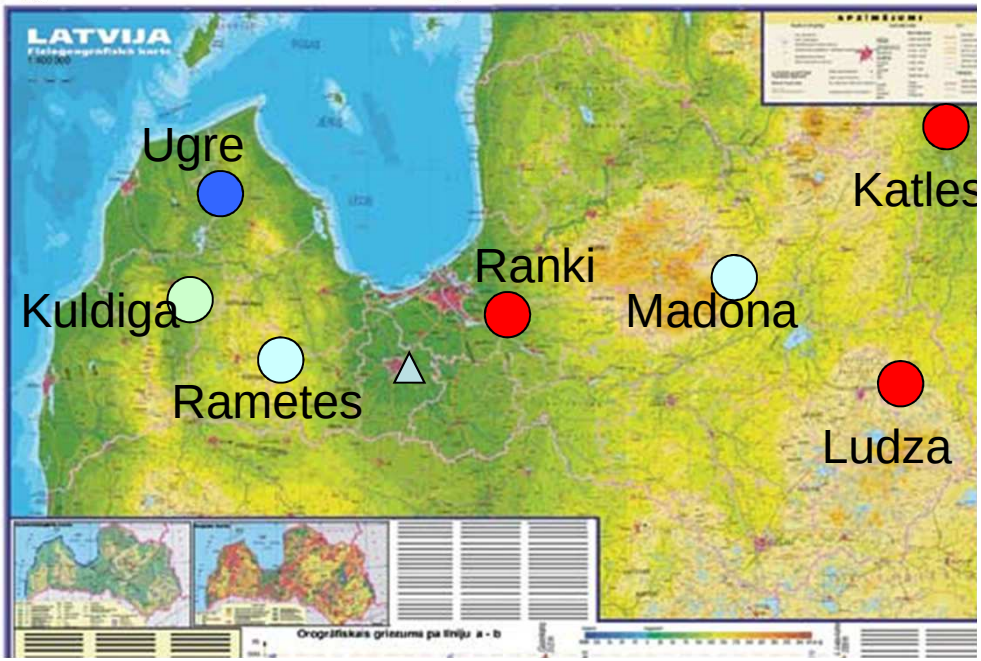
4



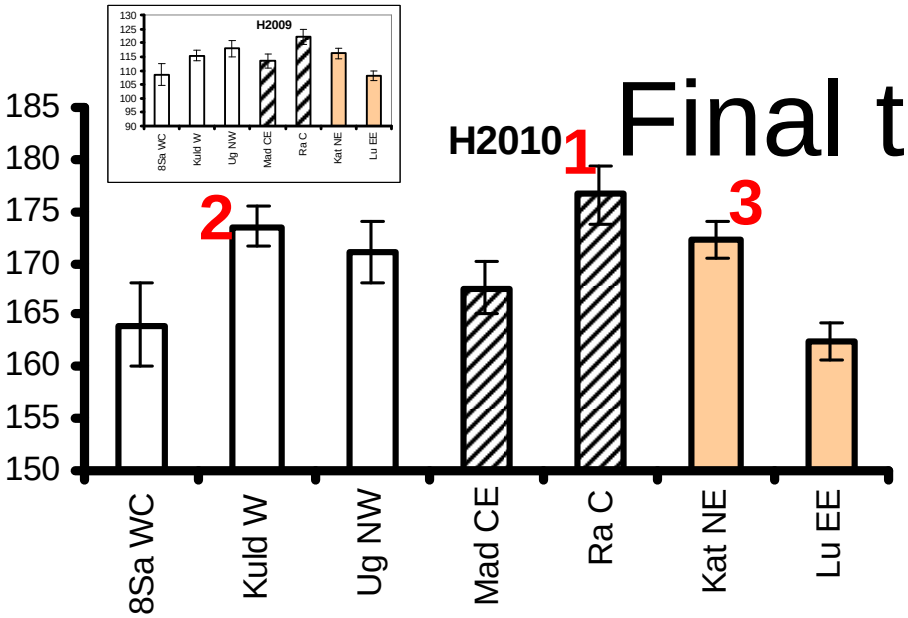
Cessation


100
80
60
40
20
0
I2505
I0206
I0806
I1606
I2206
I3006
I0607
I1307
I2007
8Sa WC
Kuld W
Ug NW
Mad CE
Ra C
Kat NE
Lu EE

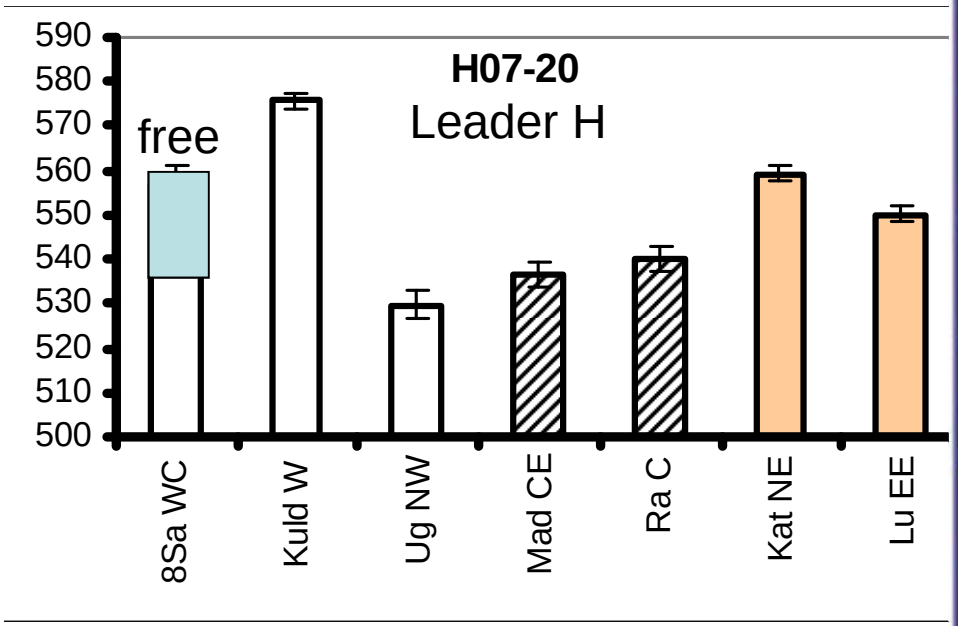

30
20
10
0
Free growth?
H07-20
8Sa WC
Kuld W
Ug NW
Mad CE
Ra C
Kat NE
Lu EE

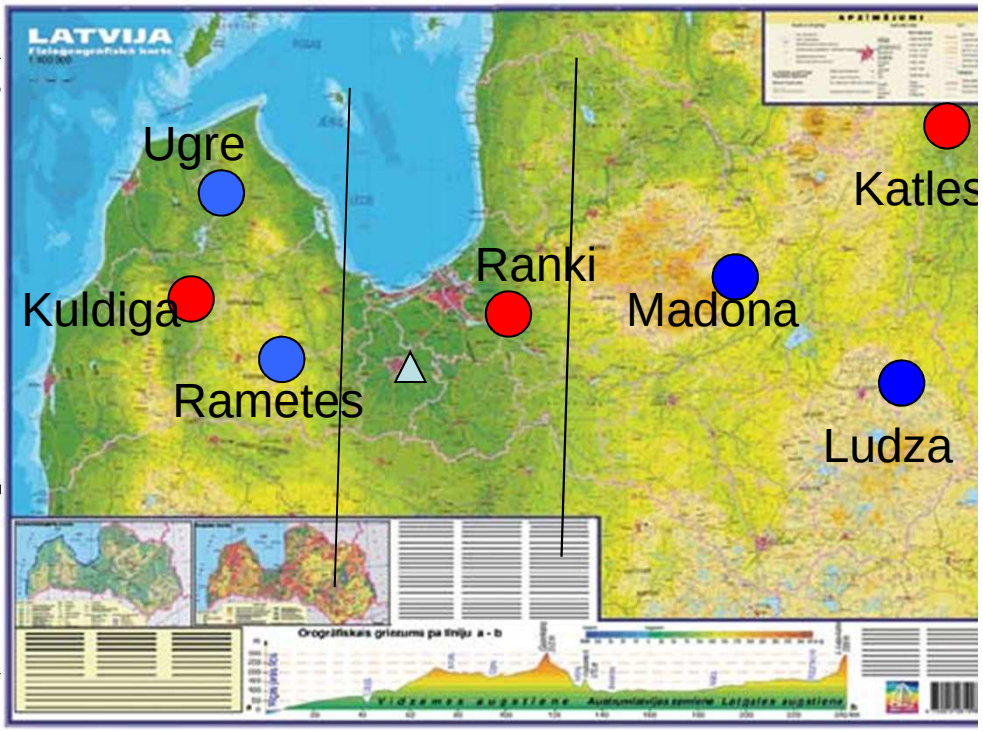

LATVIJA
Ugre
Katles
Ranki
Kuldiga
Madona
Rametes
Ludza

Final tree H

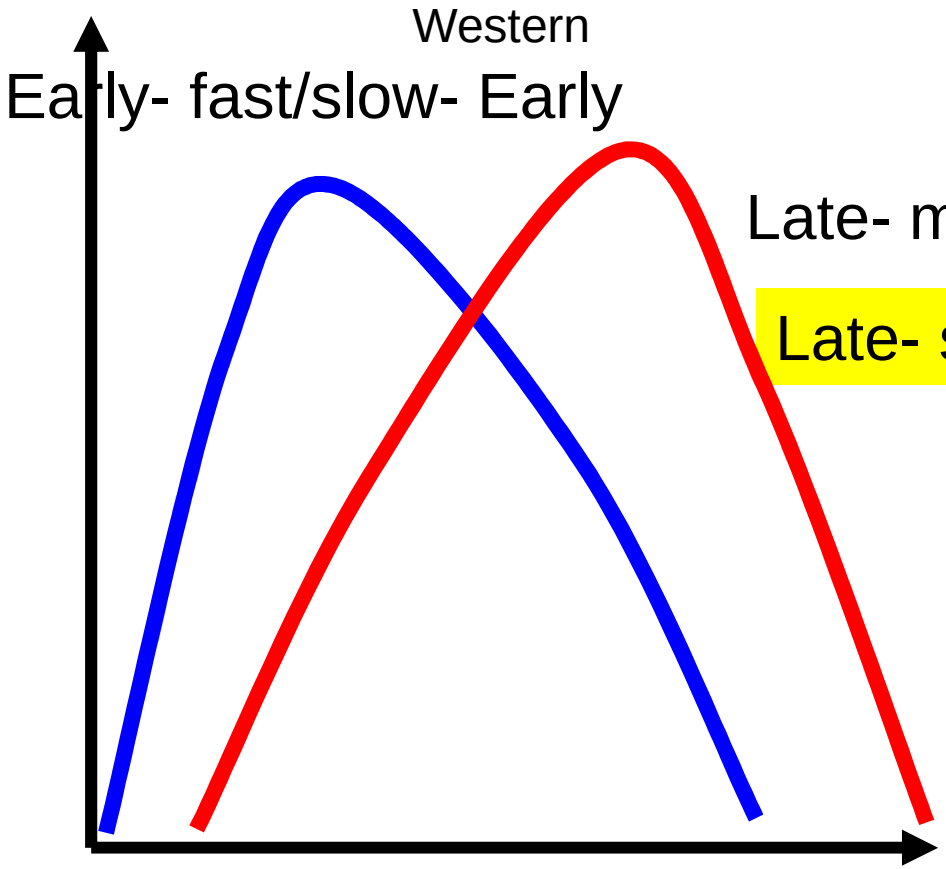


- Leader H = total H
- Effect of altitude after all?

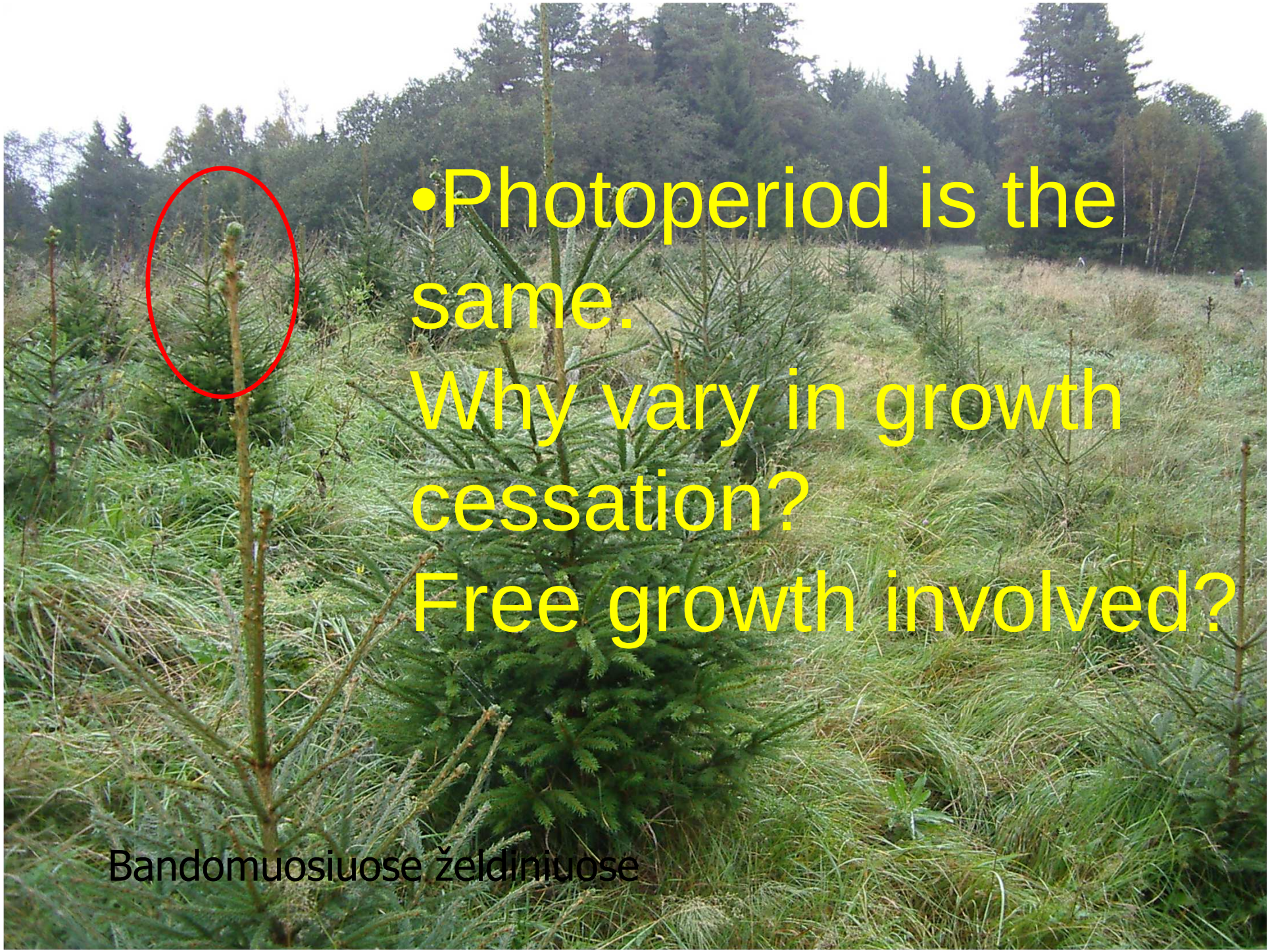




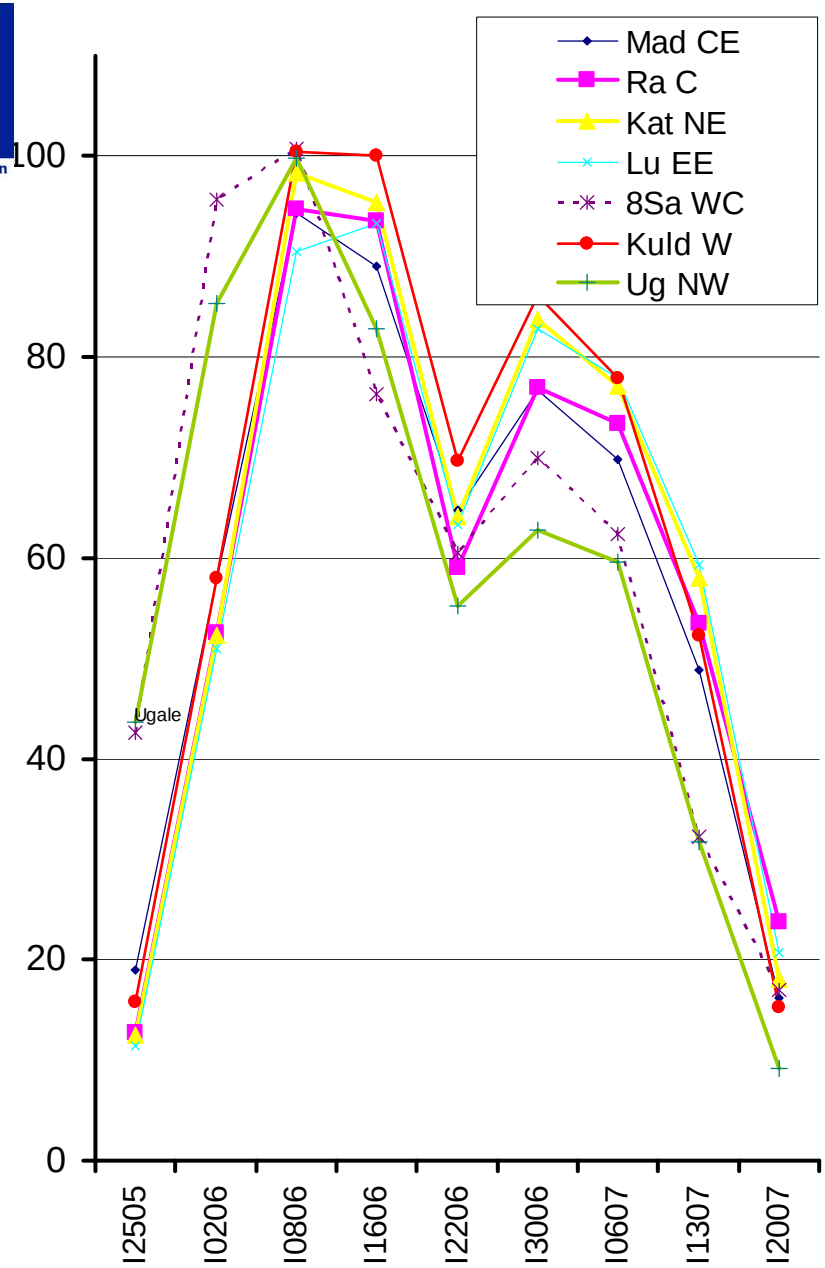
Summary



Late start and end; together with fast growth at the second half of GP are the features of success (Ranki)

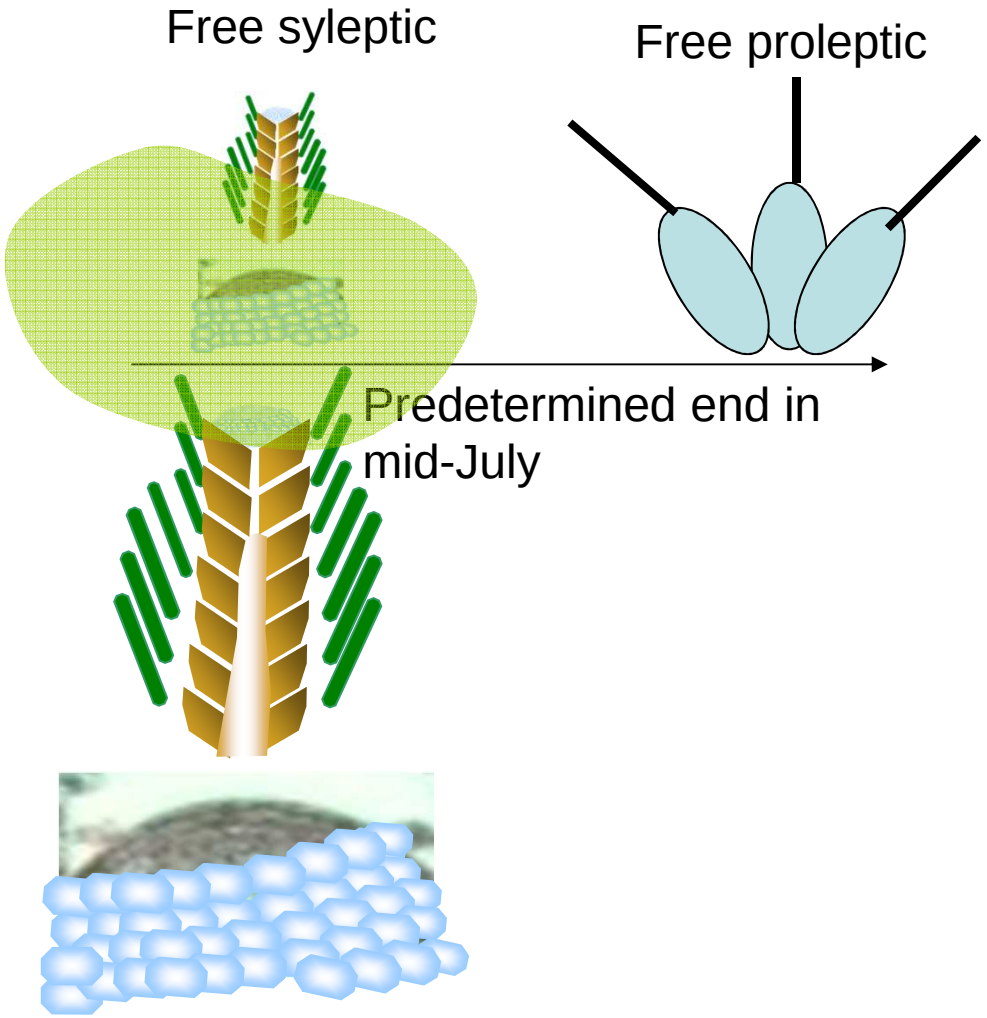

•Photoperiod is the same.
Why vary in growth cessation?
Free growth involved?
Bandomuosiuose želdiniuose

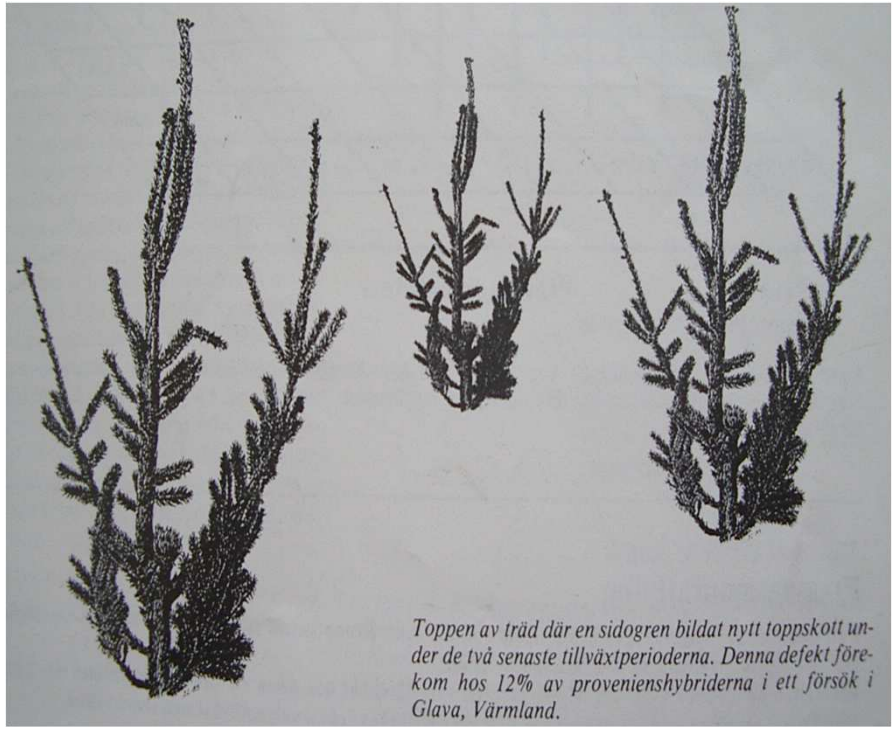
Funded by the European Union
INVESTMENT IN YOUR FUTURE



Early cessation = tendency for free growth

Shoot growth consists od predetermined and free (sylepctic /proleptic) growth

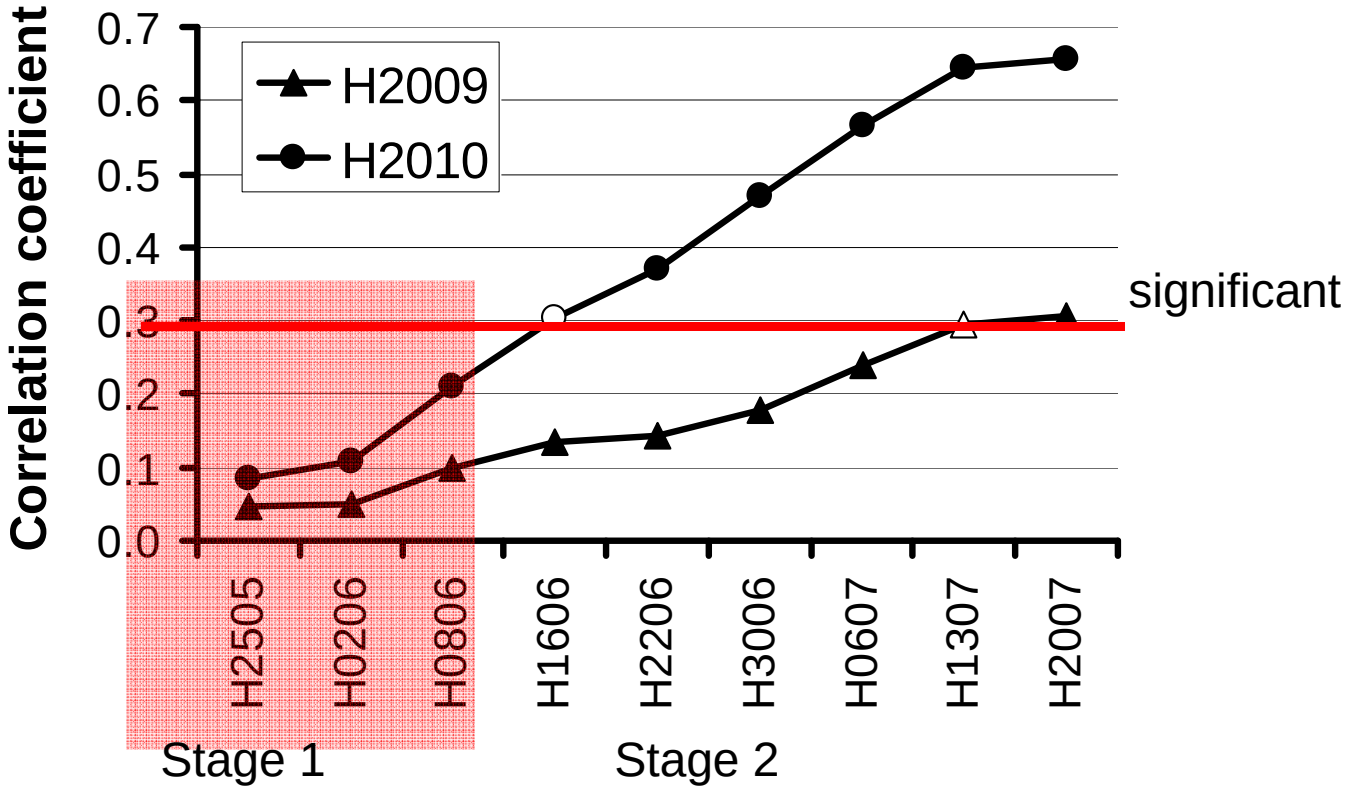




Funded by the European Union
INVESTMENT IN YOUR FUTURE

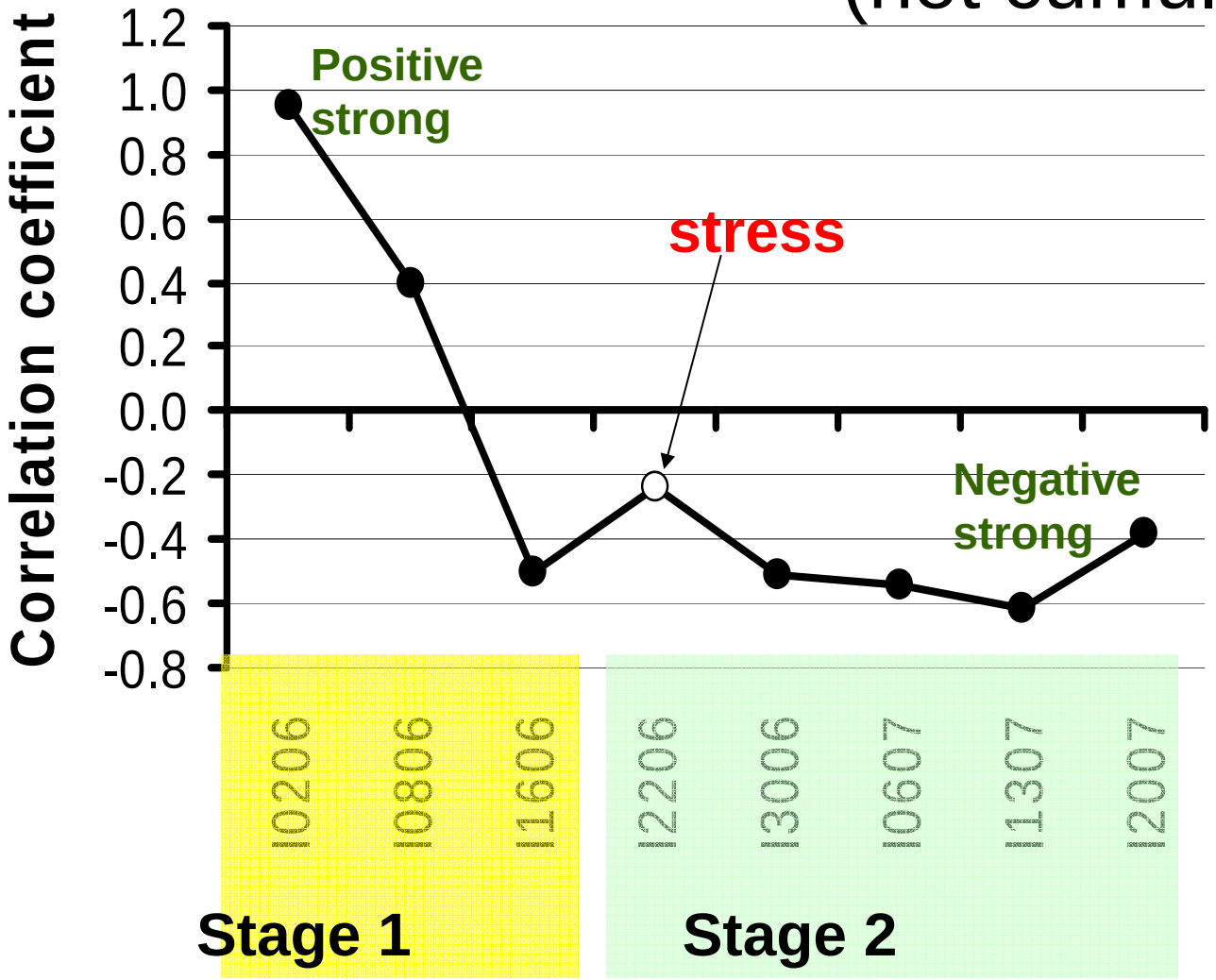
Correlations

- With what increments the Final H is correlated?
- Length of GP is more important than growth speed , because correlations tend to be significant at 2nd half of GP



Funded by the European Union
INVESTMENT IN YOUR FUTURE

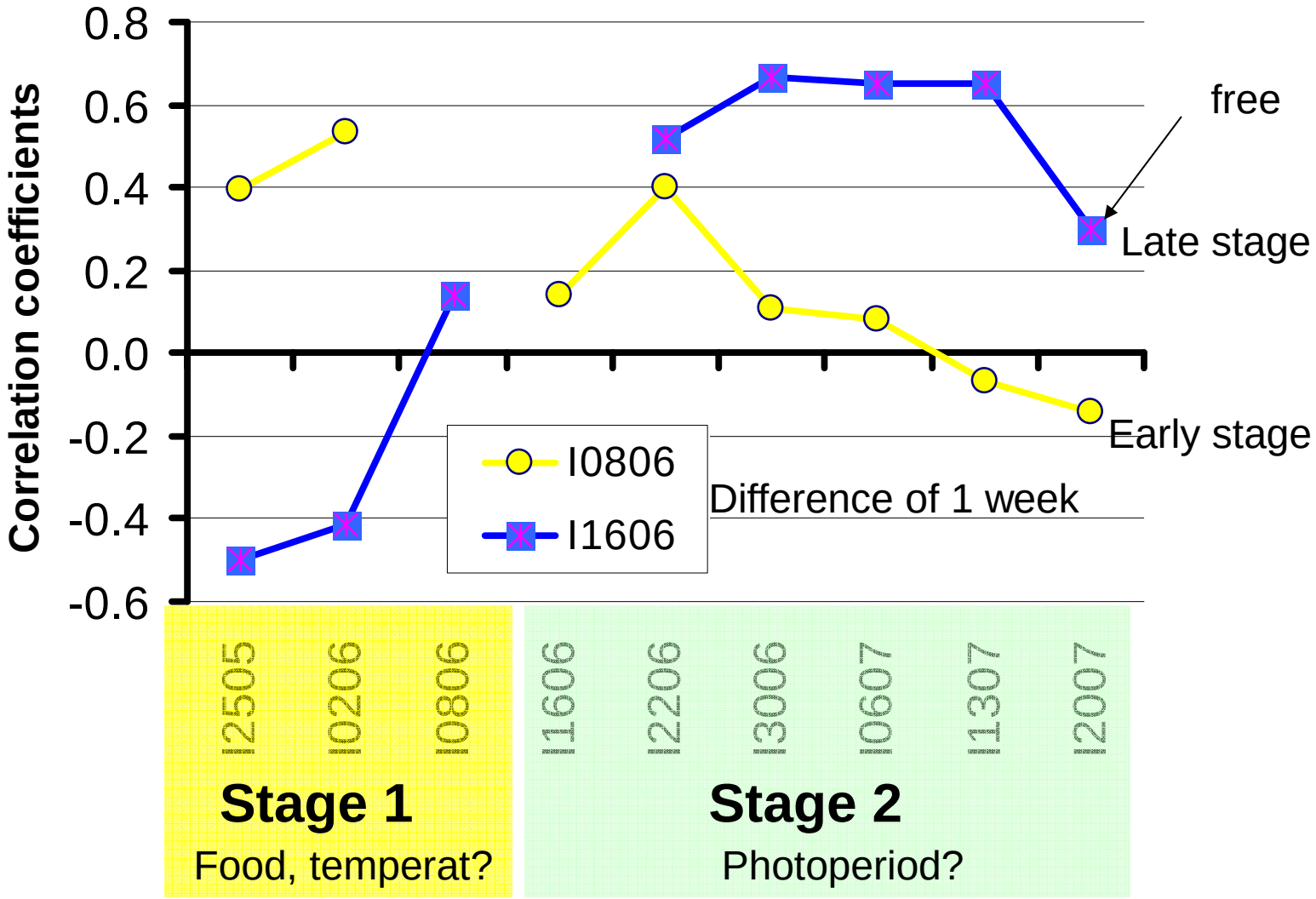
Corr between start and subsequent weekly increments (not cumulative)



- Early start means early cessation
- two uncorrelated growth stages:
- 1 stage of fast initial elongation negatively correlated with later stages of elongation

Funded by the European Union
INVESTMENT IN YOUR FUTURE

Corrs among weekly increments given for two adjacent dates reflecting different growth stages



Funded by the European Union

INVESTMENT IN YOUR FUTURE

Genetic parameters

Mixed model ANOVA

Cumulative increment

Variable	Source	DF	F	P>F
H2009	REG	2	**3.4**	0.03403
H2010	REG	2	**2.4**	0.08721
H2009	POP(REG)	4	**5.1**	0.00043
H2010	POP(REG)	4	**4.7**	0.00091
H2009	FAM(POP)	53	**2.9**	0.00001
H2010	FAM(POP)	53	**3.4**	0.00001
H2009	REP	4	**1.5**	0.18614
H2010	REP	4	**6.7**	0.00002

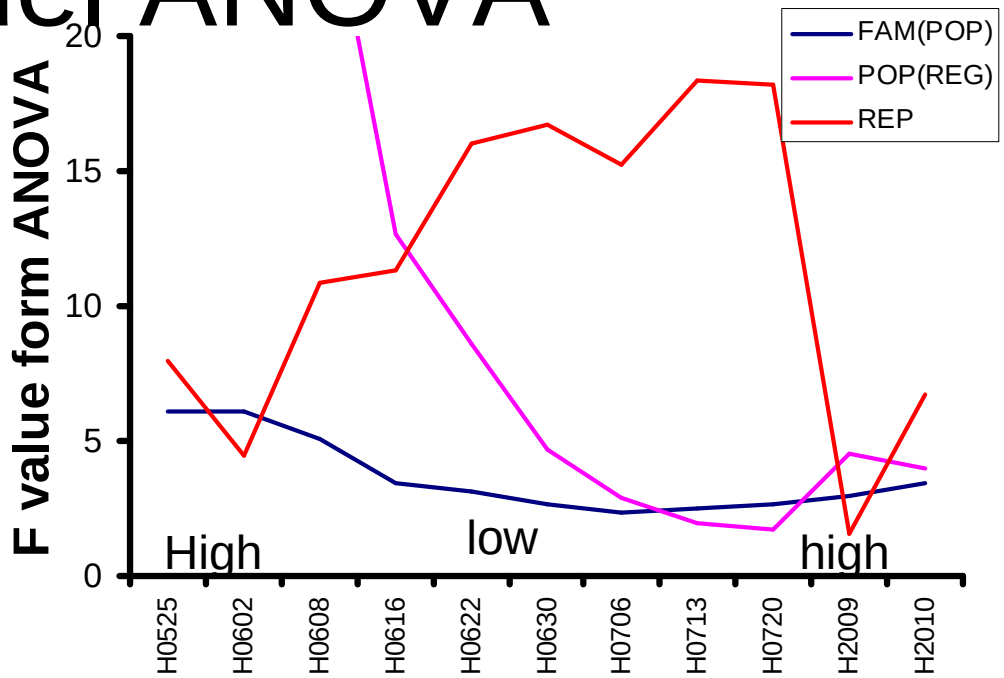
Tukey's Studentized Range (HSD) Test for variable: H0720

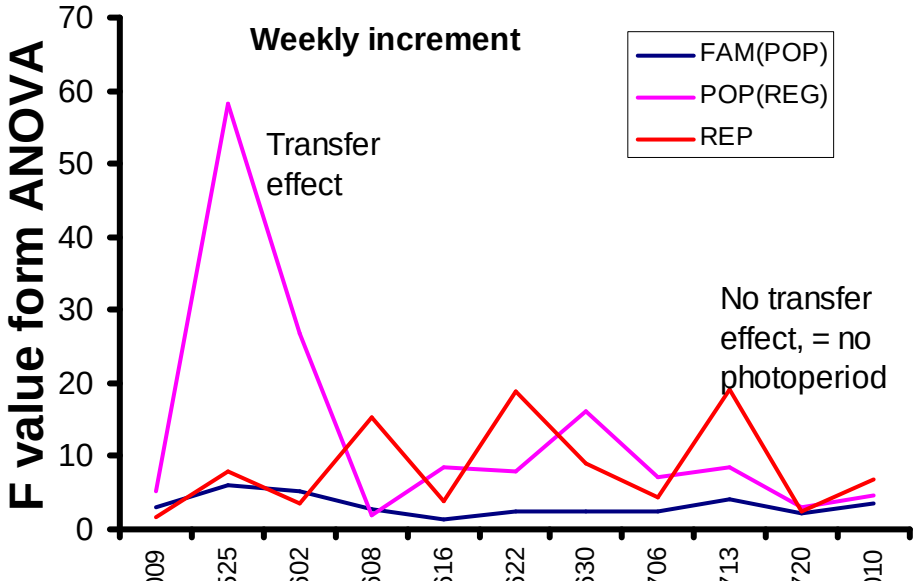
NOTE: This test controls the type I experimentwise error rat
but generally has a higher type II error rate than REG

Alpha= 0.05 df= 1209 MSE= 27479.16
Critical Value of Studentized Range= 3.864
Minimum Significant Difference= 64.969
WARNING: Cell sizes are not equal.
Harmonic Mean of cell sizes= 97.17531

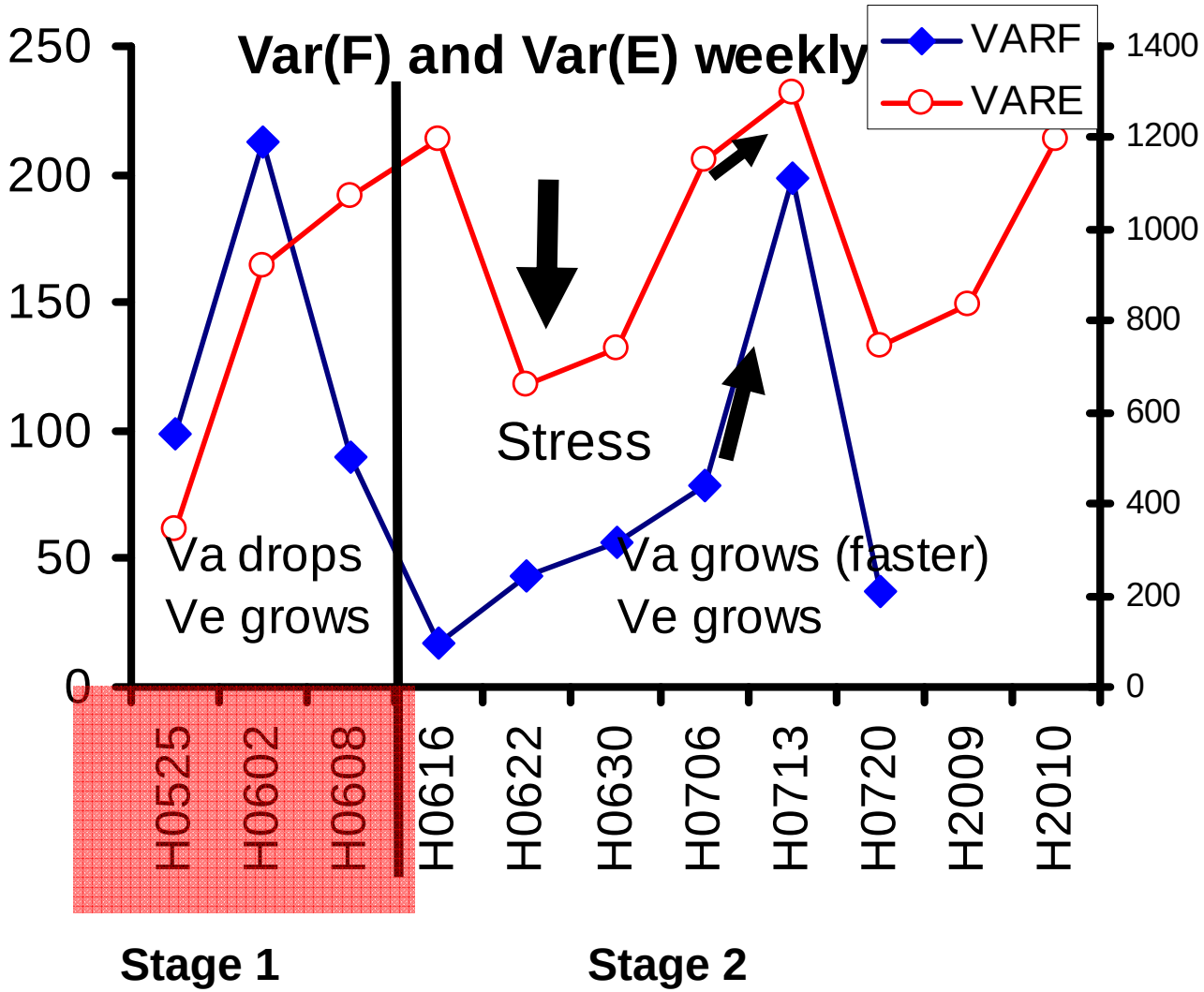
Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	REP
A	587.17	342	2
A			
A	582.52	346	1
A			
B A	548.53	295	3
B			
B C	499.73	26	5
C			
C	480.28	264	4



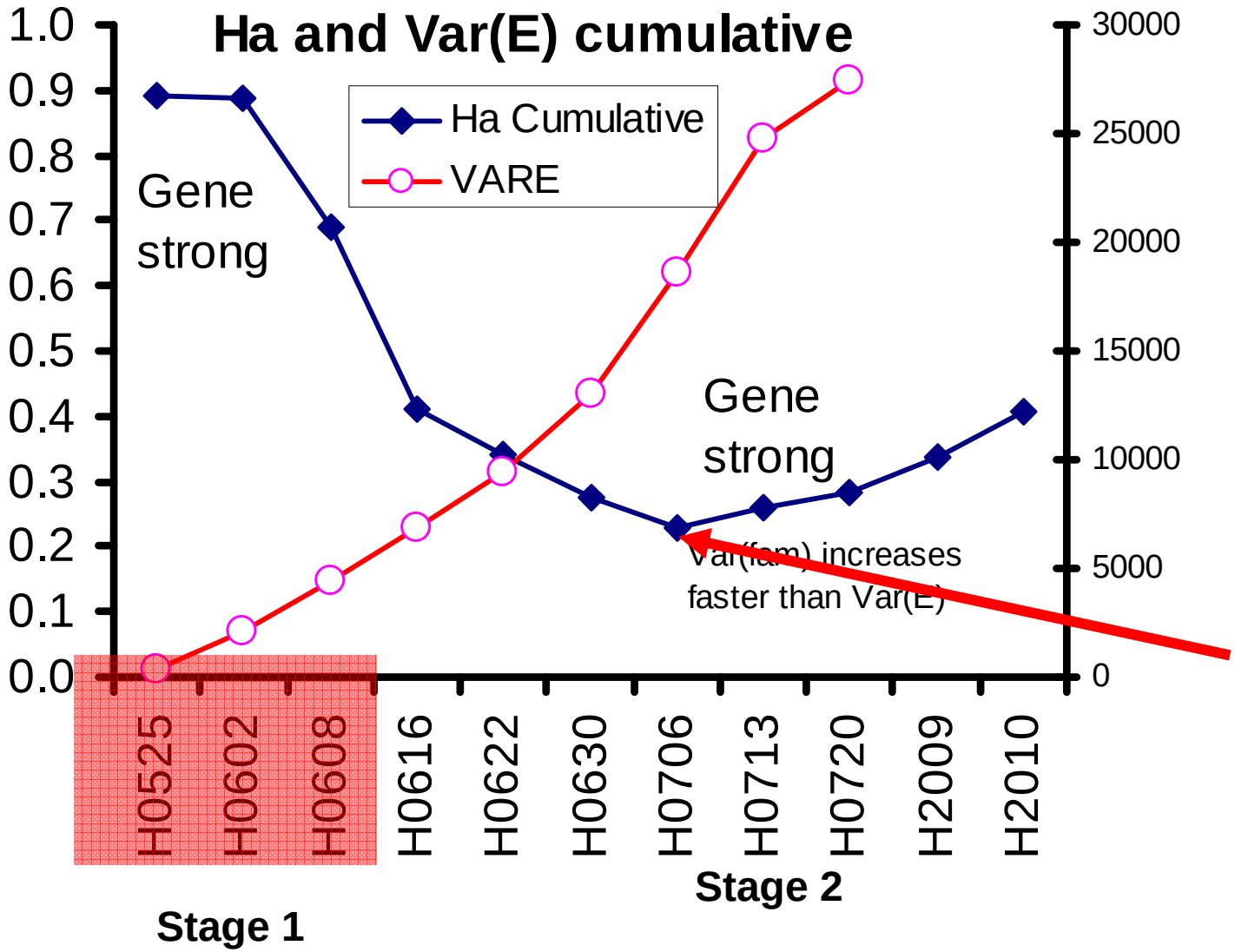


Heritability variation



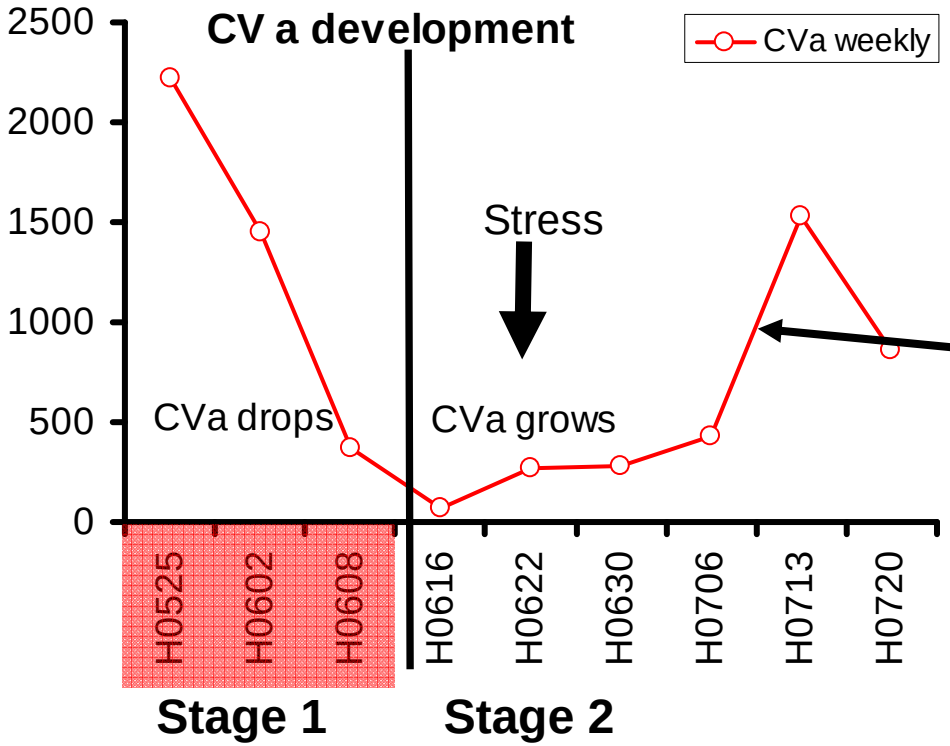
- Strong genetic control at start and end (= growth rhythm)
- Variances increase, but Va increases faster **?**
- Stress reduced Ve

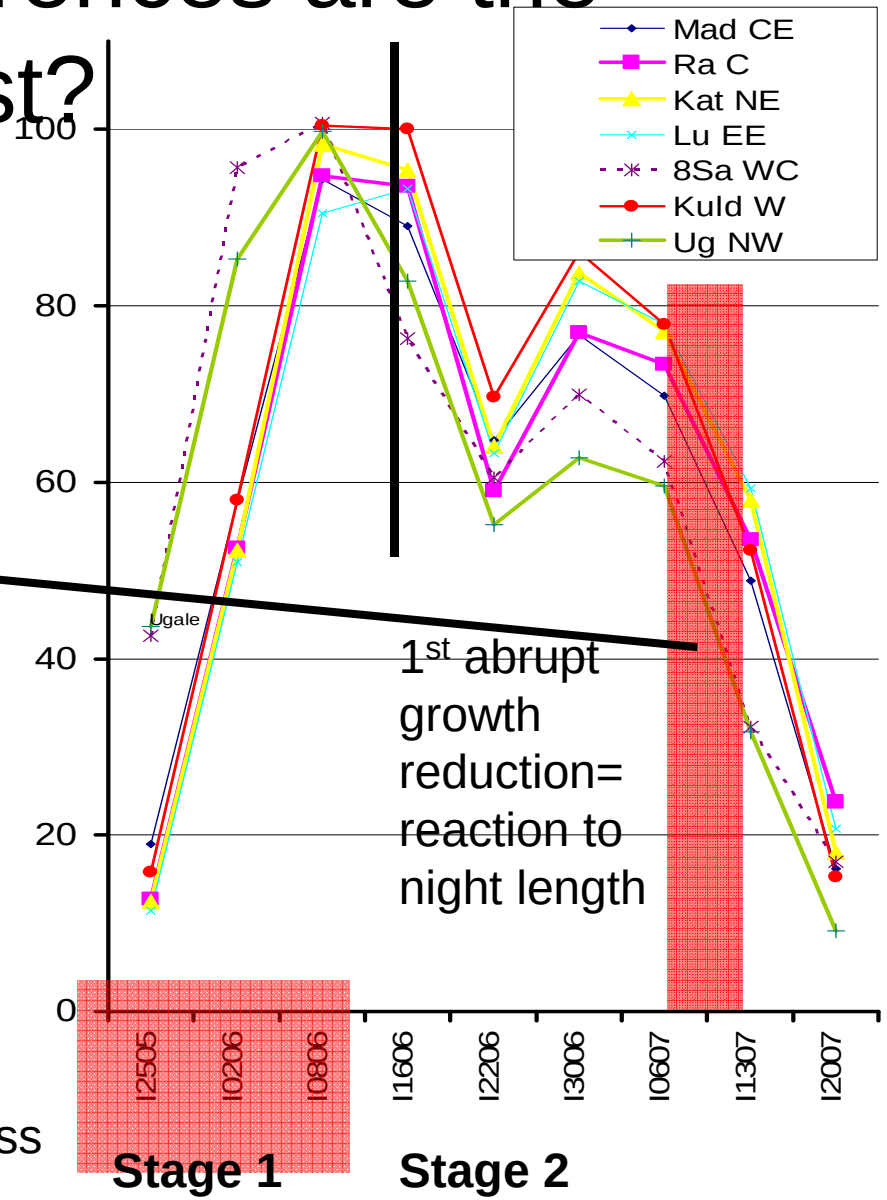
Heritability variation (cumulative)



- Strong photoperiodic response manifested in 6th of July

When genetic differences are the greatest?

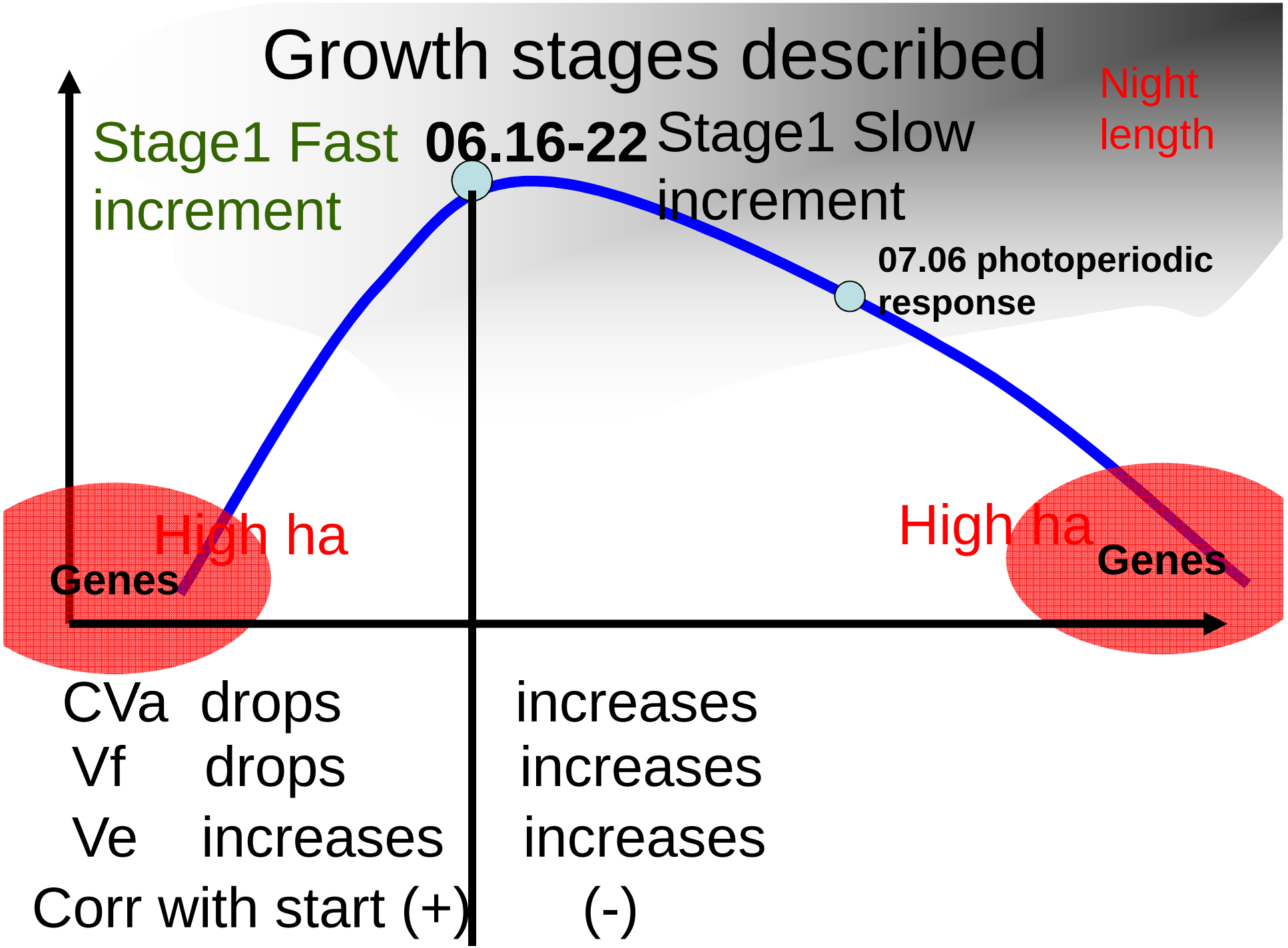




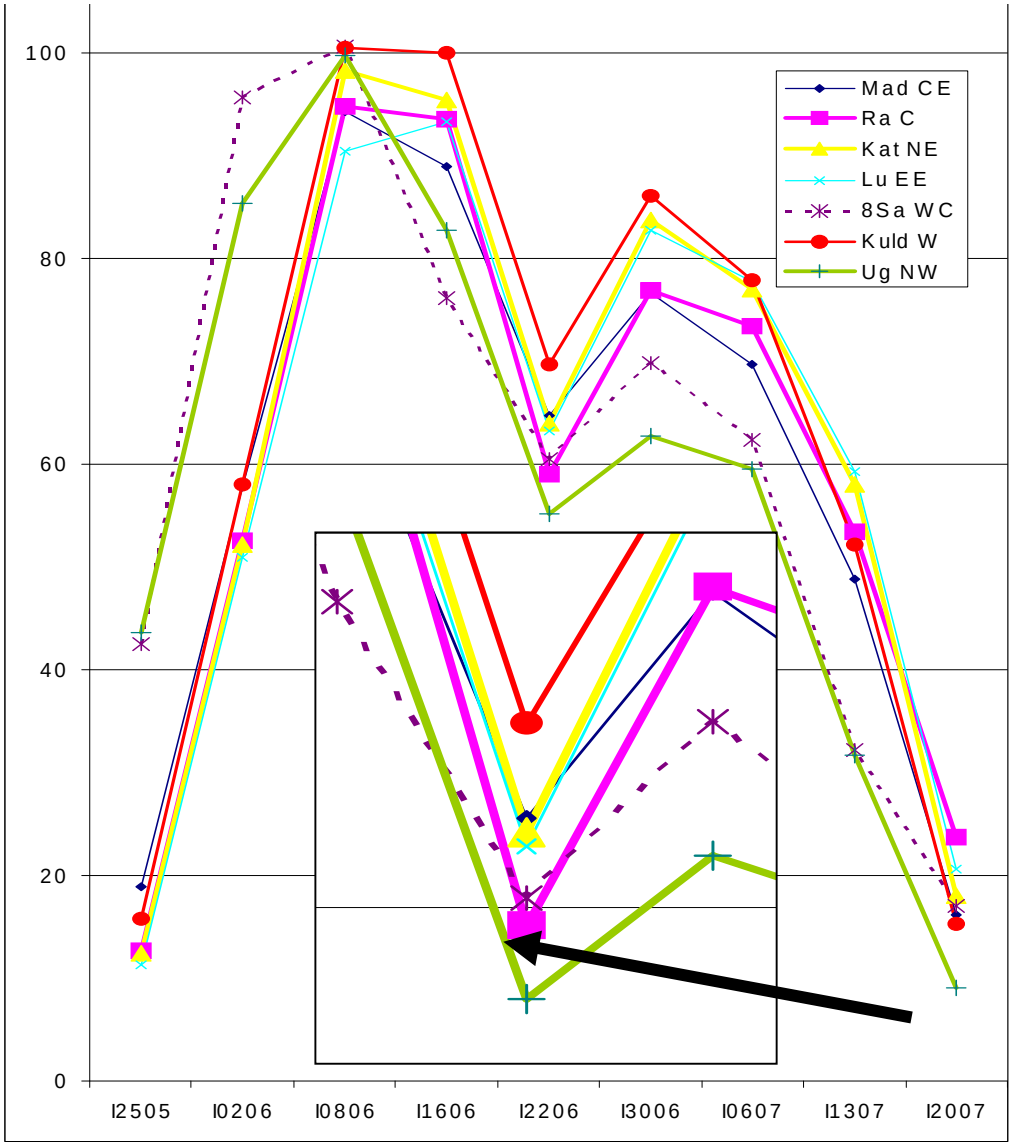
Gene differentiation increased at stage 2

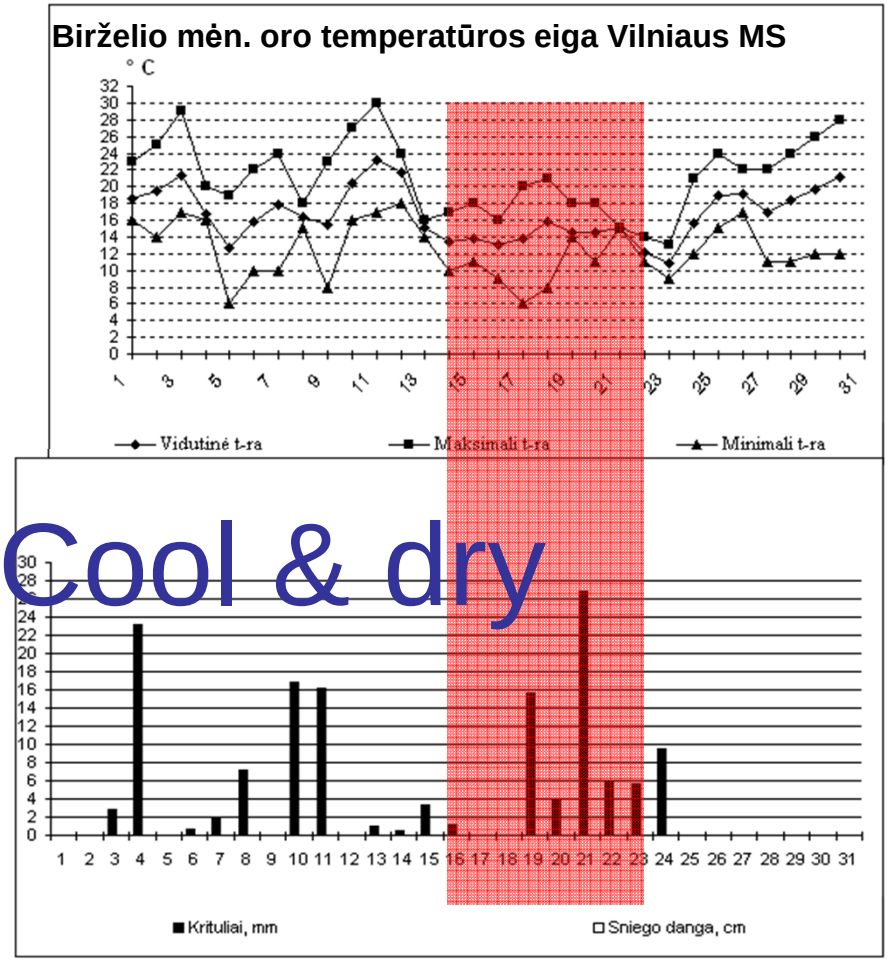
Gene differentiation slight increased at stress

Gene differentiation sharp increase at 1st slow


Growth stages described
Night length
Stage1 Fast increment
06.16-22
Stage1 Slow increment
07.06 photoperiodic response
High ha
Genes
High ha
Genes
CVa drops increases
Vf drops increases
Ve increases increases
Corr with start (+) (-)

Stress 16-22 June





Cool & dry

Worst for Ranki= the southern type

Funded by the European Union
INVESTMENT IN YOUR FUTURE

Conclusions

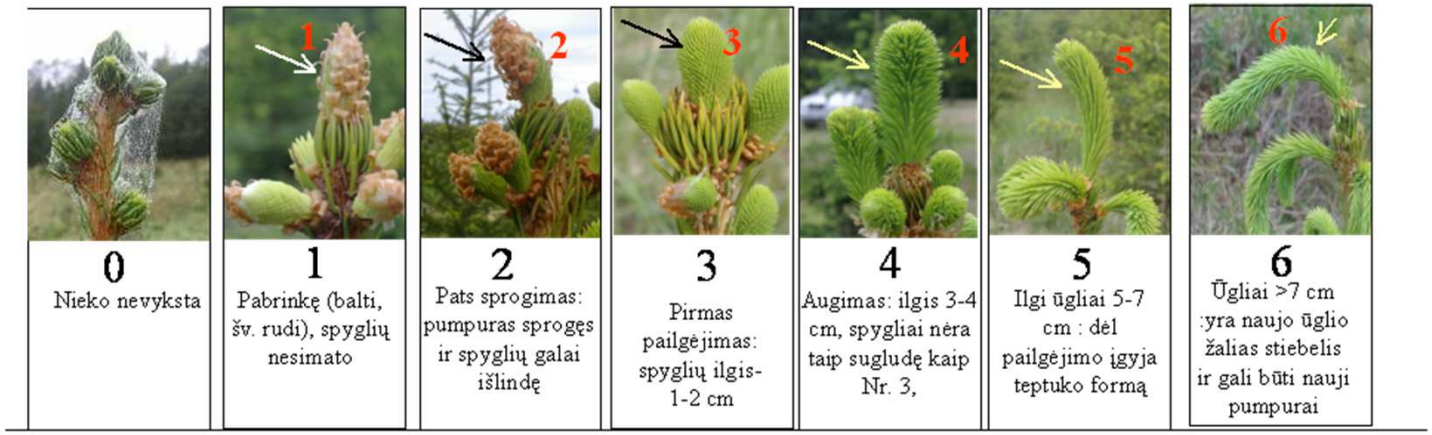
- Significant effect of altitude (may be 2 sub-zones)
- Population effect strong at start (tsum) but weak at cessation (photoperiod, free growth).
- Correlations: early start means early end.
- Ha and CVa lowest in the middle of GP.
- 2 growth stages:
  - fast growth, Ha, CVa drops, (-) corr with later stages
  - Slow growth: Ha, CVa increases (+) corr with later stages

Funded by the European Union

INVESTMENT IN YOUR FUTURE

The end

(vertinti viršūninį pumpurą ant viršūninio ūglio)



Kokybė

Study carried out in European Social Fund's Project "Importance of Genetic Factors in Formation of Forest Stands with High Adaptability and Qualitative Wood Properties" (No 2009/0200/1DP/1.1.1.2.0/09/APIA/VIAA/146)