Can we rely on nature's spontaneity in the light of climate change projections?

(an evolutionary ecological approach)

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Do we have the choice?

„Climate-triggered forest production decline is probable, but not observed yet" (IPCC 2007 report)

FAO Workshop Sopron, Hungary, 2010

„Climate Change impacts in Eastern Europe and Central Asia"

Opinions

- awareness of threats and readiness to take measures surprisingly uniform among foresters
- missing of concrete information about present impacts and expected response
- **proposed measure: increase naturalness of forests!**

How will trees respond

- Is available adaptive capacity sufficient?
- Do spontaneous processes function? (migration, evolution)
- **How much climatic (site) change is tolerated?**

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within a generation!

In forestry/conservation practice:

- **Which populations to plant, where?**
- **How to conserve, what?**

Is spontaneous adaptation/evolution possible?

Conservative answer: species and ecosystems are adapted to changes

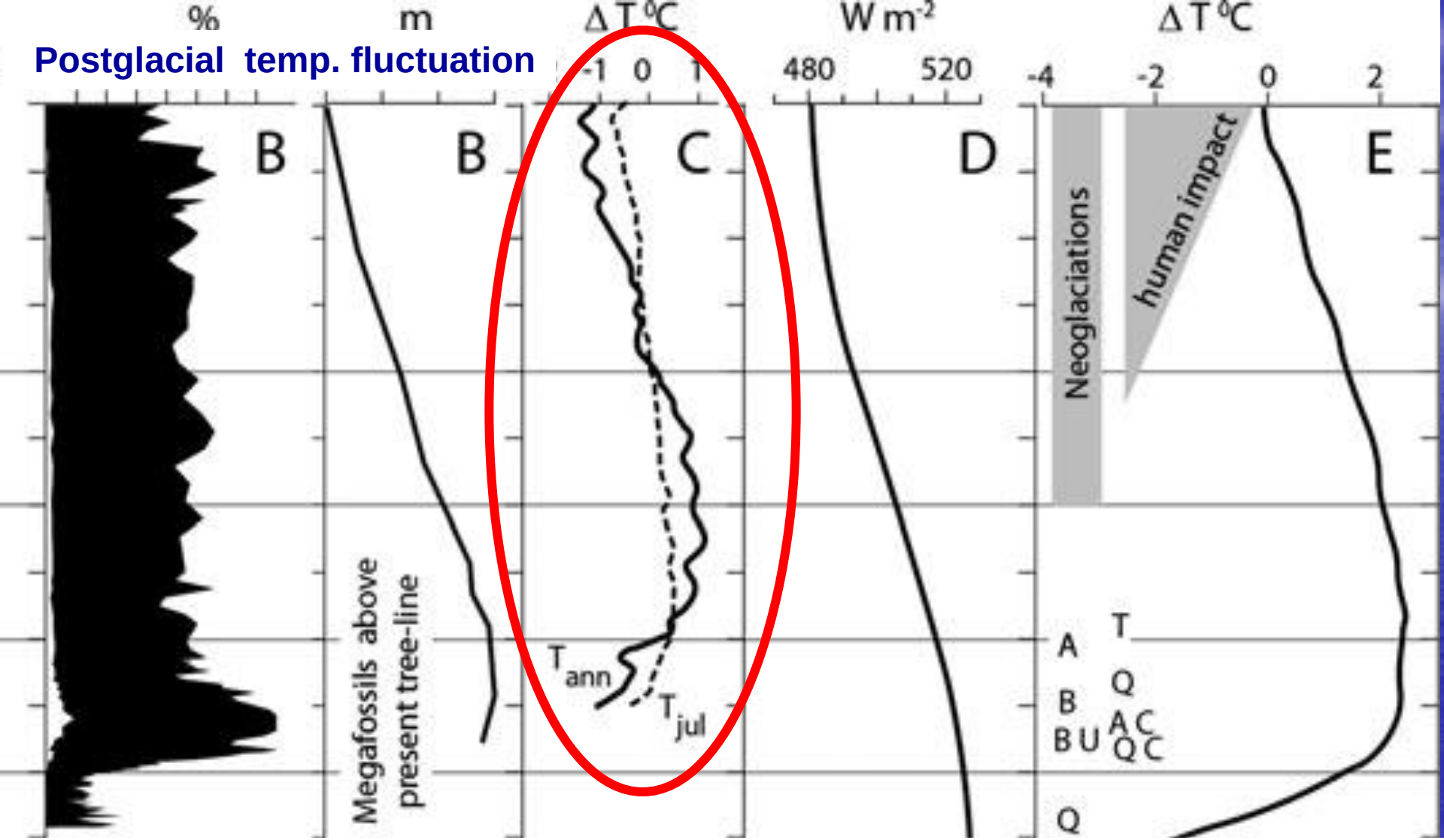
1. Evolutionary-genetic reasoning:

- Unique genetic system and diversity of trees may cope with changes,
- Plasticity of trees is high,
- Gene flow helps to exchange favorable genes across large distances
- Migration secures continuously adapted forest cover

2. Paleobotanical reasoning

- There were changes all the time,
- They were followed by plant and animal communities,
- Compared to the past, projected changes are not particularly large

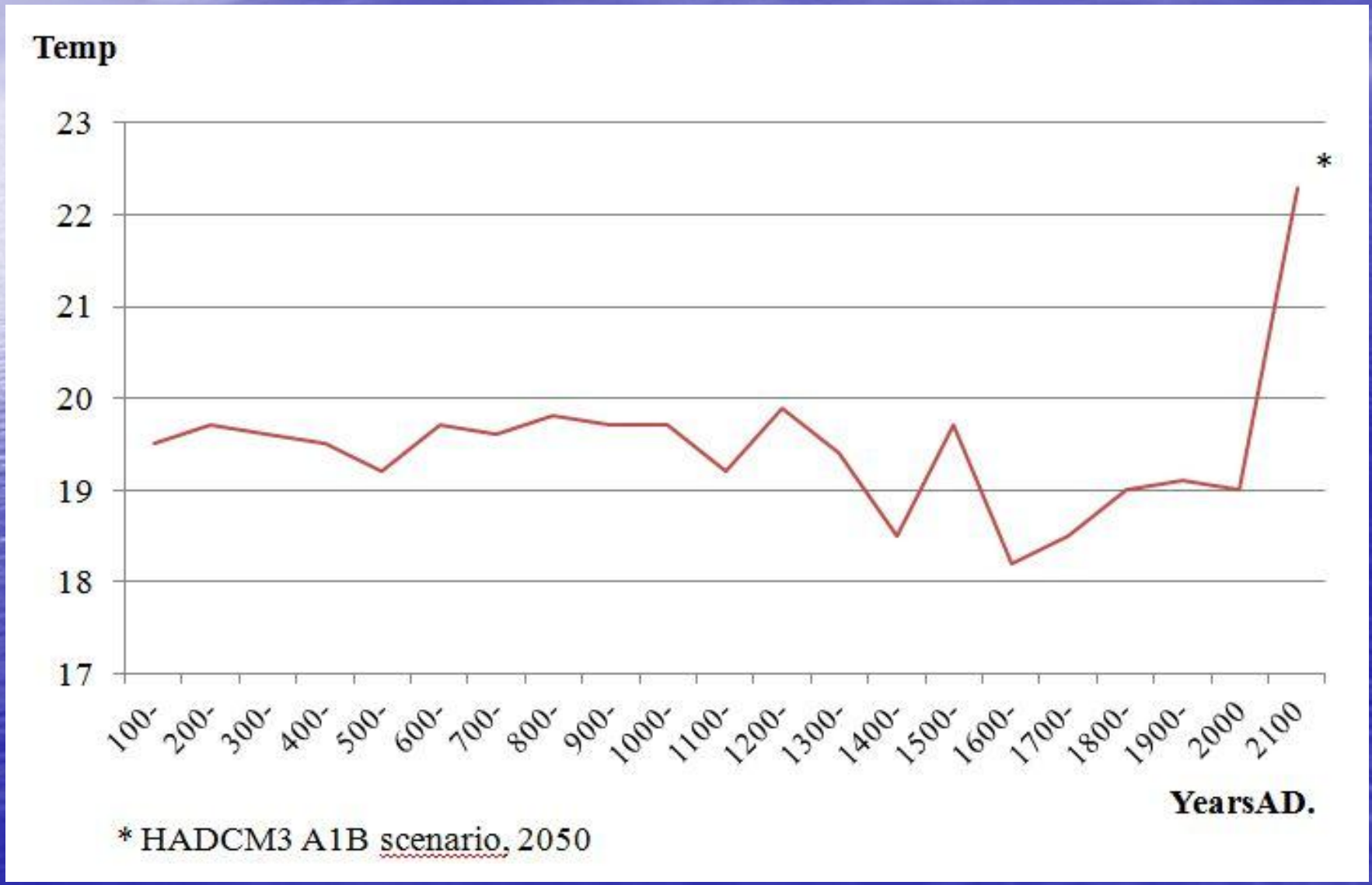
It is better to rely on nature, as human interference is only worsening the situation



Estimates of annual and July temperatures in Fennoscandia in the last 10 thousand years expressed as deviations from the present mean

(Seppä et al. 2009, in: Aage Paus, 2012, Veget. Hist. Archaeobotany).

Centennial means of midsummer temperature 100 - 2100 A.D. for Hungary (Sümegi et al. 2009)



How serious are projected changes compared to postglacial changes?

Fluctuation of annual average temperatures (deviations from the grand mean, °C)

Last 100 thousand years (global ann. average)	-8 / +2
Last 1000 years (ann. average, Europe)	-0,8 / +0,8
Projected for the 21. century	+2 ~ +4...

Is spontaneous migration a realistic expectation?

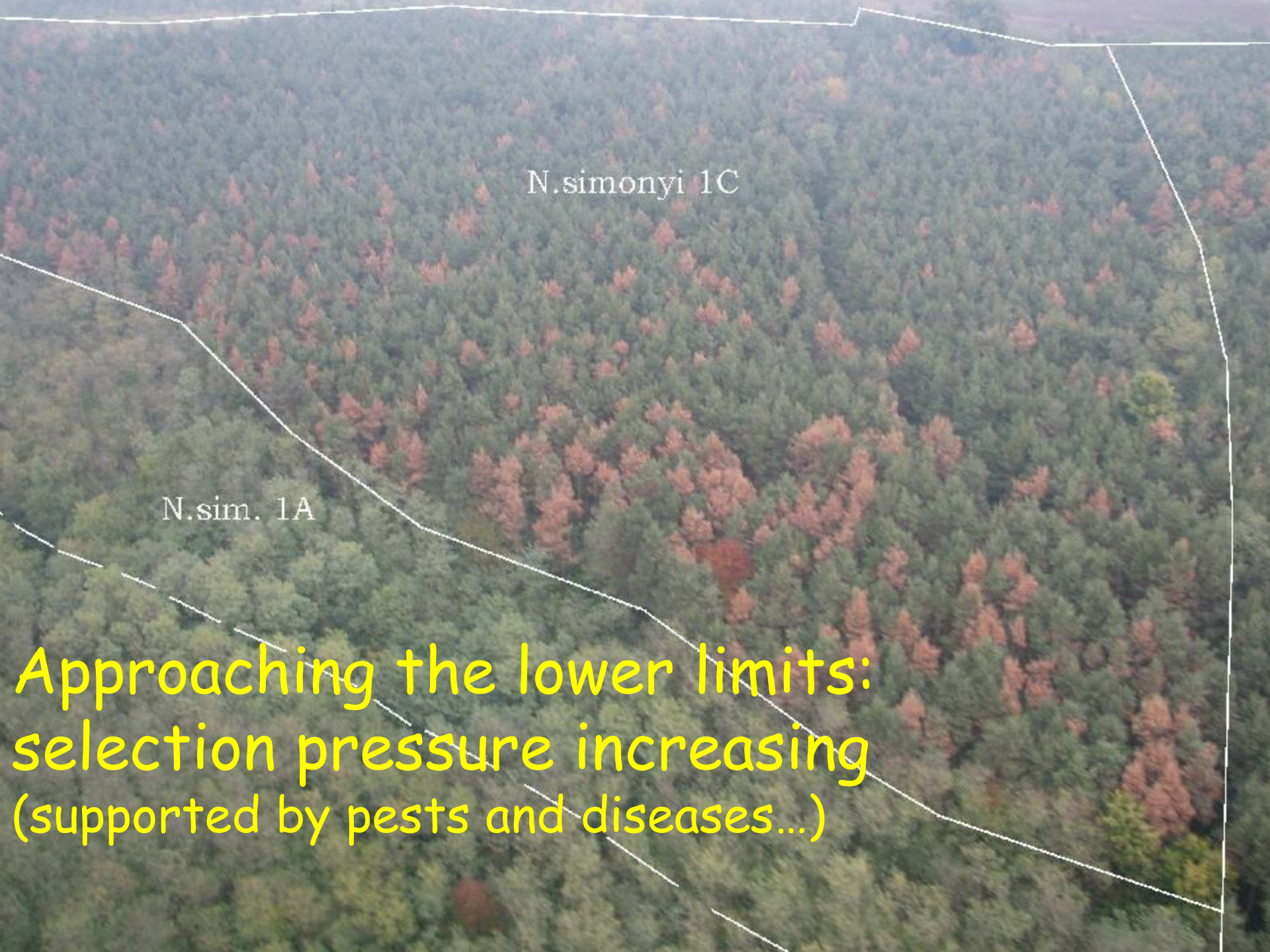
Velocities (km/century) of postglacial migration vs. projected S→N isotherm-shift

Beech (Davis-Shaw 2001)	20-30
Oaks (Davis-Shaw 2001)	7,5-50
Spruce (Davis-Shaw 2001)	8-50
Isotherm shift speed, 2.0 °C temp. increase	290 (= 600 years!)
Isotherm shift speed, 4.0 °C temp. increase	580 (= 1150 years!)

(Jump, Mátyás, Penuelas 2009, Mátyás, 2002)

Unlimited adaptation?

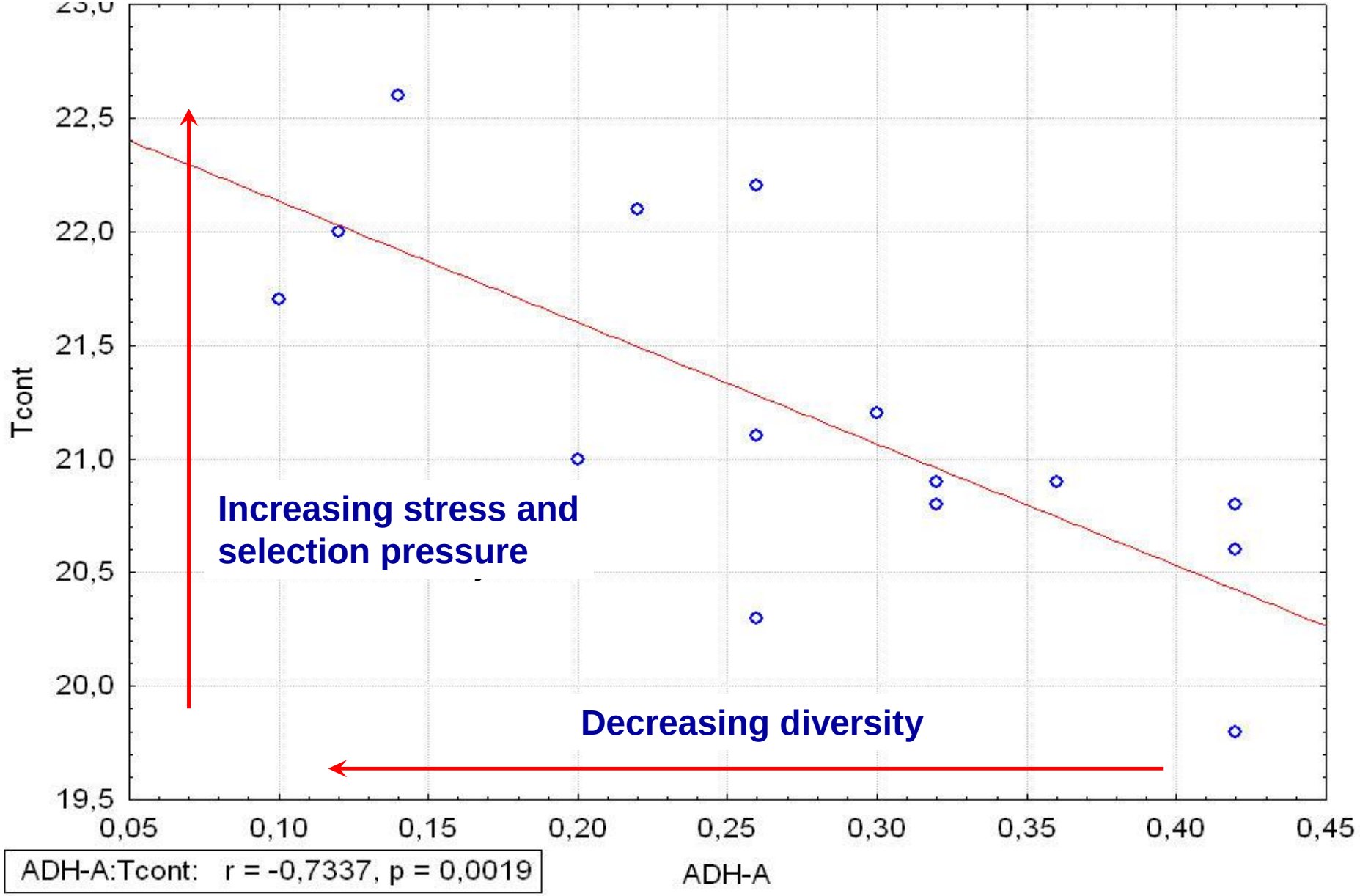
- Temporal limit: theoretically, 100 years
  → one generation
- Uncertainty limit: single extreme event/calamity
- Genetic limit: current genetic heritage (tradeoffs between growth cycle, metabolism, resistance, competitiveness)
- Field validation: clear thresholds
  - *limit of available genetic resources (variation)*
  - *unexpected plasticity*
  - *species limitation at „xeric limit"*



Approaching the lower limits: selection pressure increasing

(supported by pests and diseases…)

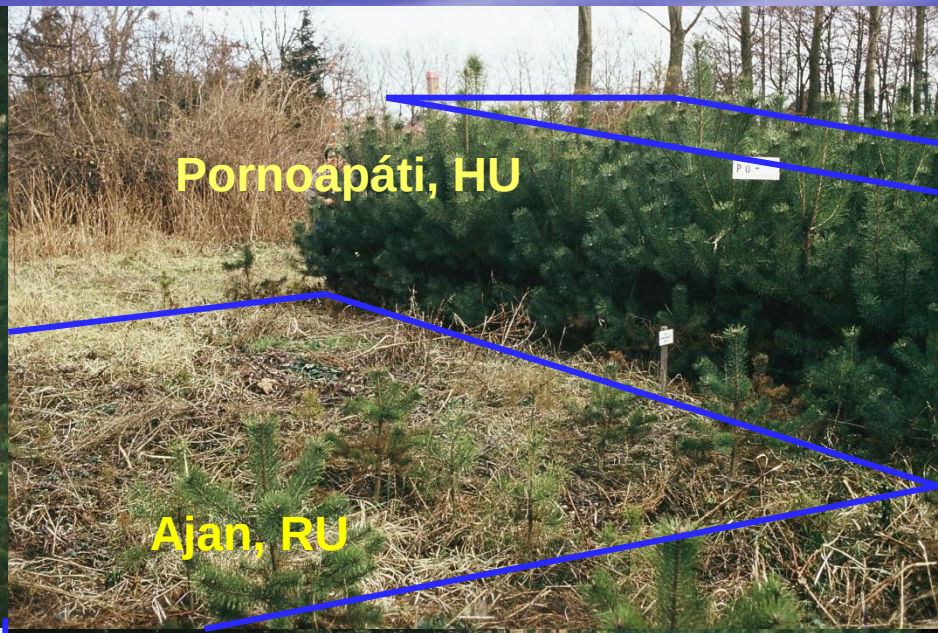
Effect of strong climatic selection on genetic diversity (ped. oak, Borovics, unpubl.)

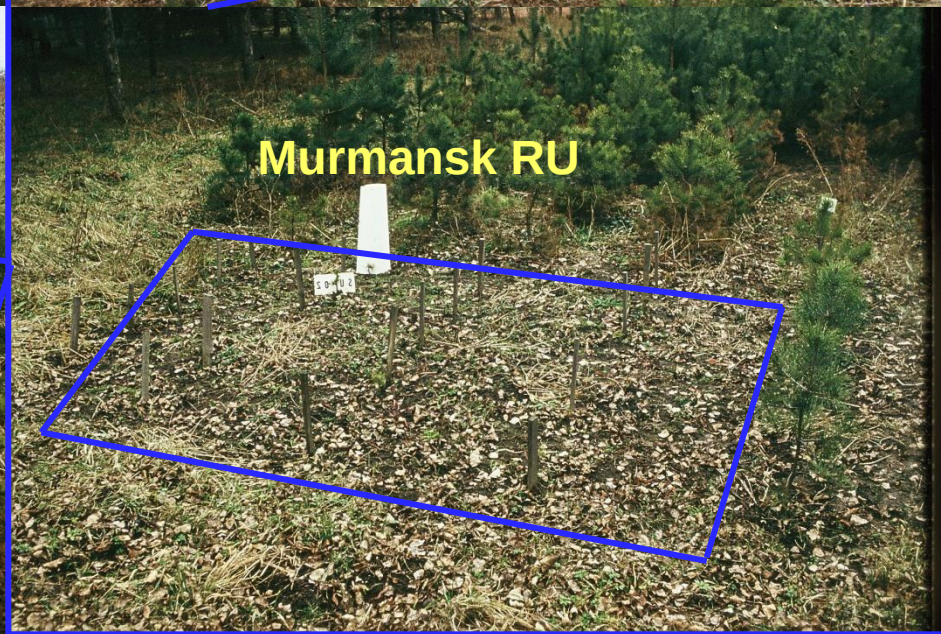


Observed heterozigosity at locus ADH-A vs. continentality (Tmax-Tmin)

Vitality depends on available adaptive variation!

Scots pine demonstration test Arboretum Kámon,Hungary






Nothing of adaptivity left…
Beech provenance test, age 15, Bucsuta, HU
Torup, DK


Beech provenance test, age 15, Bucsuta, HU
Farchau, D


Dendroctonus calamity on P. contorta
Lake Bonaparte, British Columbia

Conclusions 1

Relevance of genetic processes

- **Migration**: diploid (seed) irrelevant
  haploid (pollen) limited role
- **Mutation**: irrelevant
- **Selection**: effective in medium extreme cond.
  (insects and pests inclusive)

Often forgotten:

- **Acclimation potential: plasticity!**
  Important actor in trees!
- **Epigenetics**: probably effective
  (on northern/forward limits?)
- **Human interference in genetic adaptability**
  Forestry: FRM deployment!

Conclusions 2
Spontaneity and adaptive vulnerability

- compared to past millennia, climate shifts in this century are **unprecedented** on geological/evolutionary scale;
- changes will happen **within one tree generation time**;
- spontaneous processes, **evolutionary potential** are limited;
- spontaneity is inhibited also by **human resource use**
- **impacts** strongest at low elevation flat lands;
- **Human interference unavoidable in exposed regions → human-aided migration**

Urgent tasks

- Principles of evolutionary ecology should become part of forest management and gene conservation strategy
- Linking basic and empirical research about plasticity and phenotypic response: retrospective evaluation of field trials, establishment of well designed new field trials aiming at limits
- Approach of nature conservation to be dynamised
- Communication to professionals and the public is essential