Biodiversity at gene level in Pinus nigra range wide and in the Troodos Mountain of Cyprus: a bibliographic synthesis

Bruno Fady

Biodiversity at gene level in Pinus nigra *range-wide and in the Troodos Mountains of Cyprus: a bibliographic synthesis*

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EXPERTS WORKSHOP ON
THE CONSERVATION OF BLACK PINE HABITAT IN CYPRUS
October 29-31, 2007, Cyprus

EU – LIFE-NAT PROJECT
'CONSERVATION MANAGEMENT IN NATURA 2000 SITES OF CYPRUS'
(Action E5 - LIFE04NAT/CY/000013 Project)

Distribution of Pinus nigra *range-wide*

A collective species with many marginal populations

This distribution map was compiled by members of the EUFORGEN Conifers Network
and was published in: Isajev, V., B. Fady, H. Semerci and V. Andonovski. 2004. EUFORGEN Technical Guidelines for genetic conservation and use of European black pine (Pinus nigra). International Plant Genetic Resources Institute, Rome, Italy. 6 pages

http://www.bioversityinternational.org/networks/euforgen/

35 member countries. National coordinator for Cyprus: M. Andreas Christou

Maps regularly updated from voluntary contributions

EUFORGEN

The genetic (bio)diversity of Pinus nigra *range-wide*

What do we know about the "neutral" genetic diversity of* Pinus nigra *?
Surprisingly little for such a wide ranging species!

"Cab abstracts" search from 1973 to 2007:
Less than 20 relevant references
2 references related to adaptive traits and experimental tests

Most of them regional (e. g. Spain, Crimea, Bulgaria, Anatolia, etc)
and/or
Very few populations tested
and/or
Very few markers or loci tested

One genetic diversity reference includes Cyprus

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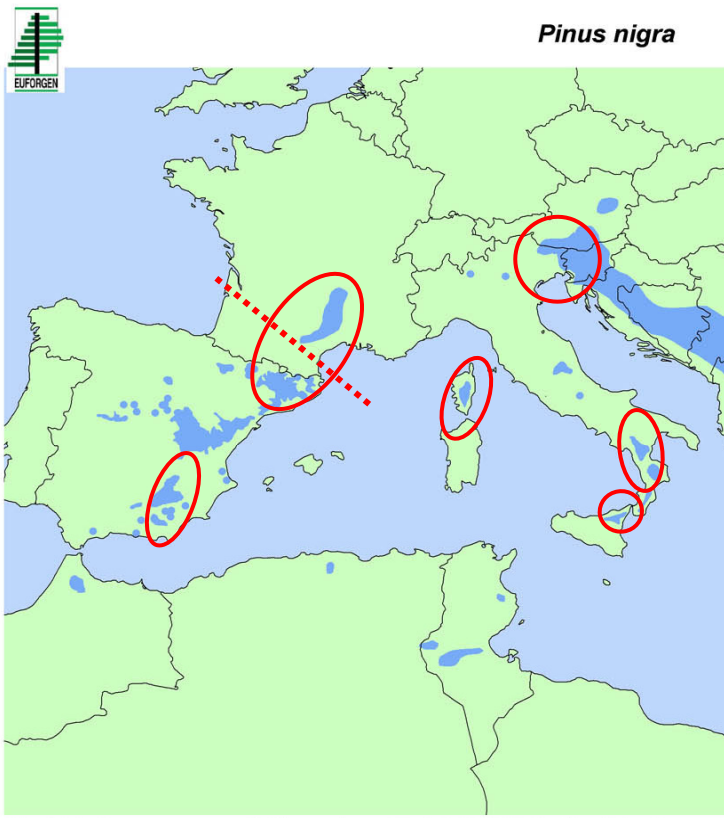
Genetic diversity of Pinus nigra *(western range)*



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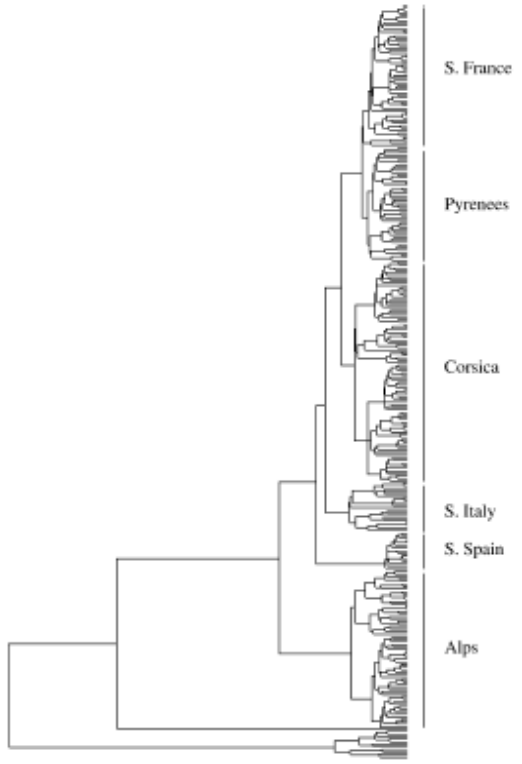

Fig. 2 Unrooted chloroplast microsatellite genealogical tree based on a coalescent model with population splitting (Wilson *et al.* 2003) performed using BATWING version 1.03. See text for parameter settings. Vertical bars at right identify major clades that include at least 65% of individuals from the named geographical regions.

Afzal-Rafii & Dodd, Mol. Ecol. 2007

17 western European populations (with gaps), 6 main regions.
10 cpSSRs

High Haplotype diversity: 0.93 – 1.00

- ***Populations isolated before the Holocene : at the onset of the last glaciation or at LGM (----). Local and regional originality.***
- ***Same for Cyprus?***

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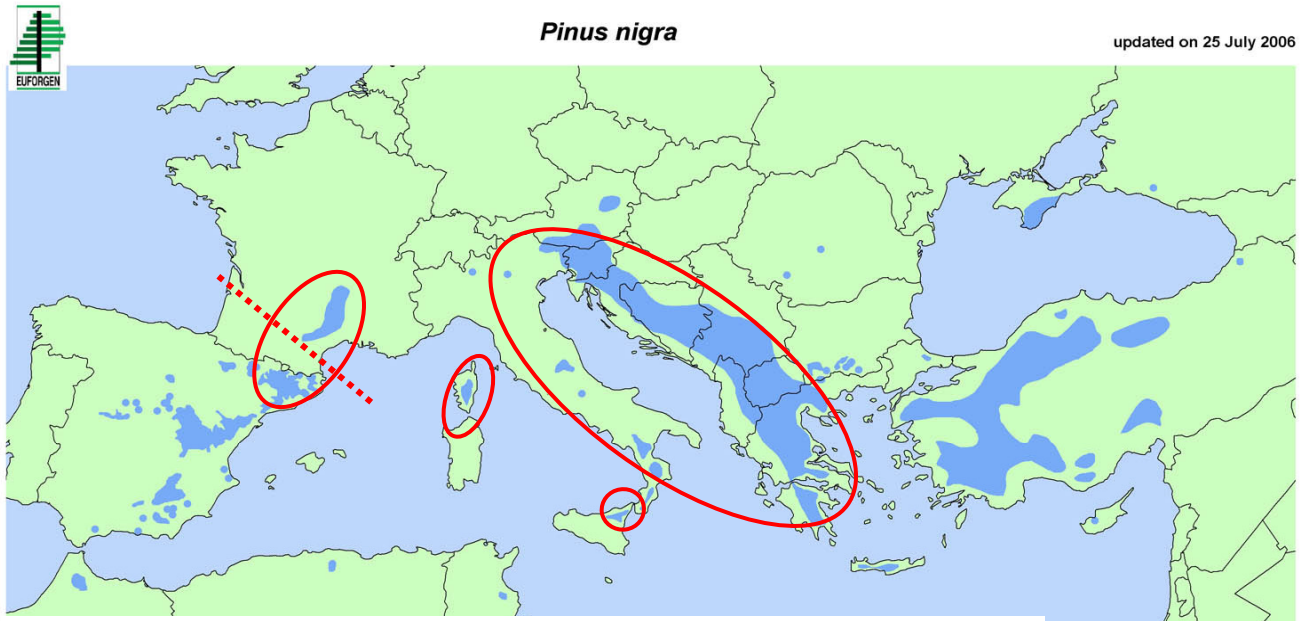
Genetic diversity of Pinus nigra *(central range)*



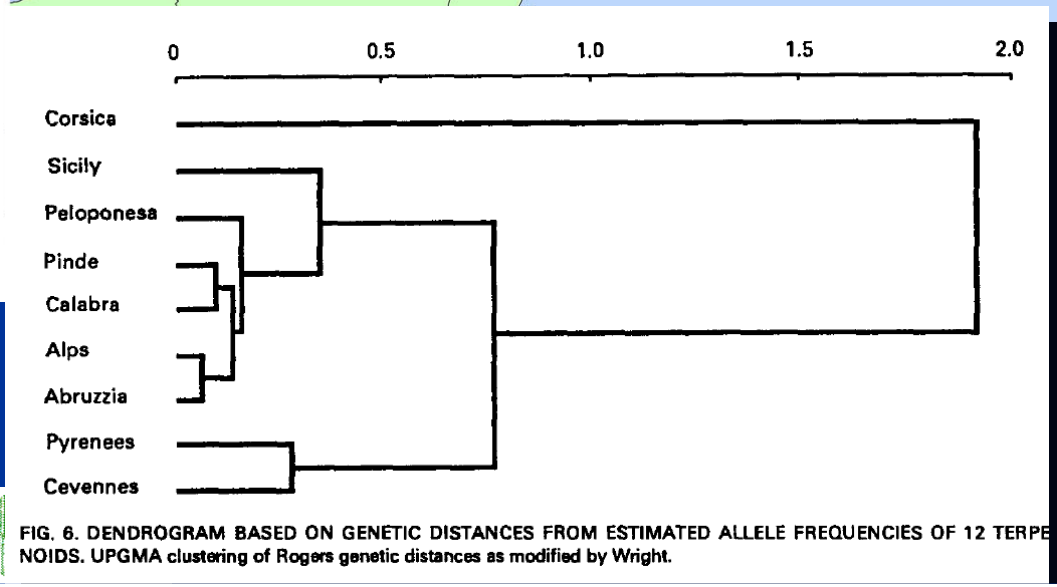


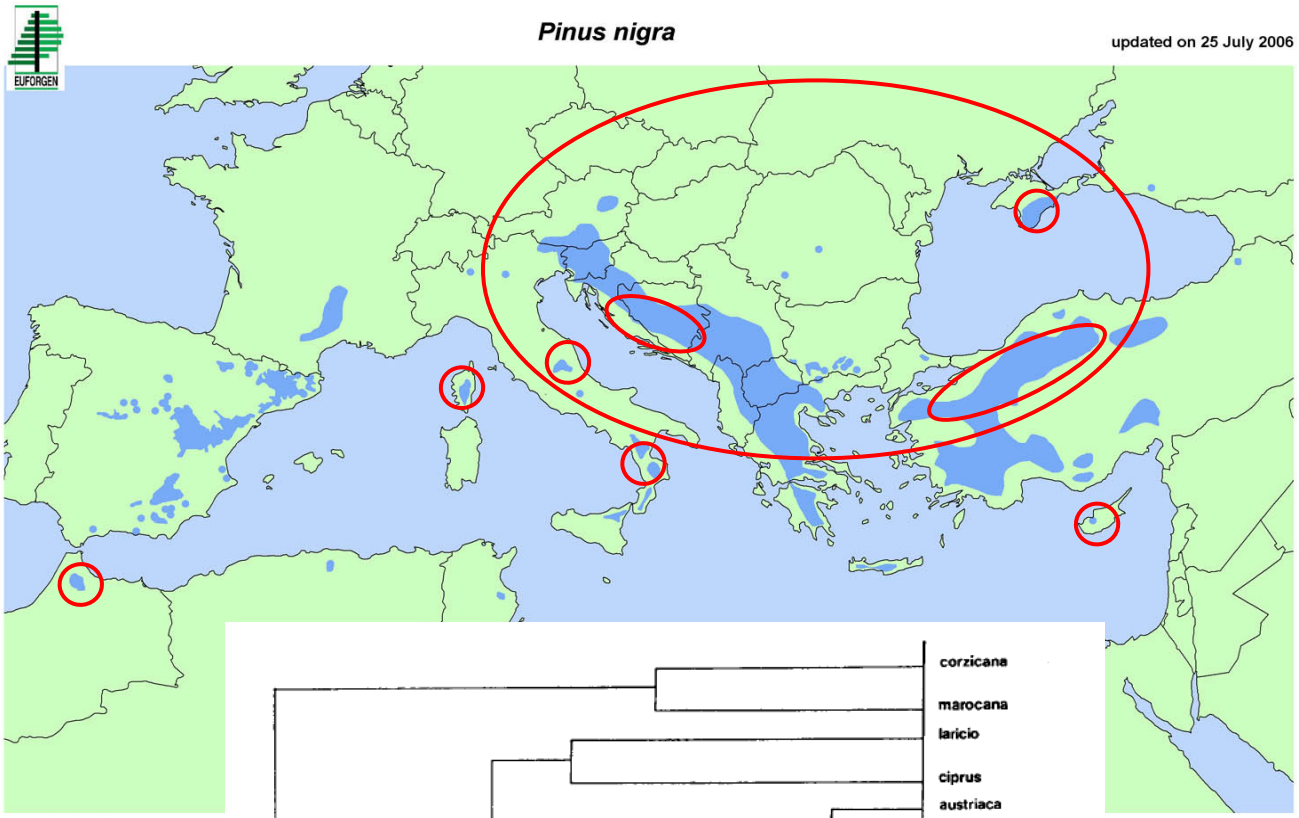
FIG. 6. DENDROGRAM BASED ON GENETIC DISTANCES FROM ESTIMATED ALLELE FREQUENCIES OF 12 TERPE
NOIDS. UPGMA clustering of Rogers genetic distances as modified by Wright.

41 central range populations (with gaps), 9 main regions, 39 terpenoid compounds

- *Corsica and Sicily: Tertiary relict.*
- *Mainland: more recent expansions and gene flow*
- *What about Cyprus, the other island black pine population?*

Afzal-Rafii et al., Biochem Syst. Ecol. 1996

Genetic diversity of Pinus nigra *(central-eastern range)*



This distribution map was co
and was published in: Isajev,
European black pine (Pinus

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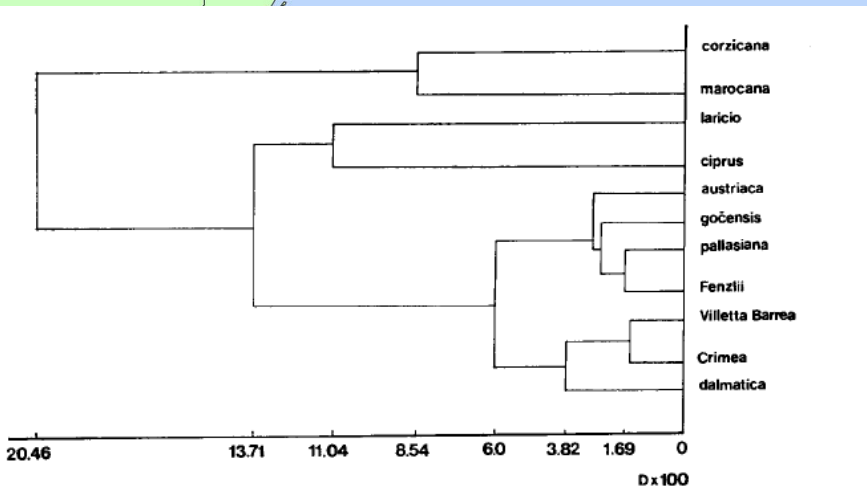

Figure 2. — A dendrogram, based on UPGMA clustering, of *Pinus nigra* subspecies using the genetic distances of Nei (1972).

28 populations range-wide (with gaps), 11 main regions.
4 isozyme loci

High gene diversity within and among populations.

Black pine from Cyprus is a separate subspecies, along with Morocco, Corsica and Calabria.

Nicolic & Tucic, Silvae Genet. 1983

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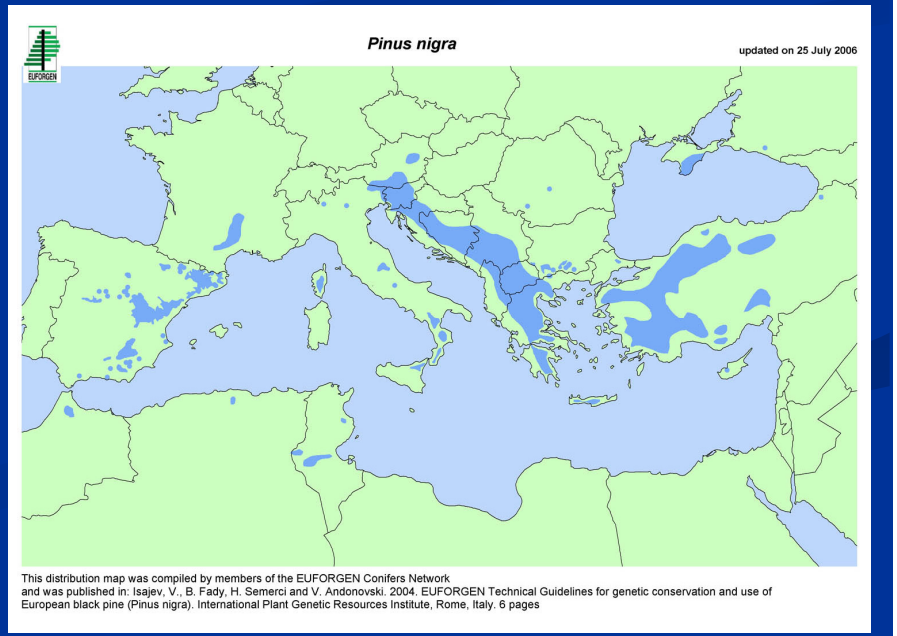
Understanding the evolutionary history of Pinus nigra

Pinus nigra*: a Tertiary species with many refugial-based regional population groups. High regional originality => regional conservation strategies.*

Many references are local. Lack of global understanding. Many gaps in studies.
➔ A need for a range wide detailed assessment of genetic (bio)diversity in **Pinus nigra.**

Problem: are populations natural?
➔A need to work with historically documented / old growth populations in **Pinus nigra.**
➔ A need to study gene flow and hybridization



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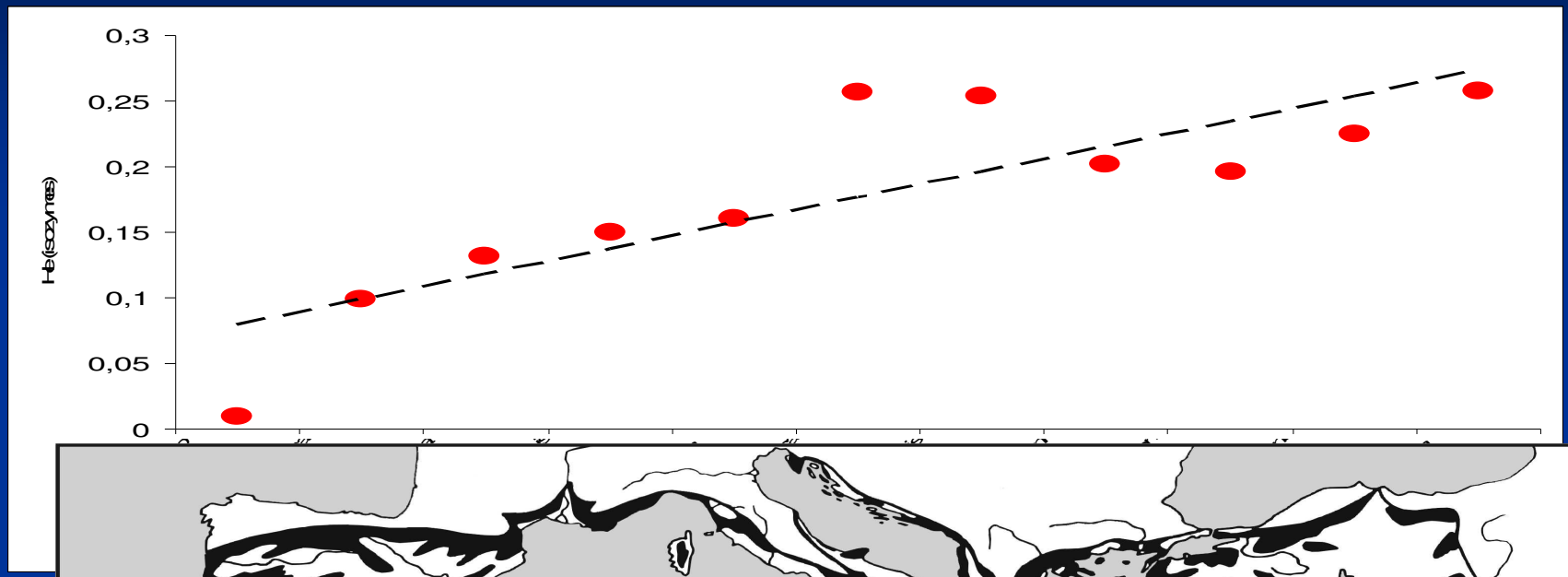
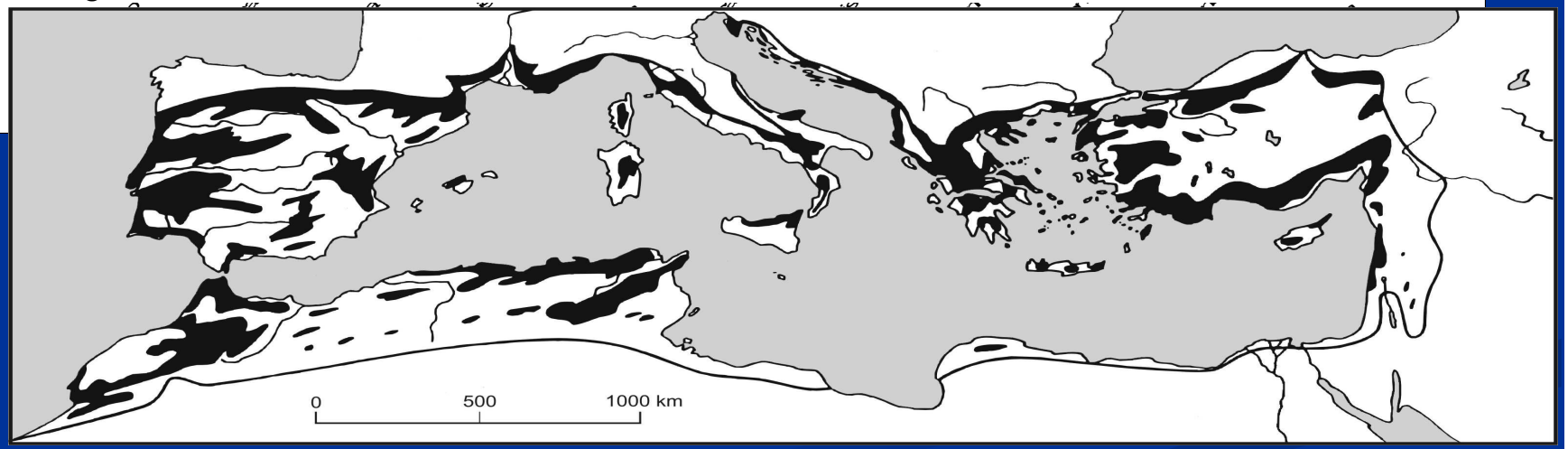
Pinus nigra *fits within the east-west pattern of increasing genetic diversity in the Mediterranean*





Black pine from Cyprus has one of the highest within population gene diversity range wide (Nicolic & Tucic, 1983).

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Pinus nigra *range-wide: what about adaptive trait diversity*

Black pine adaptive traits (Wheeler et al. Silvae Genet. 1976):
North American test, 24 populations range-wide (with gaps), 4 sites

- *Considerable variation in survival, growth and tree shape*
- *Considerable variation in resistance to insects and diseases*
- *Considerable variation in frost hardiness*
- *Significant genotype x site interaction, i.e plasticity*

Black pine adaptive traits :
A need for a complete assessment

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Pinus nigra*: a species strongly affected by climate change*

The simulations of BIOMOD concern European timber trees and they do not take into account effective migration rate and survival rate of the species. They provide a predicted distribution of the climatic envelope of the species. The simulations use the Hadley Center climate model HadCM3 output and two IPCC scenarios, A1Fi which are consumerist individualist scenarios leading to a global mean increase in temperature of 4.5°C by 2100 in Europe and B2 which is a conservationist, communitarian scenario leading to a global mean increase of temperature of 2.5°C in Europe. The simulations of PHENOFIT concern North

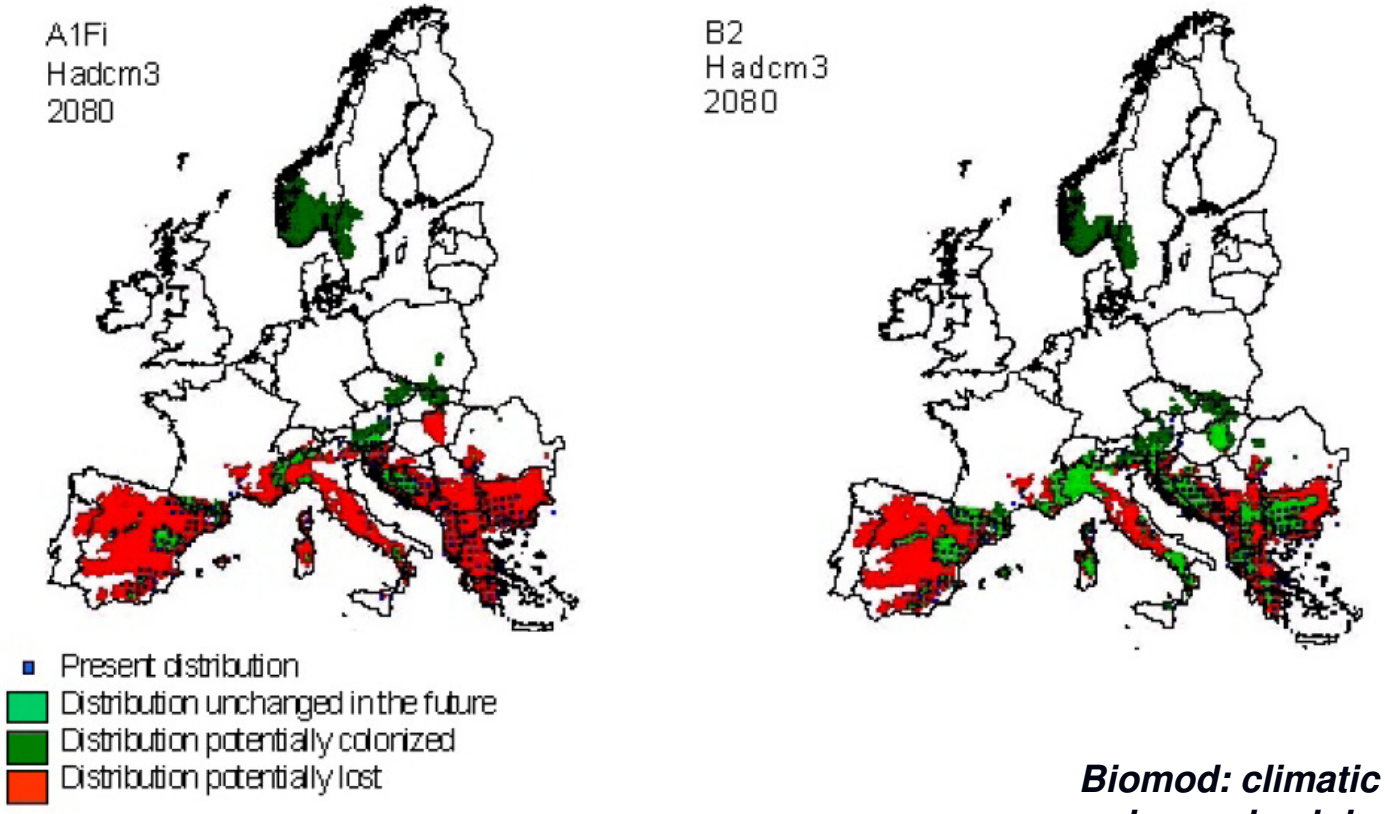

Figure 4. Predicted potential distribution of *Pinus nigra* sp.

Biomod: climatic envelope and eco-physiological (no migration, no mortality) model (Thuillier 2003, 2004)

Pinus nigra genetic resources

Black pine adaptive traits: considerable variability and plasticity.

Black pine neutral genes : complex history, considerable variation and an eastern richness.

Black pine from Cyprus and the eastern Mediterranean: a combination of original evolutionary potential and adaptive traits. A model to study evolutionary processes in marginal populations.

A threatened resource worth conserving!

An invasive species: North America, South Africa. Some precautions are needed if* ex situ *conservation is undertaken

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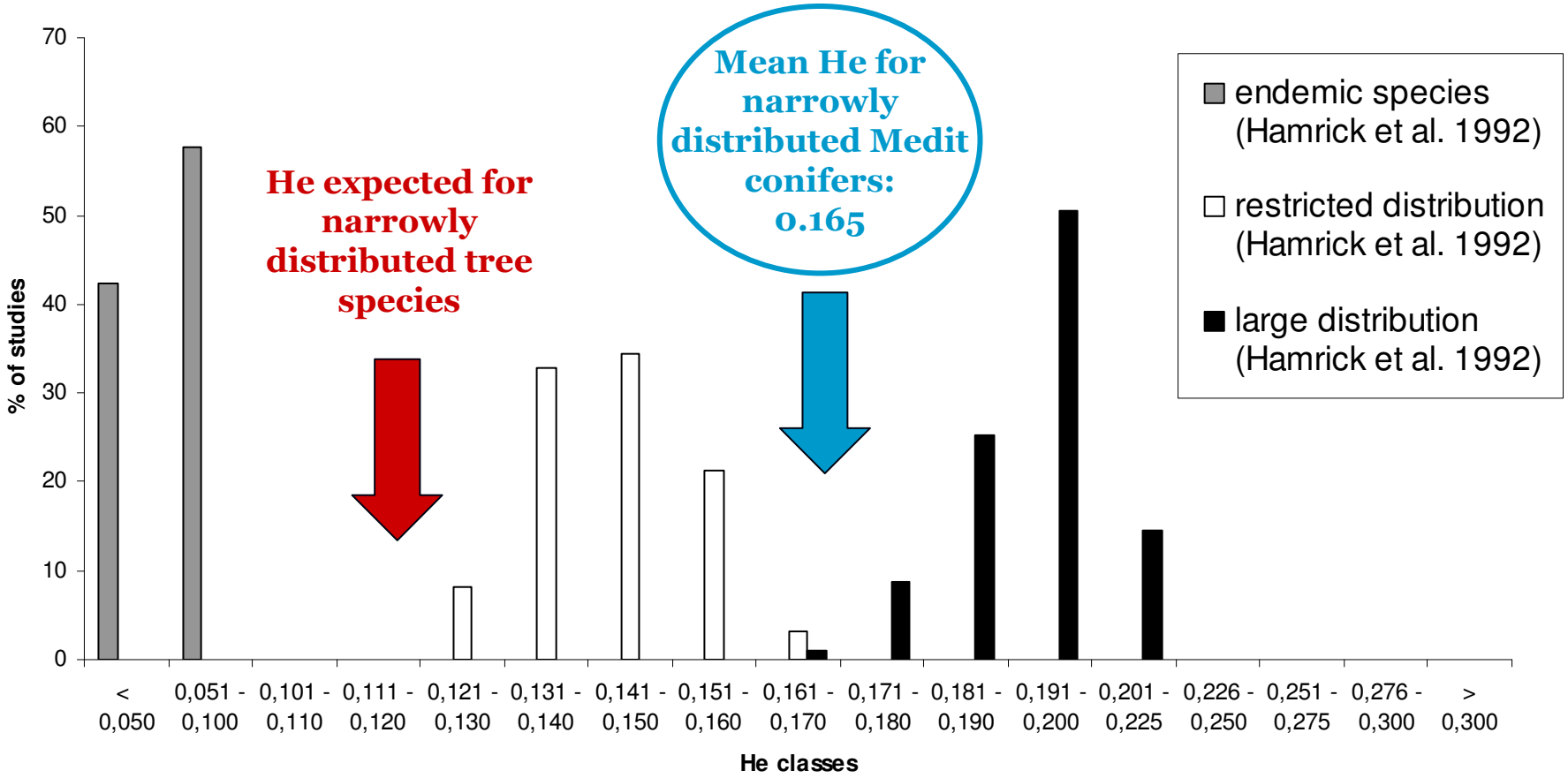
Pinus nigra from Cyprus: a resource to conserve and use

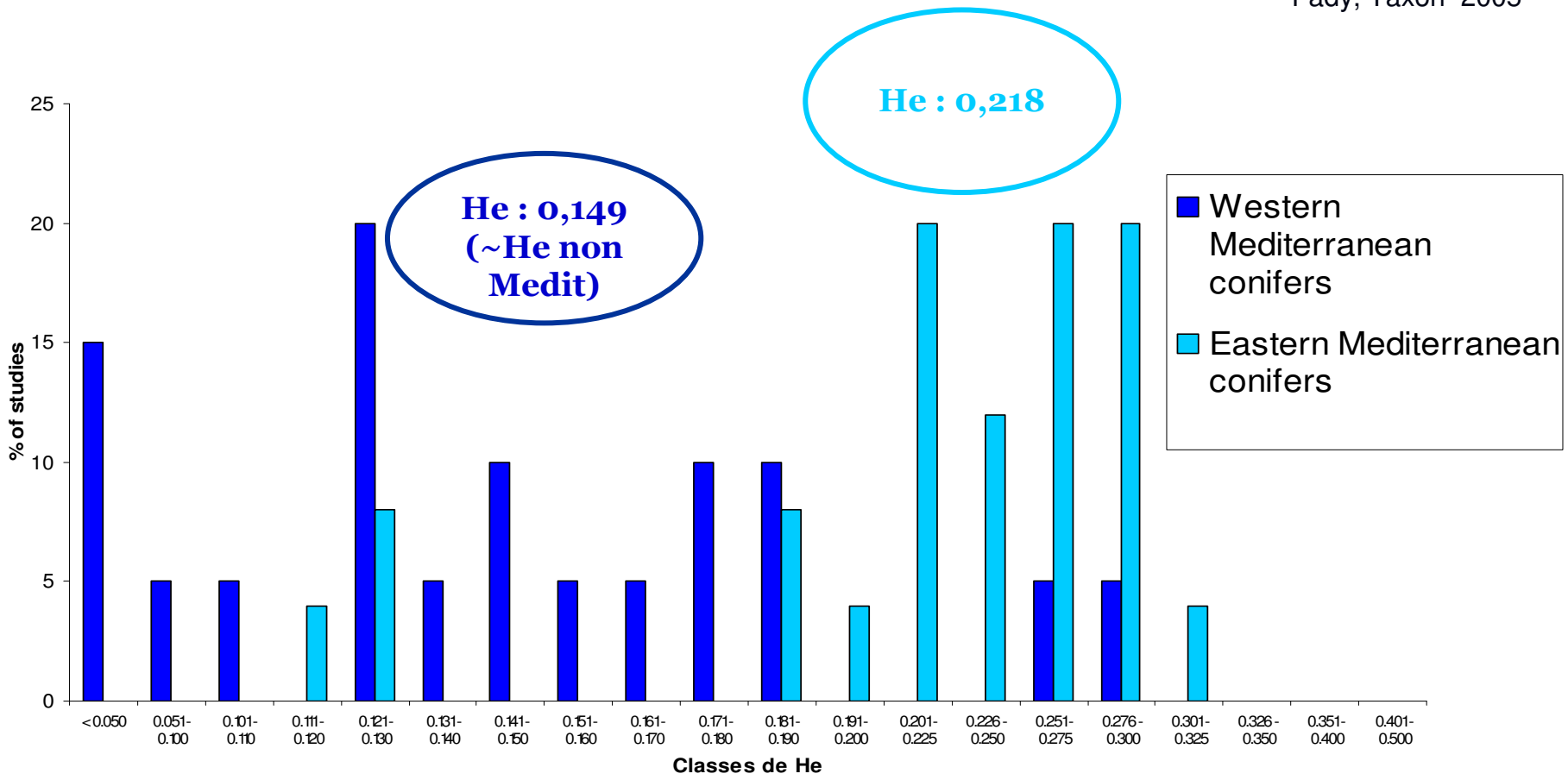
Thank you for your attention

The gene diversity of conifers outside and within the Mediterranean: narrowly distributed species



Structure of gene diversity in Mediterranean conifers

Fady, Taxon 2005



Western Mediterranean regions show significantly less within population genetic diversity … *but similar differentiation*

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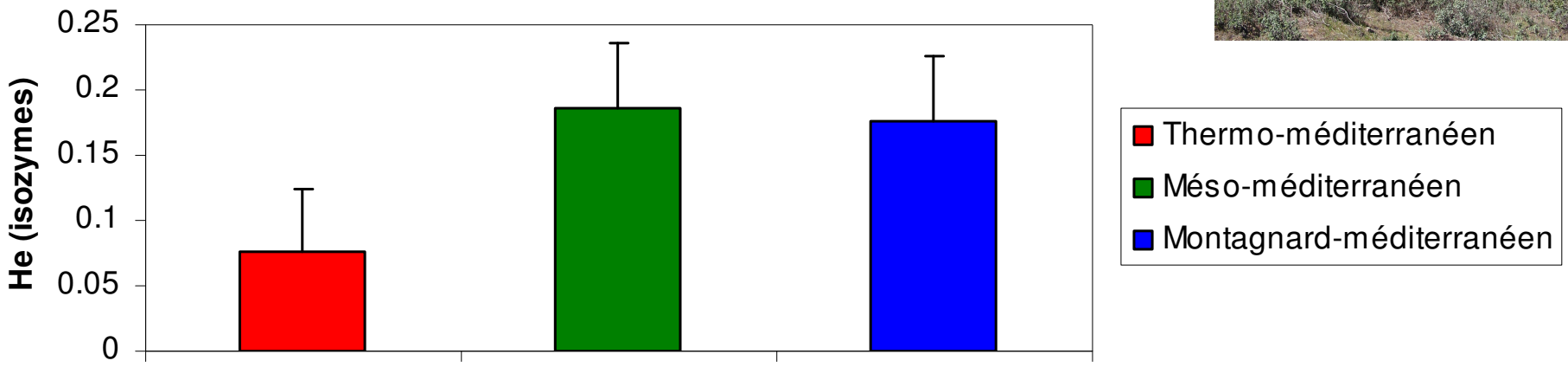
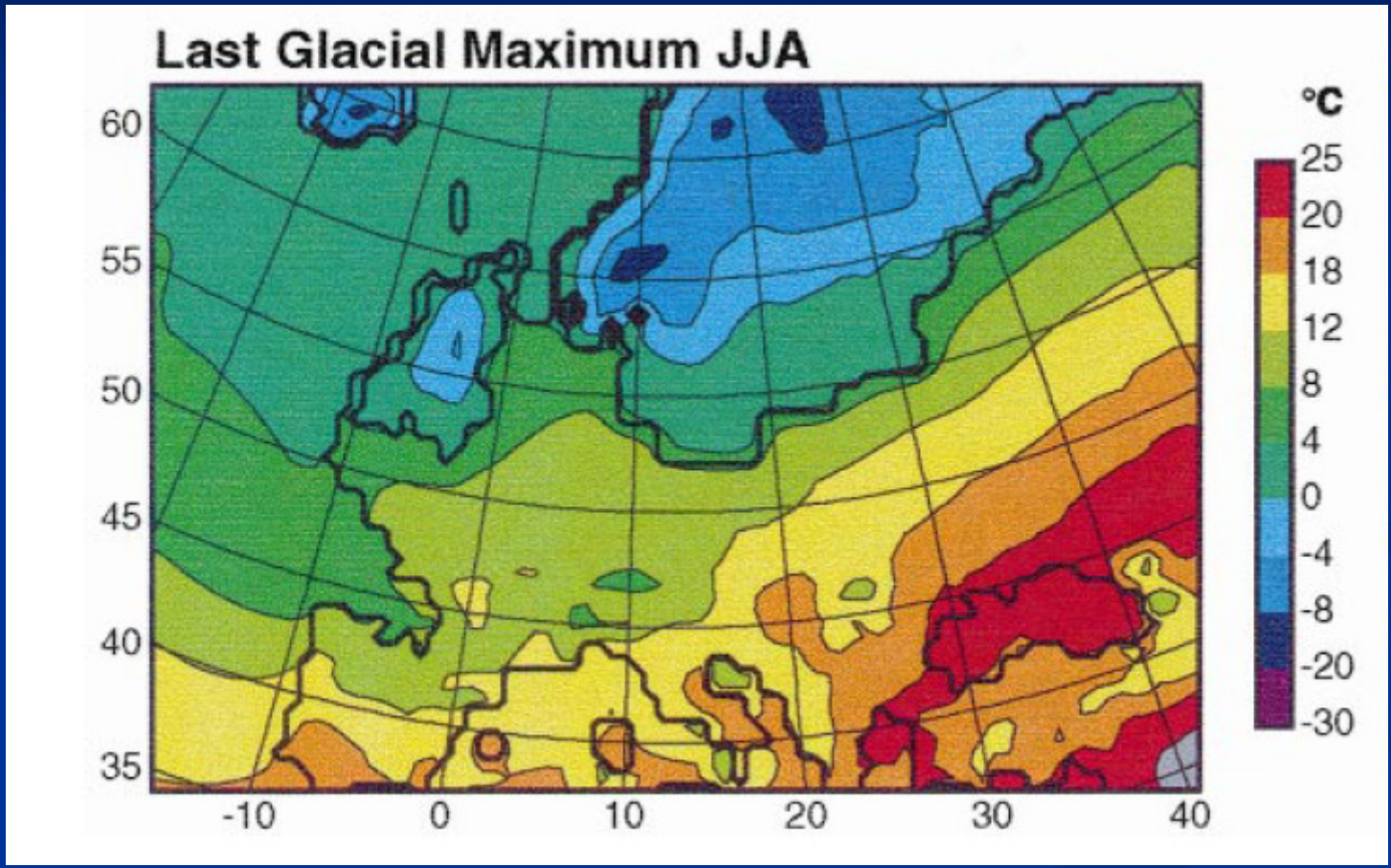
Bioclimatic structure of gene diversity in Mediterranean conifers

Within population genetic diversity in Mediterranean (*s.l.*) conifers depending on their bioclimatic requirements



Thermo-Mediterranean conifers show significantly less within population genetic diversity

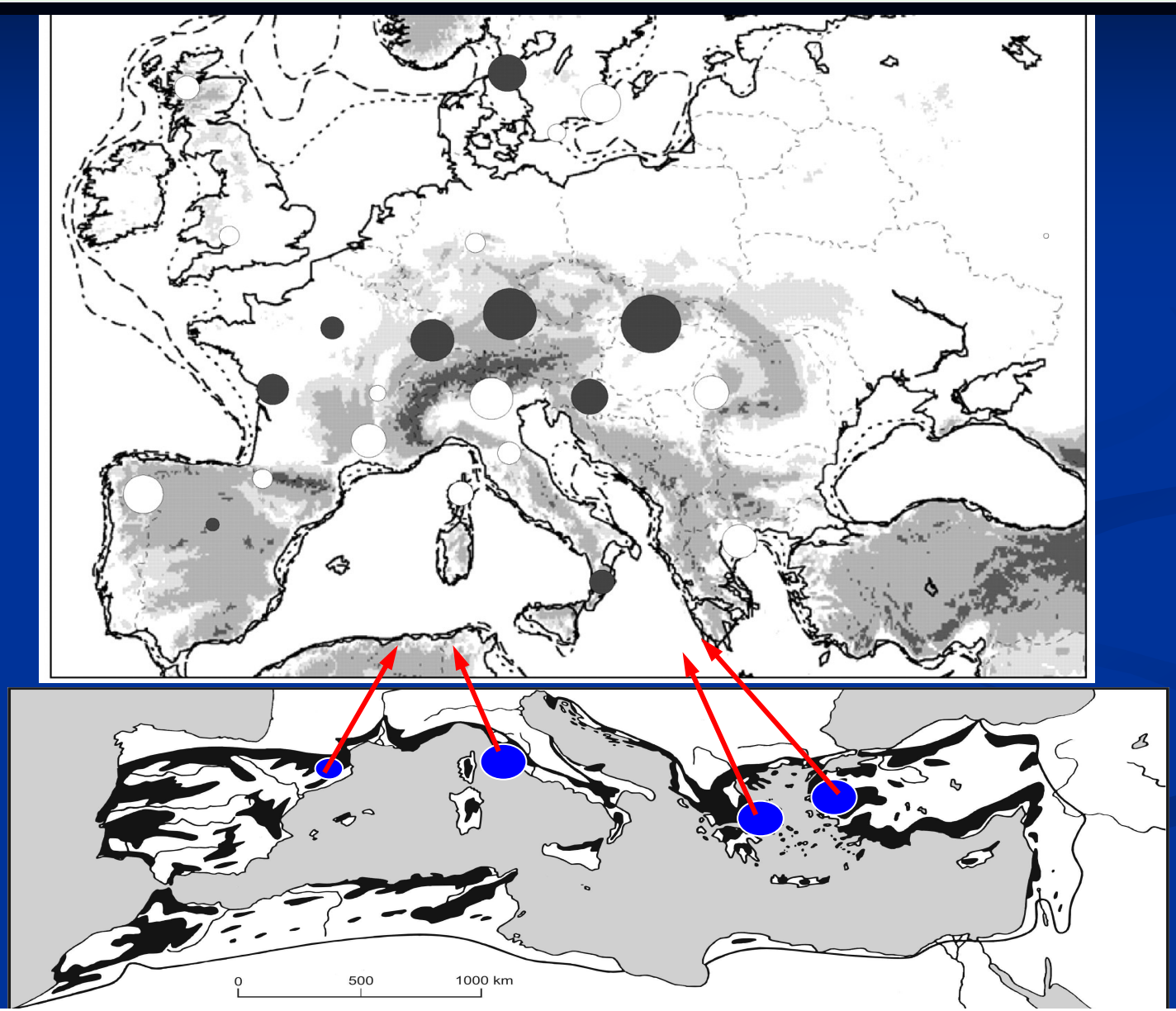
The imprint of the Quaternary Ice ages on gene level biodiversity



Colder (and dryer) climatic conditions in the western Mediterranean during the late Glacial maximum (18 000 years BP) ==> reduction of favorable ecological niches ==> reduction of pop size ==> genetic bottlenecks

van Andel, Quaternary research 2002

The imprint of the Quaternary Ice ages on gene level biodiversity



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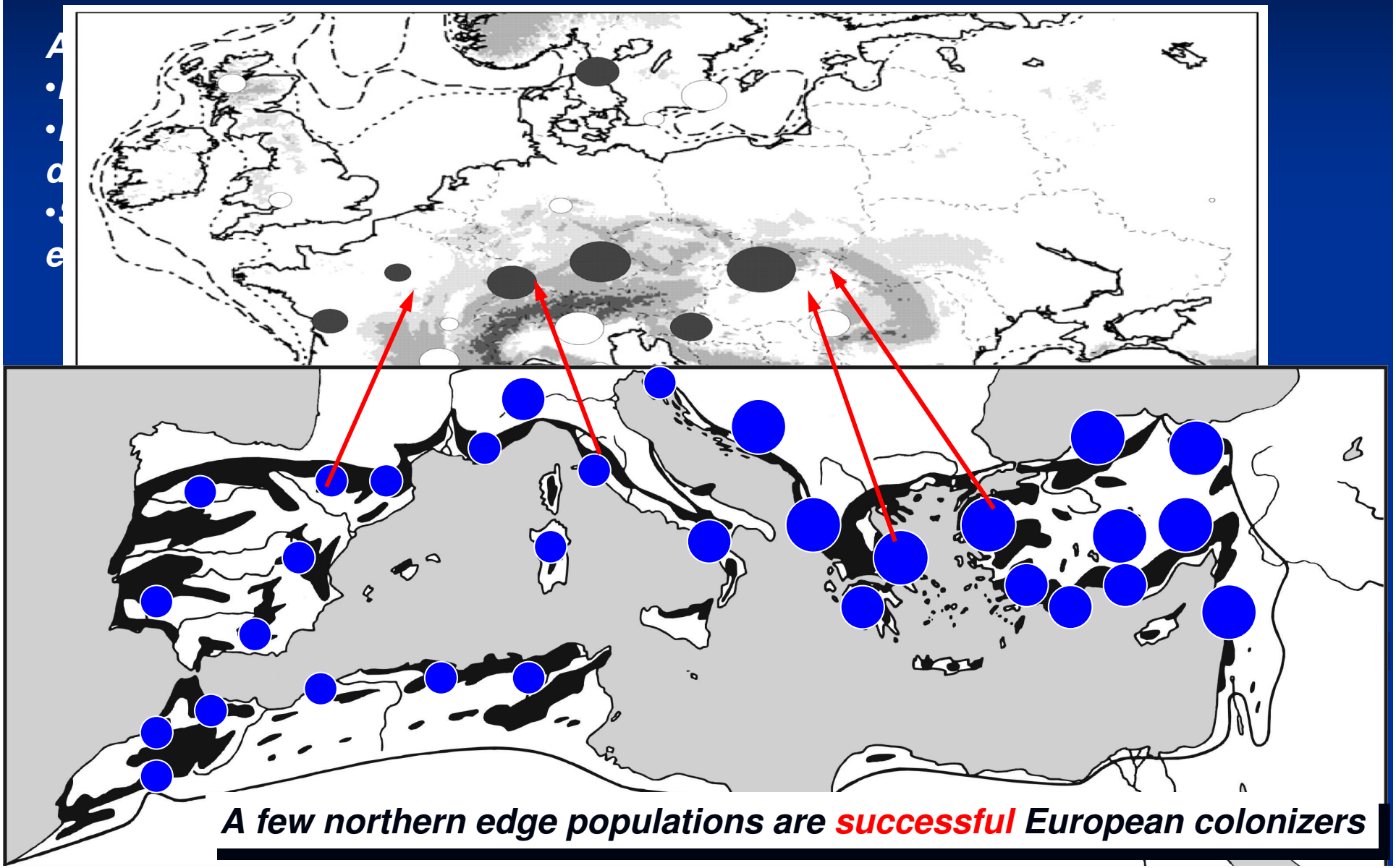

A few northern edge populations are successful European colonizers