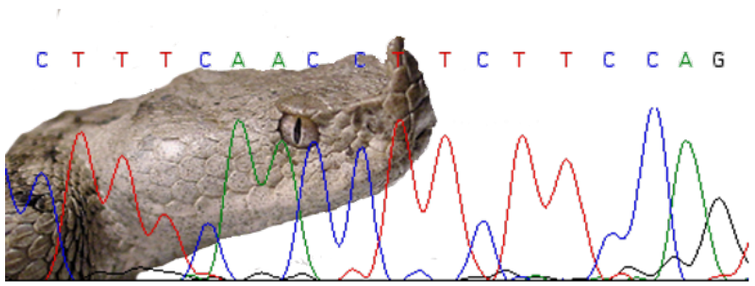
Phylogeography
of European reptiles



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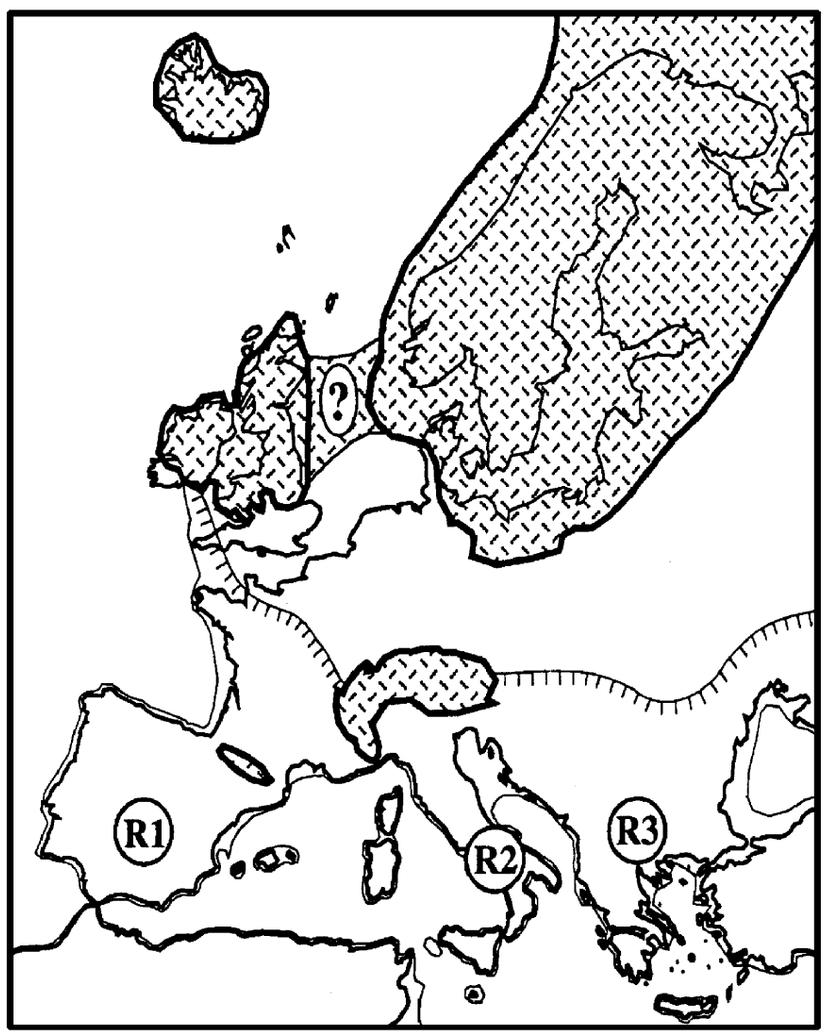
Phylogeography and DNA

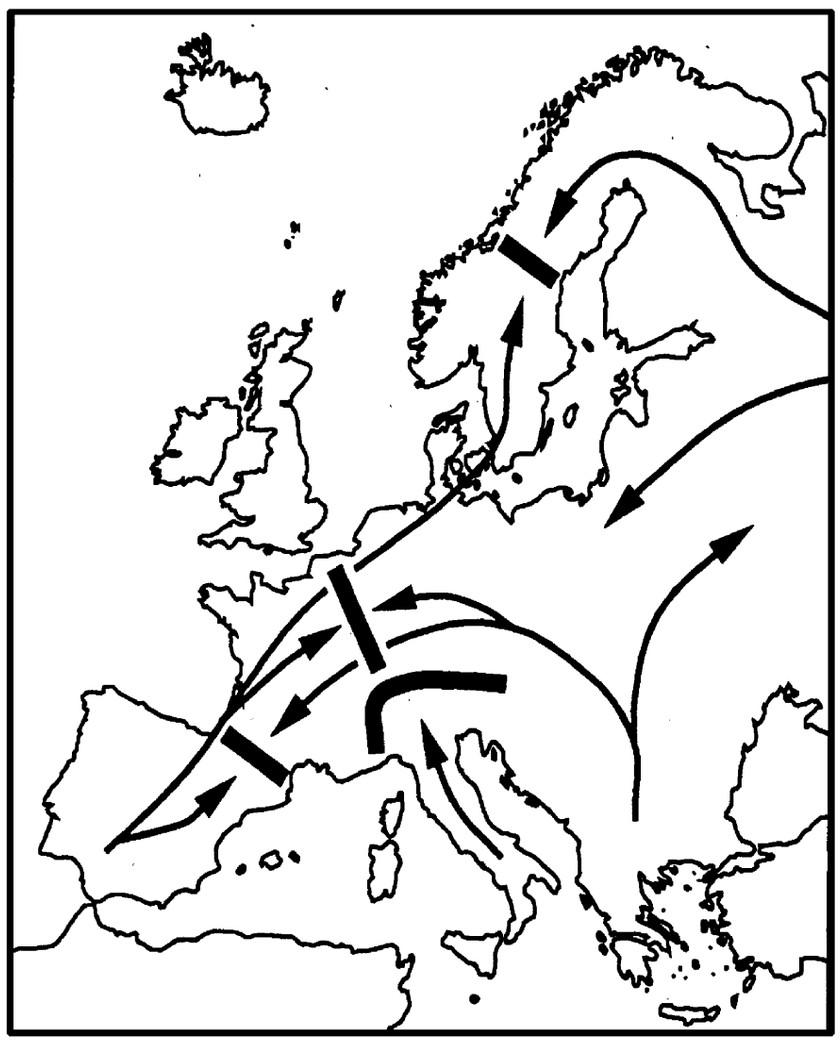
- Phylogeography: historical processes that may be responsible for the contemporary geographic distributions of individuals
- previously based on morphology (but coevolution)
- with PCR: sequencing and genetic relationships
- using mtDNA
  only female genetic structure
- also introns or genetic diversity of nuclear genes
- increase of phylogeography since about 1990

Phylogeography in Europe: *introduction*

- research of general pattern of genetic structure between species (animals and plants)
- P Taberlet / GM Hewitt



A

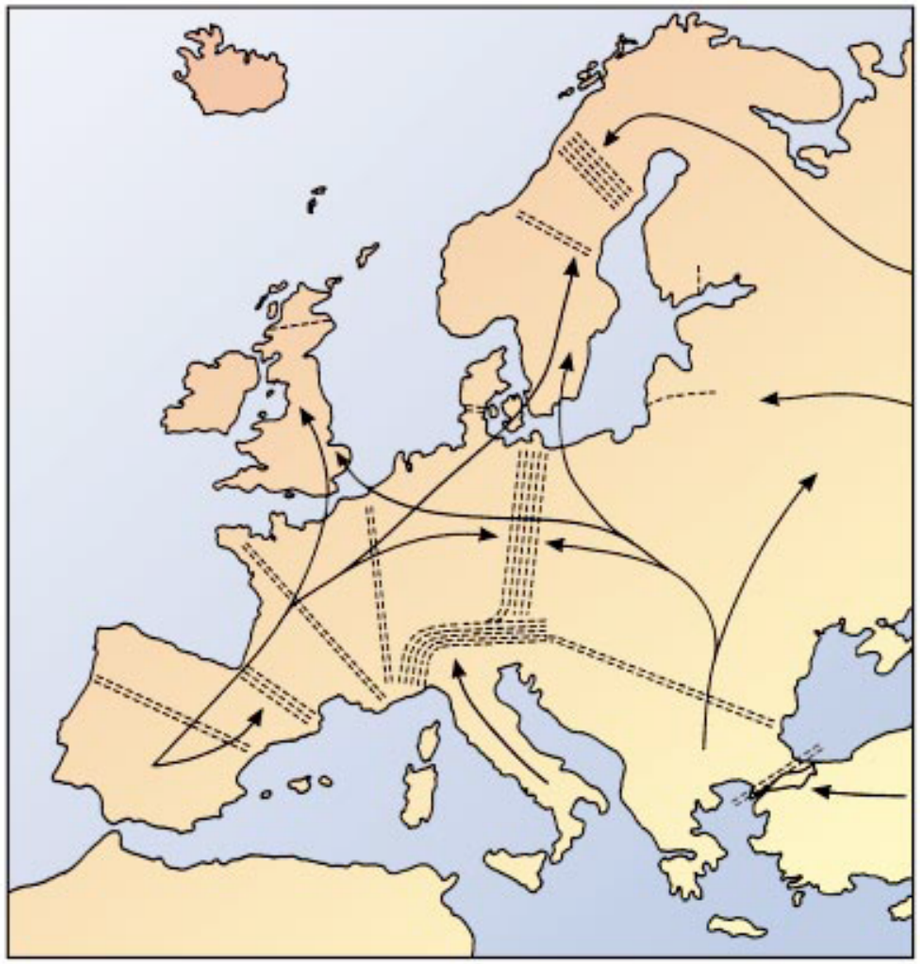


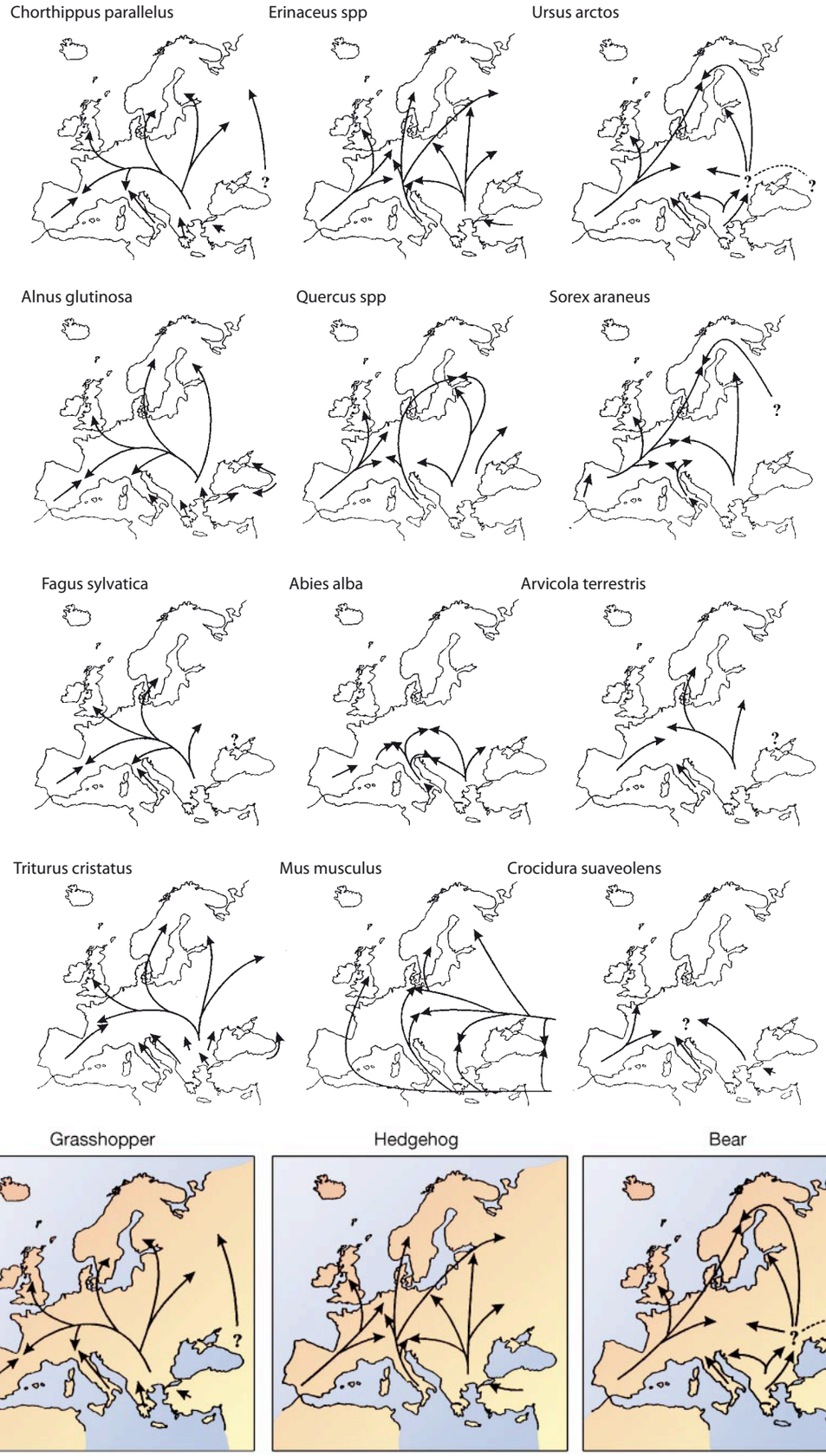
B

Taberlet et al (1998)

Phylogeography in Europe: *introduction*

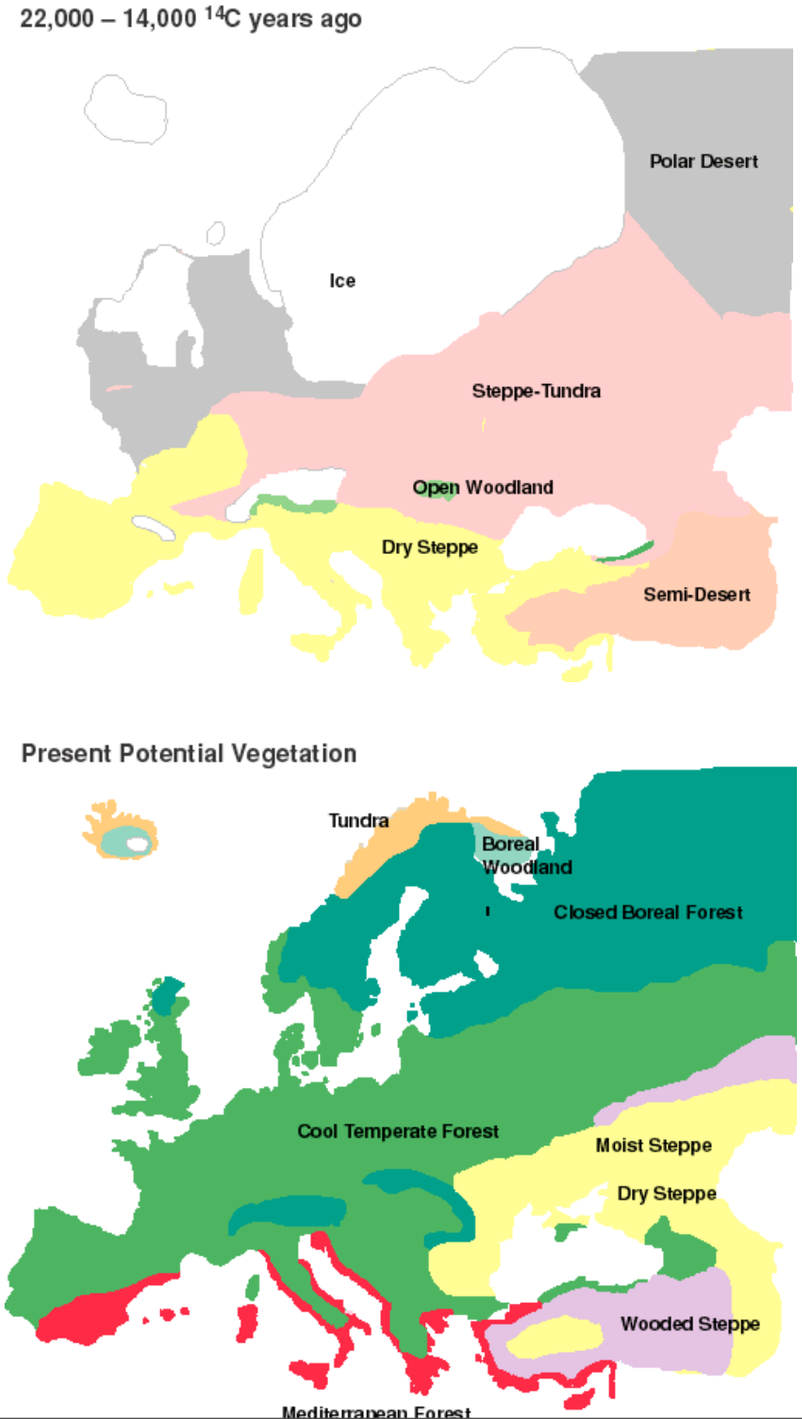
- Hewitt (1999, 2000)

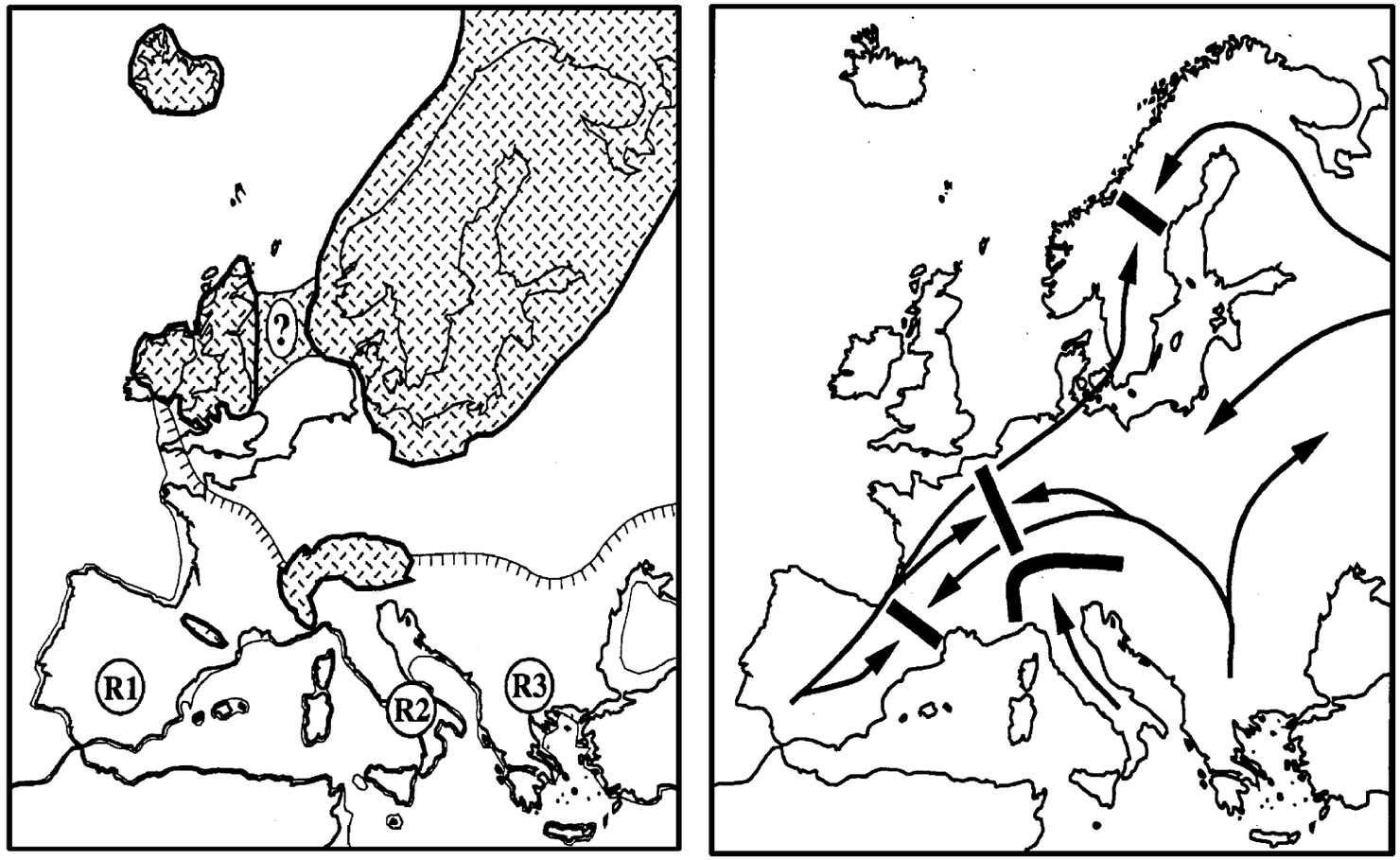




Phylogeography in Europe: *introduction*

- southern refugia for temperate species



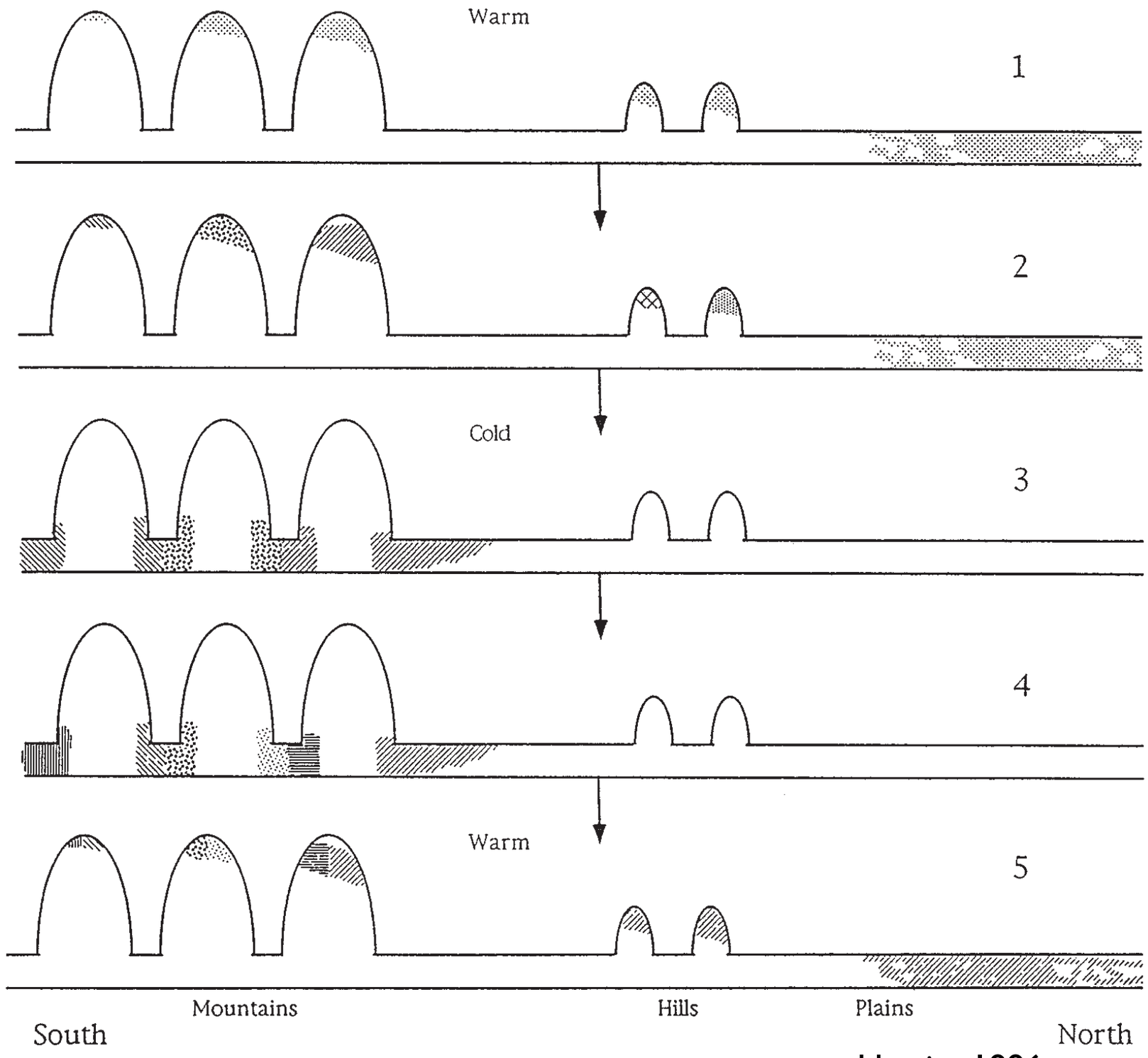


A

B

Phylogeography in Europe: *introduction*

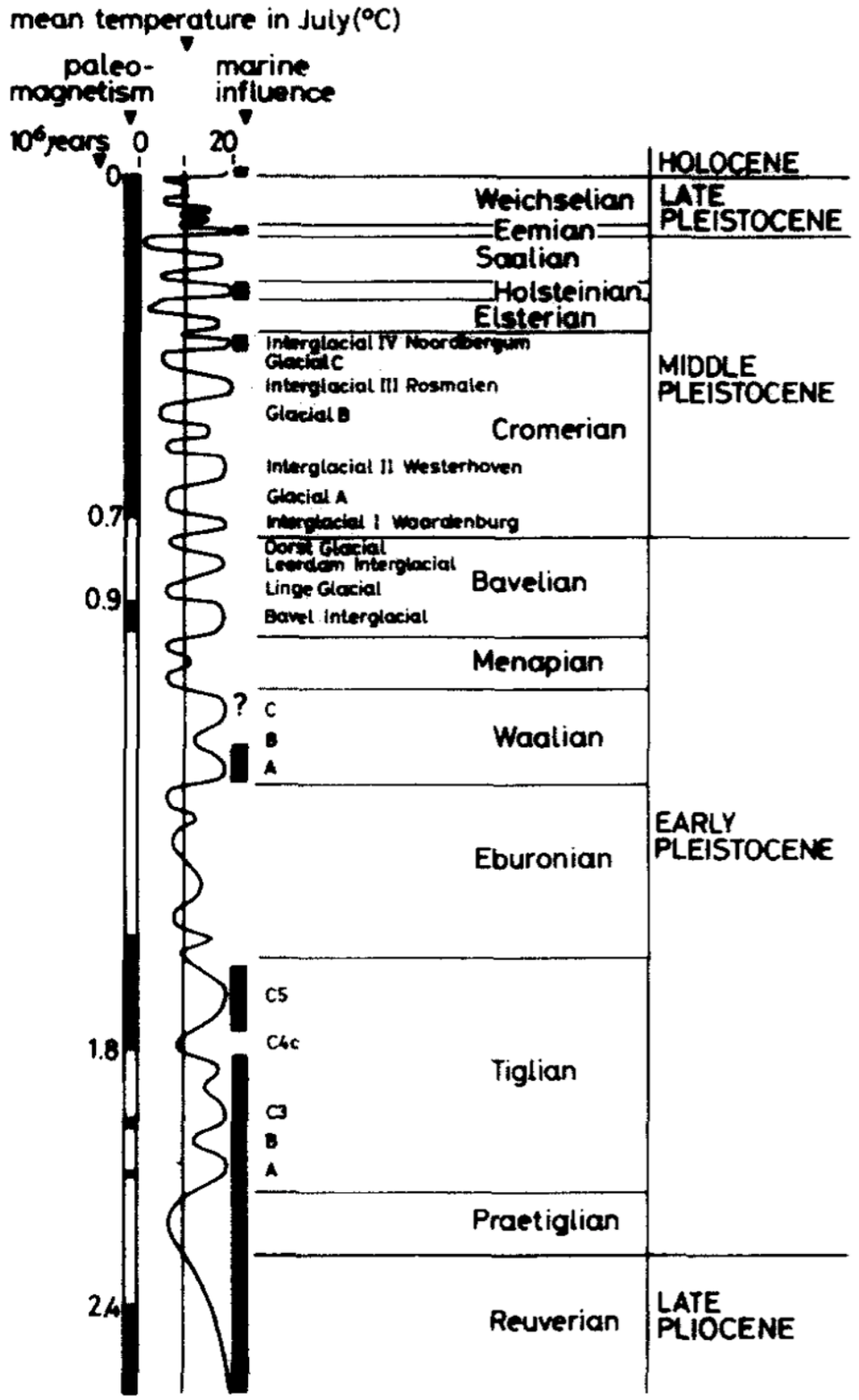
- Differentiation



Hewitt, 1996

Phylogeography in Europe: *introduction*

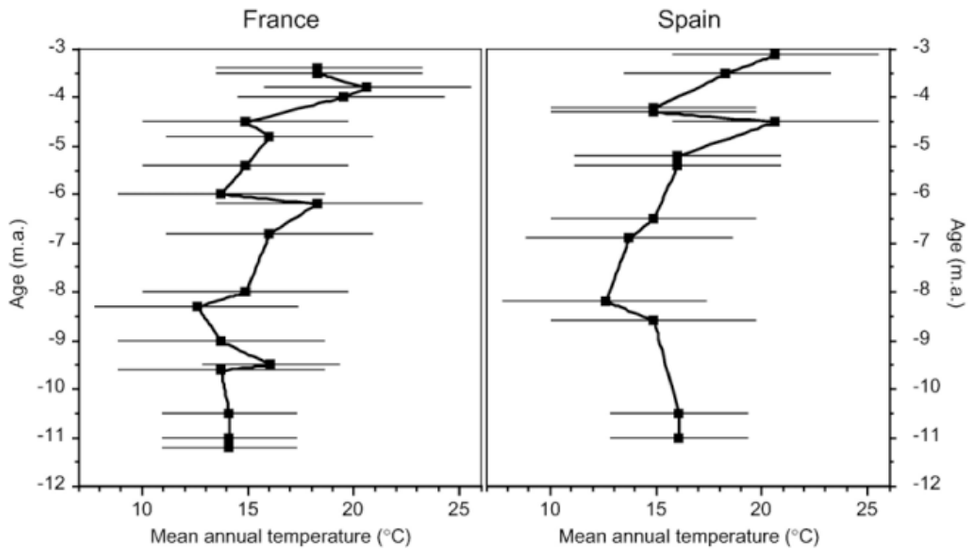
- timing: based on molecular clock / complex bayesian methods estimated e.g. with fossil on islands, historical split between species, ...
- for most mammals: only Pleistocene (max. 1.5 mya)



reptiles characteristics

- possibility to hibernate (not depending on winter conditions)
- directly dependant on the temperature (ectothermic animals)
- low migration rate (most species)
- slow morphological differentiation
- ...

- impact of previous Pleistocene temperature fluctuations



Phylogeography of several European species

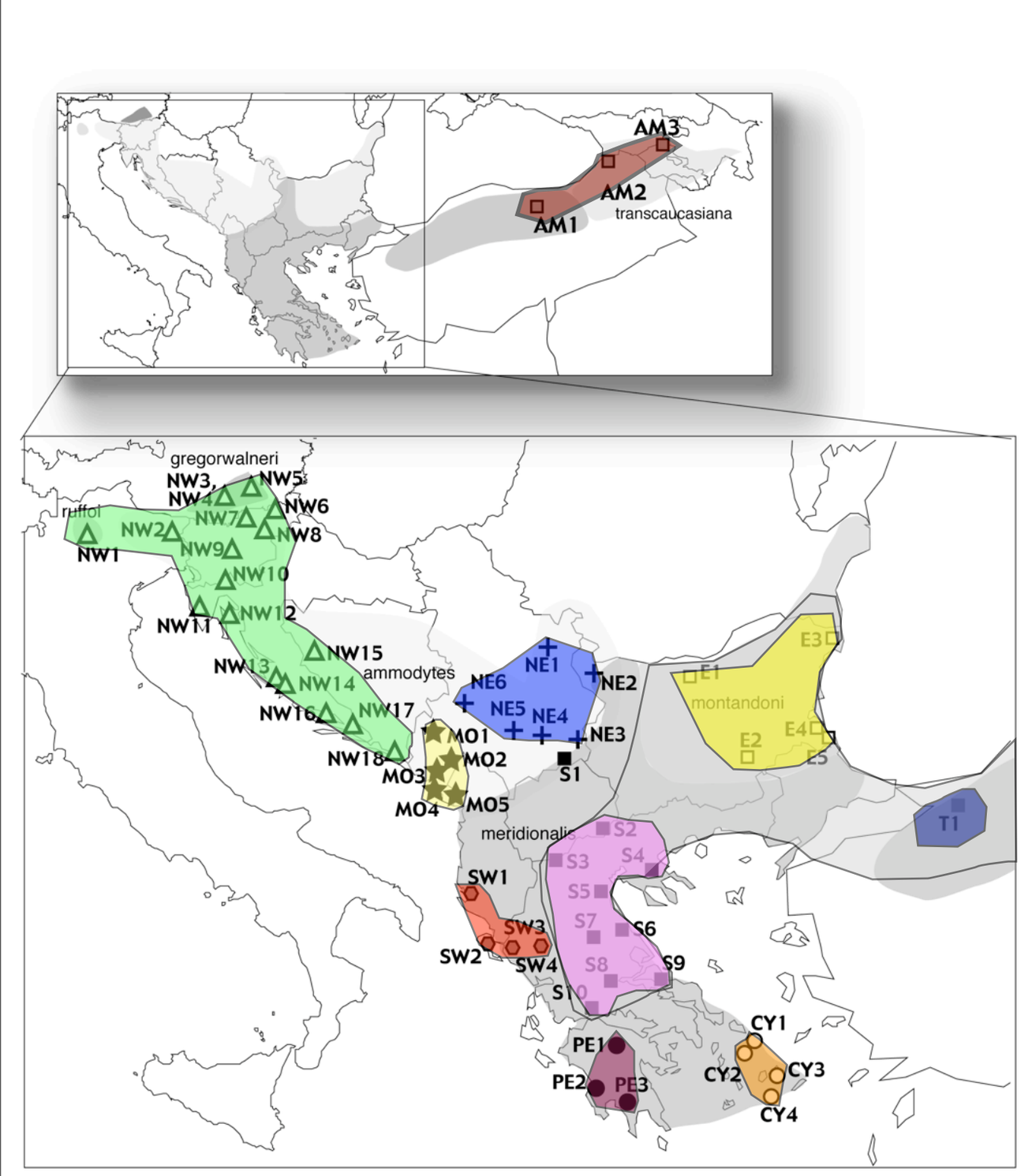
- "warm" species
  - *Vipera ammodytes* (Balkan peninsula)
  - *Podarcis* species (Balkan peninsula, Greece and Aegean Islands)
- "medium temperate" species
  - *Vipera aspis* (Italy, Spain, France, Switzerland)
  - *Emys orbicularis* (Spain to Caspian sea)
- "cold-tolerant" species
  - *Vipera berus* (France to Sakhalin Island)
  - *Zootoca vivipara* (Spain to Sakhalin Island)

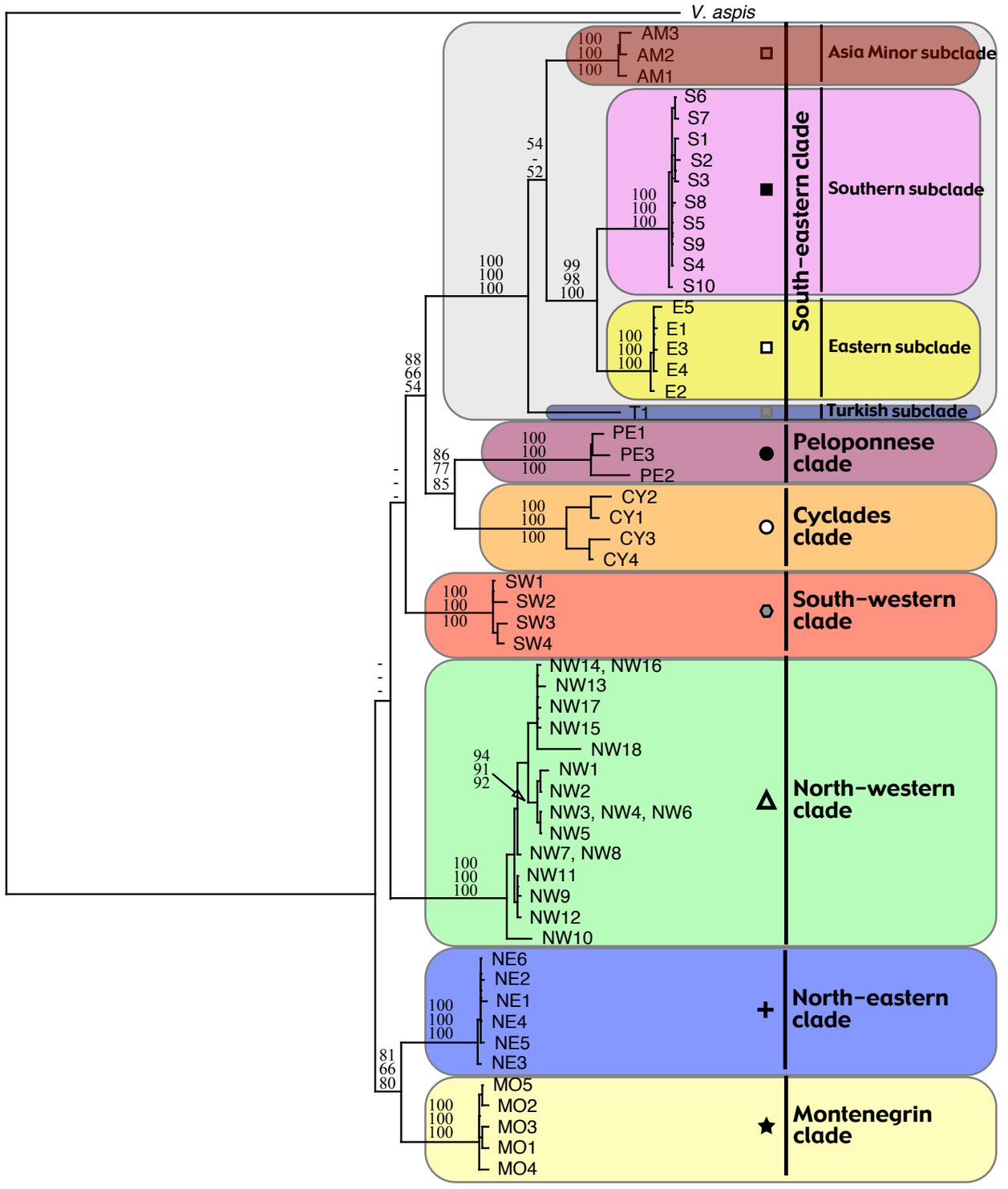
“warm” species: *Vipera ammodytes*

- (GB) nose-horned or sand viper
- (D) Sandotter, hornotter

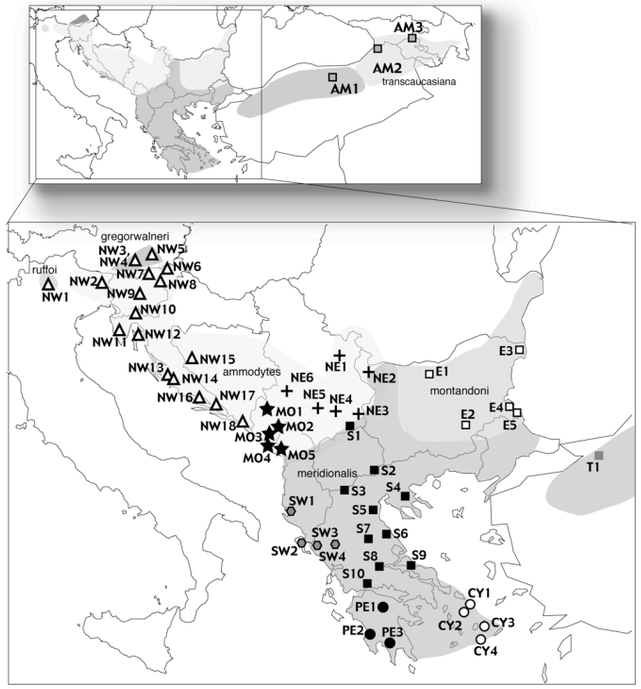
“warm” species: *Vipera ammodytes*

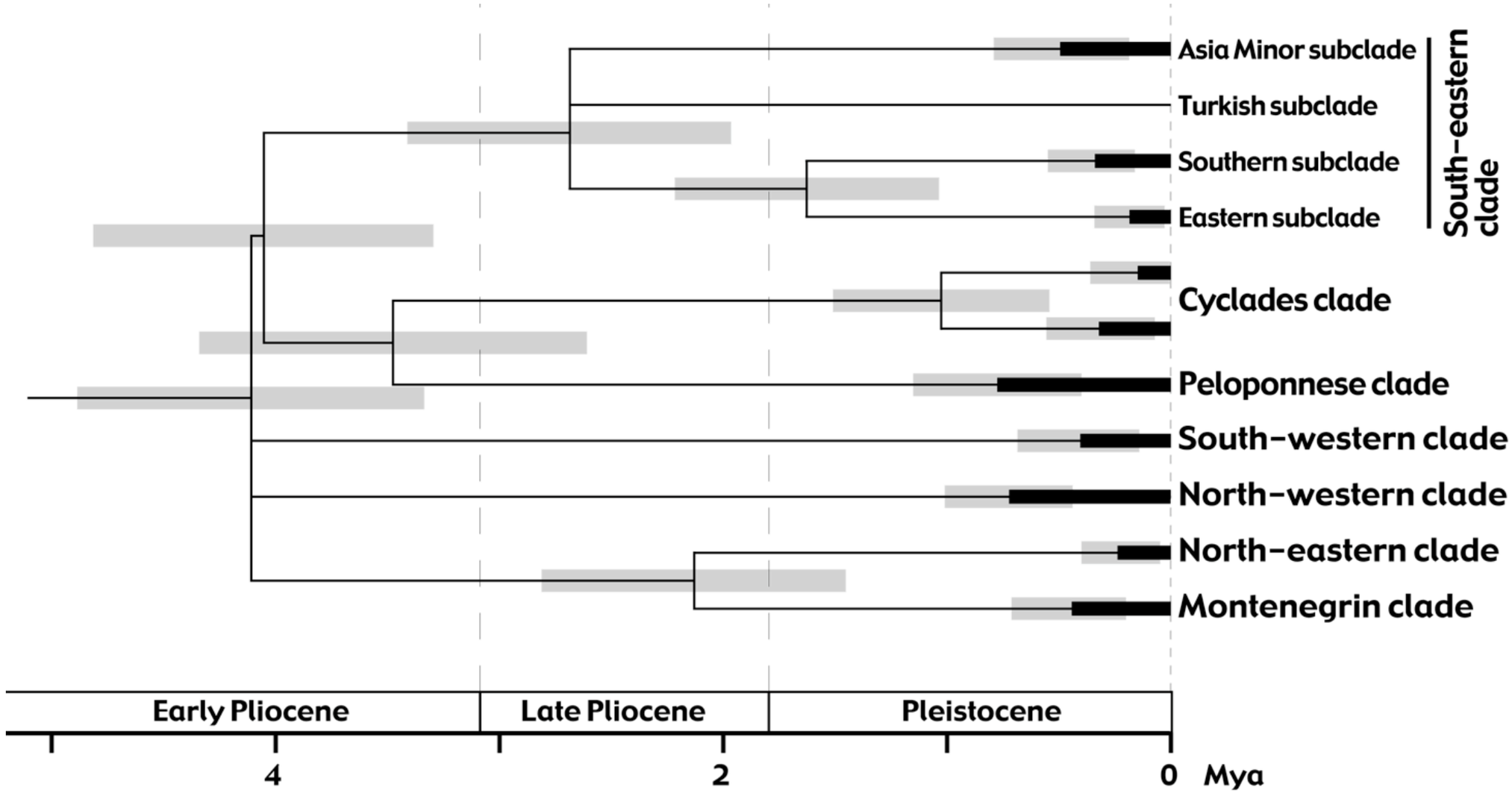
Ursenbacher et al. 2008





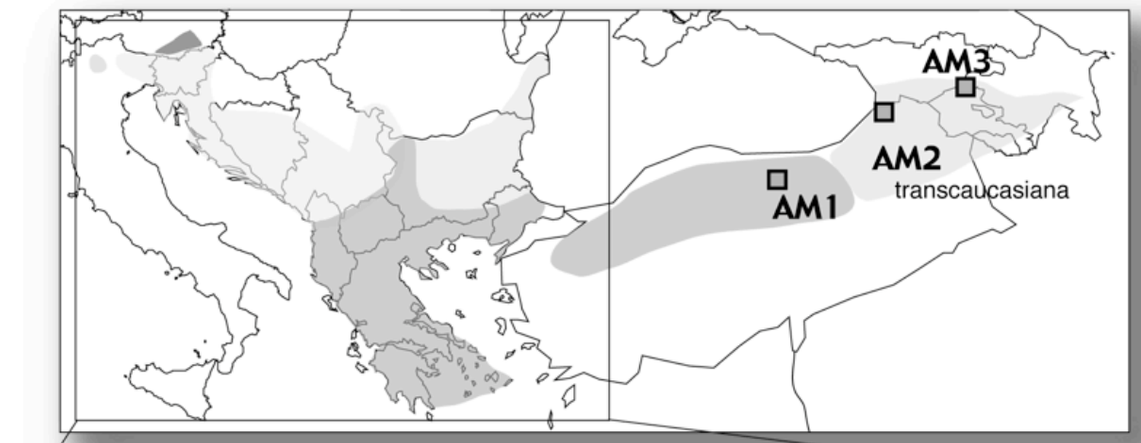
“warm” species: *Vipera ammodytes*

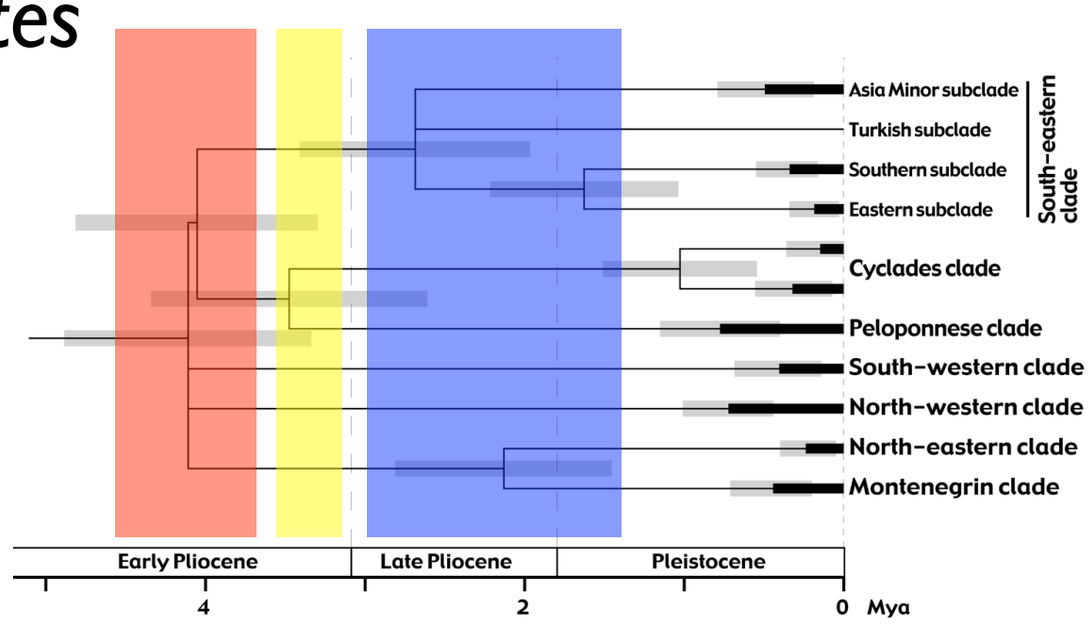


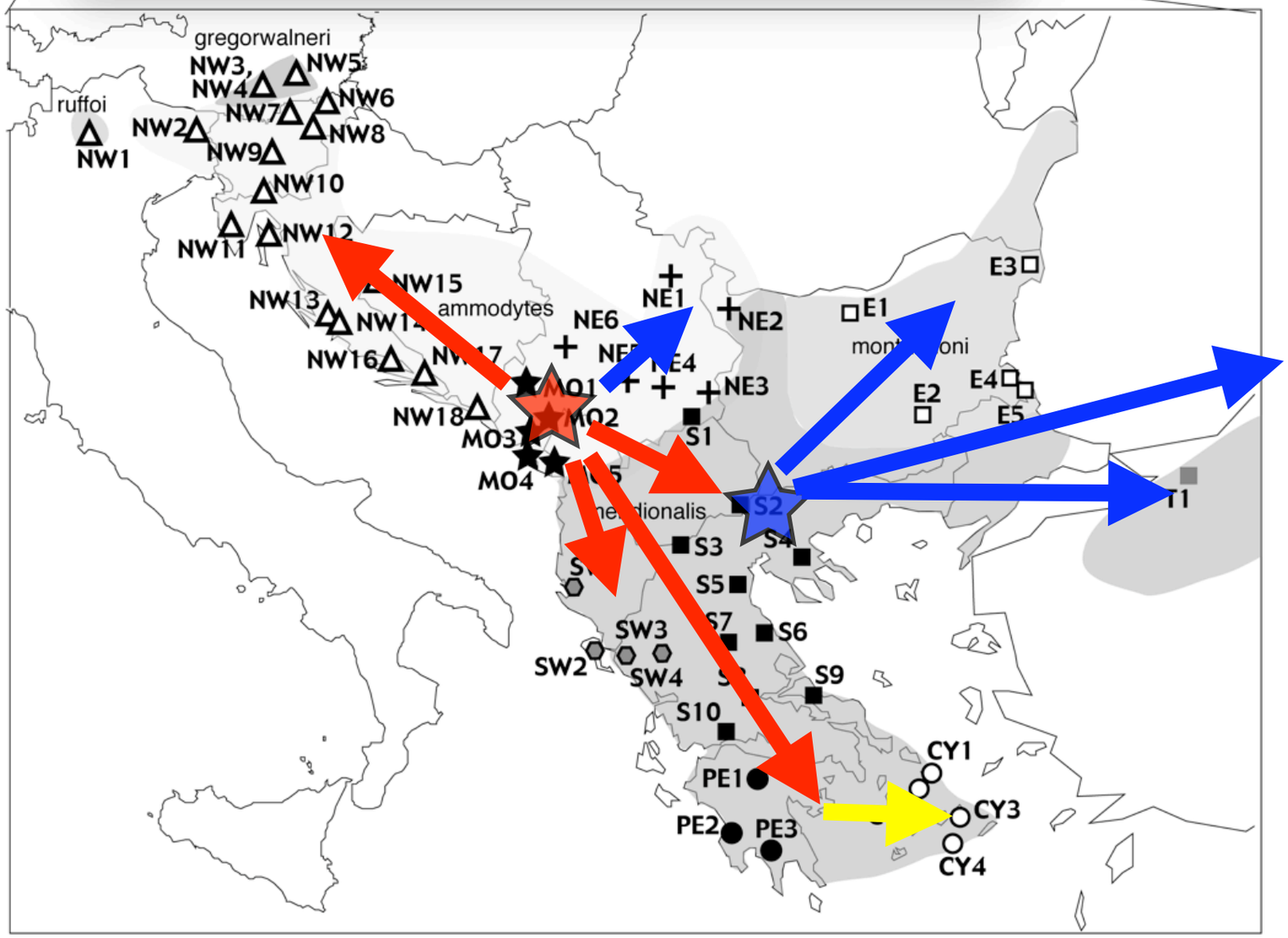


timing estimated with BEAST (Drummond and Rambaut, 2002)

“warm” species: *Vipera ammodytes*







“warm” species: *Vipera ammodytes*

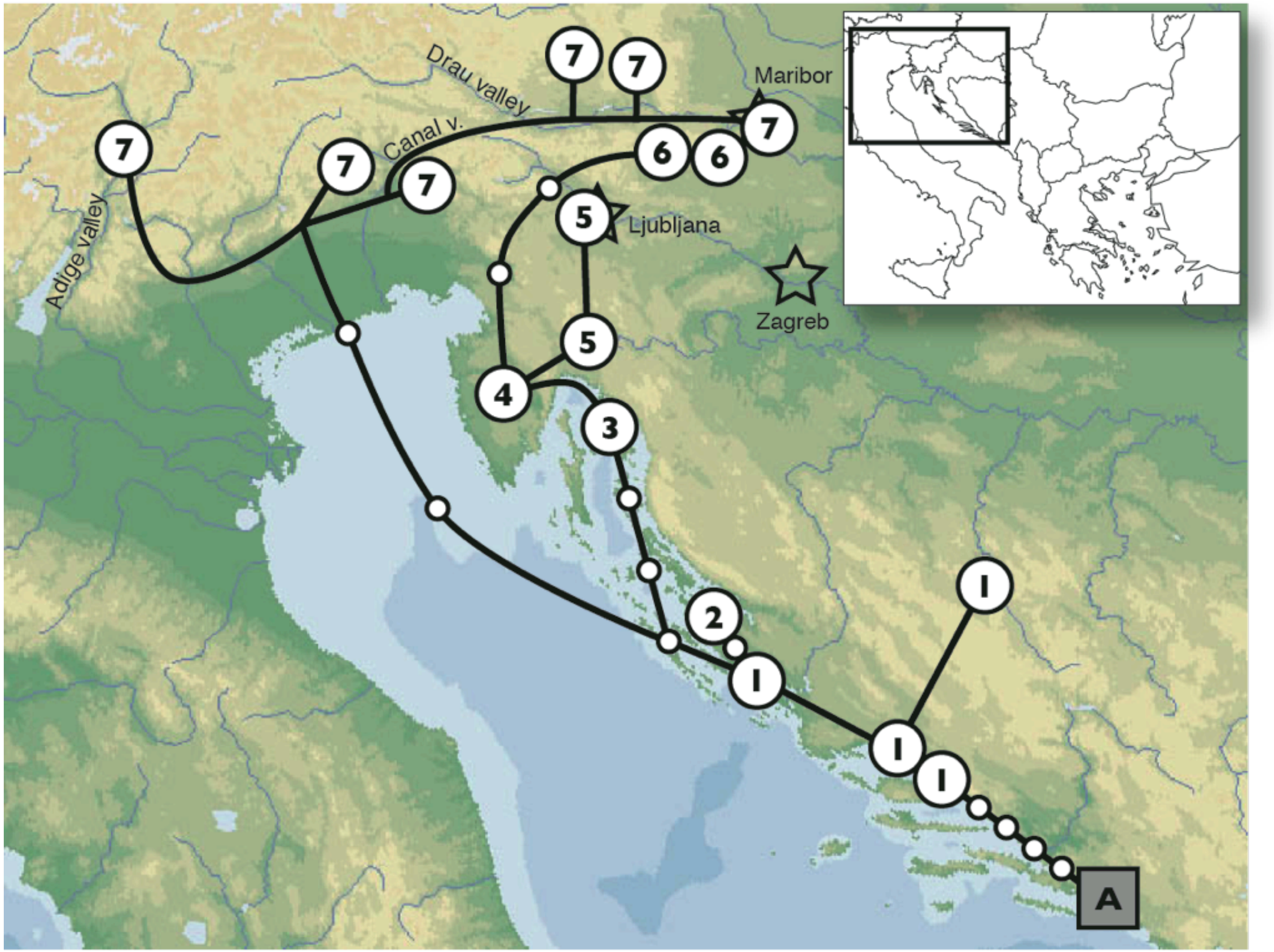


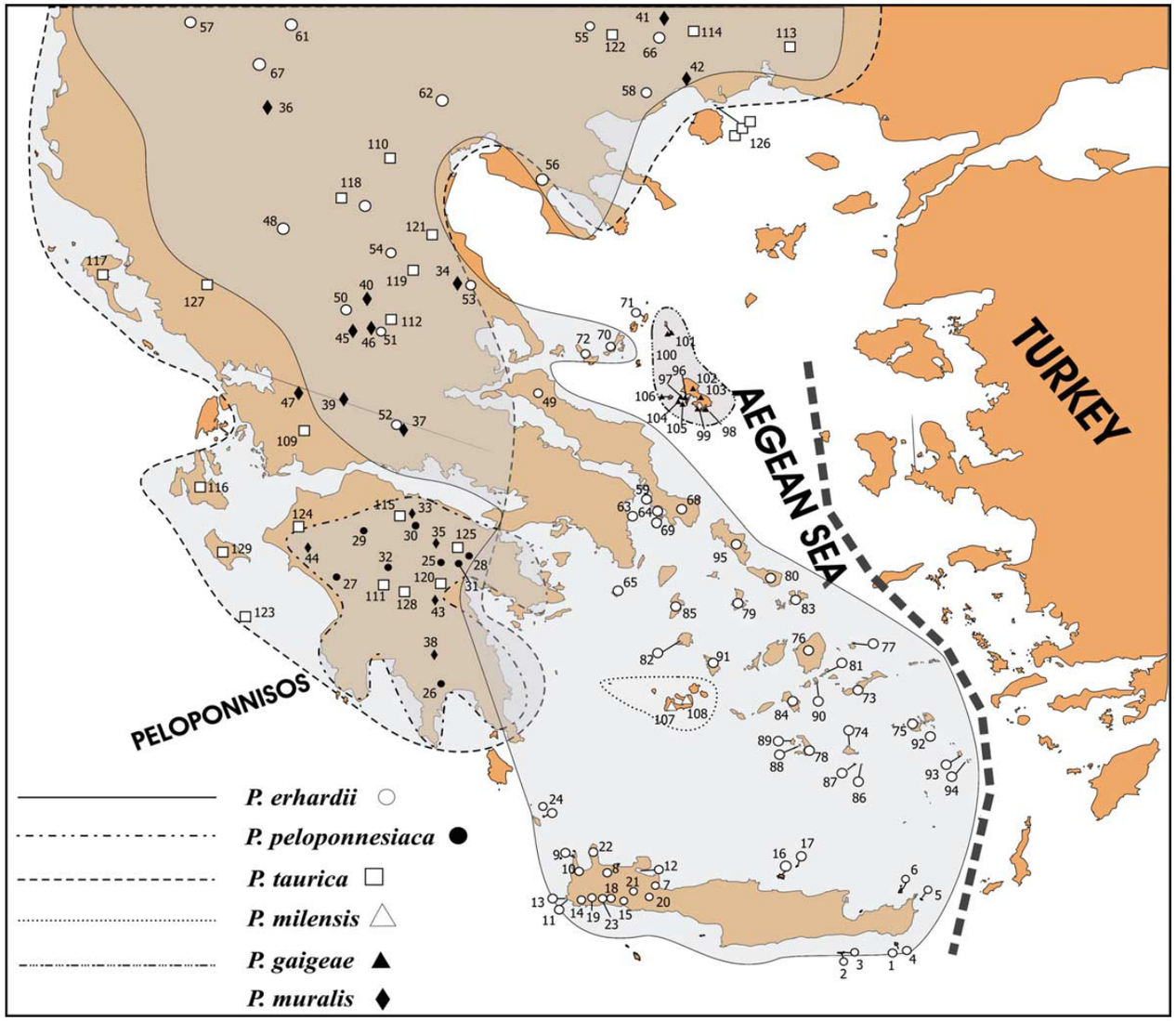
Figure 3. Parsimony network of cytochrome b haplotypes. Numbered circles: recorded haplotypes. Small circles stand for missing haplotypes. A: The haplotype assumed as ancient for postglacial spread to the north

“warm” species: *Podarcis* species in Balkan peninsula

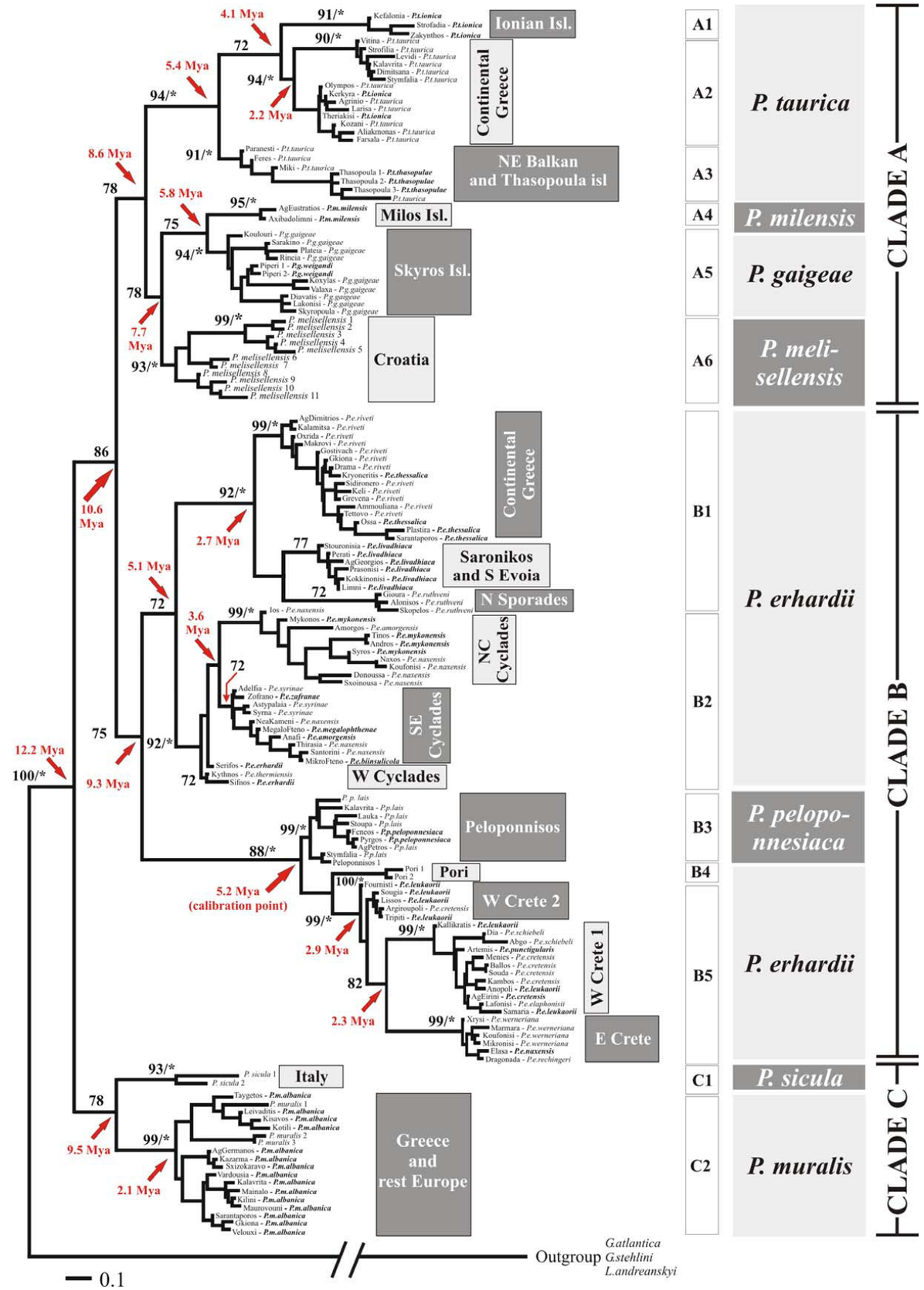
- (GB) Balkan wall lizard group
- (D) Mauereidechse Groupe

"warm" species: *Podarcis* species in Balkan peninsula

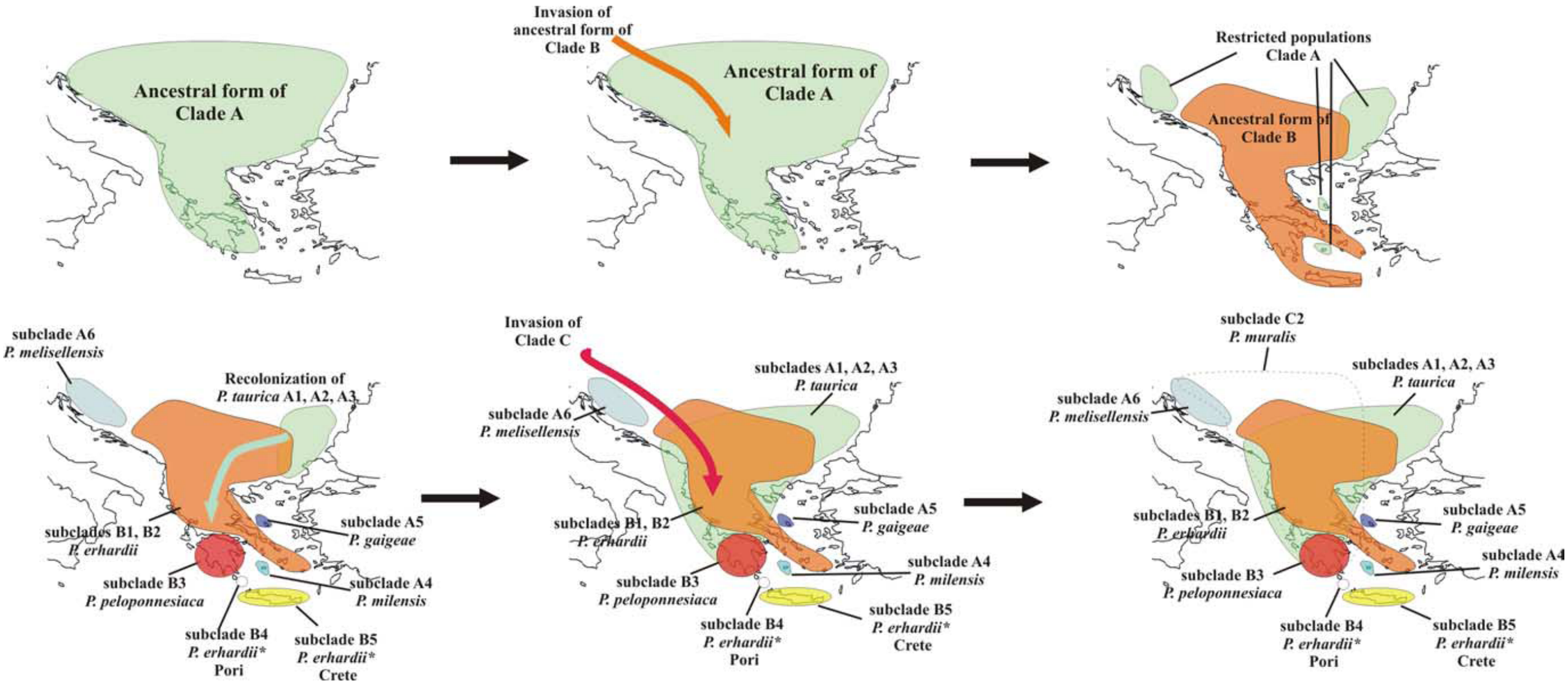
129 samples; cytochrome *b* and 16S, 927 bp.



Poulakakis et al. 2005



“warm” species: *Podarcis* species in Balkan peninsula



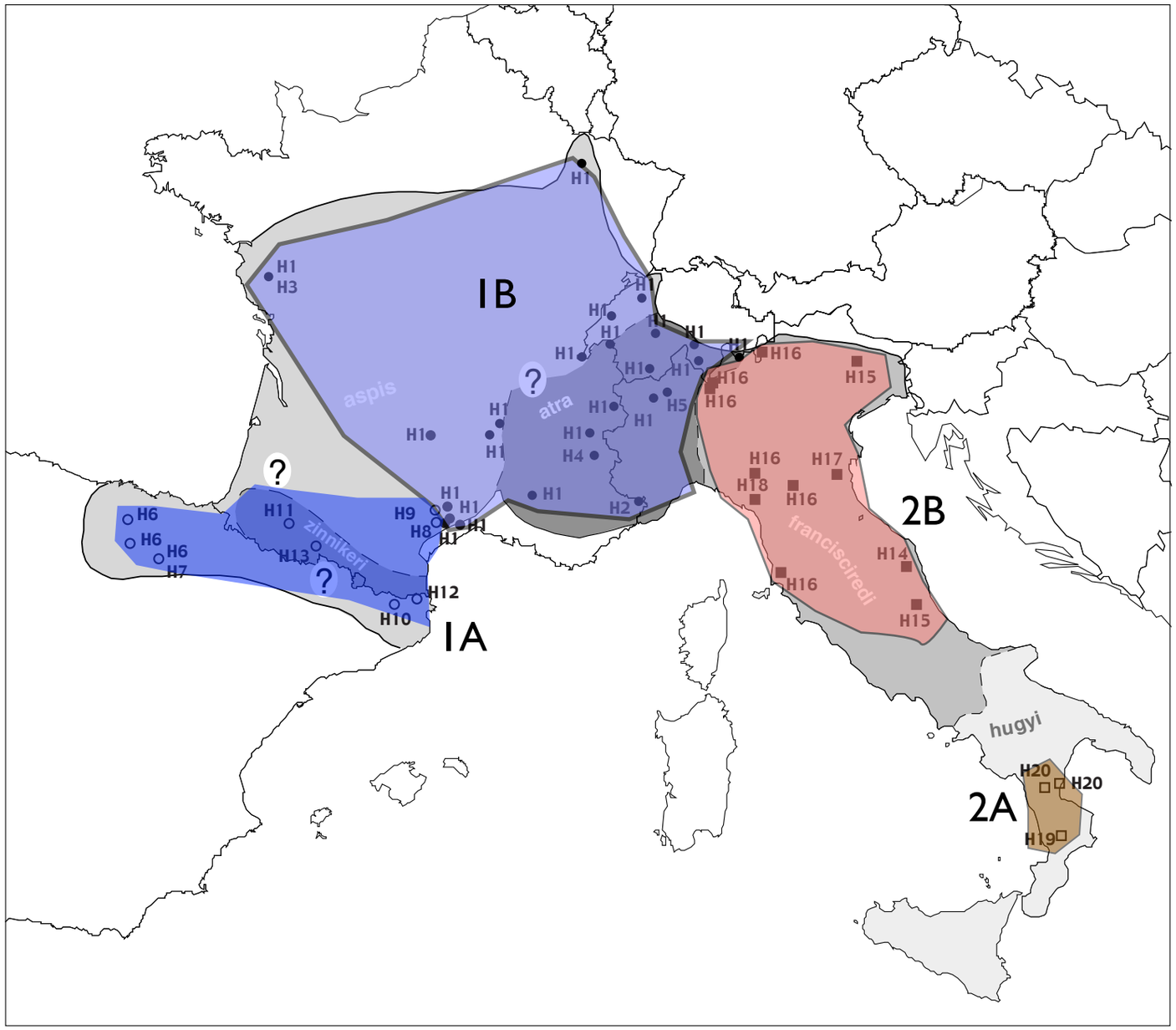
“medium temperate” species: *Vipera aspis*

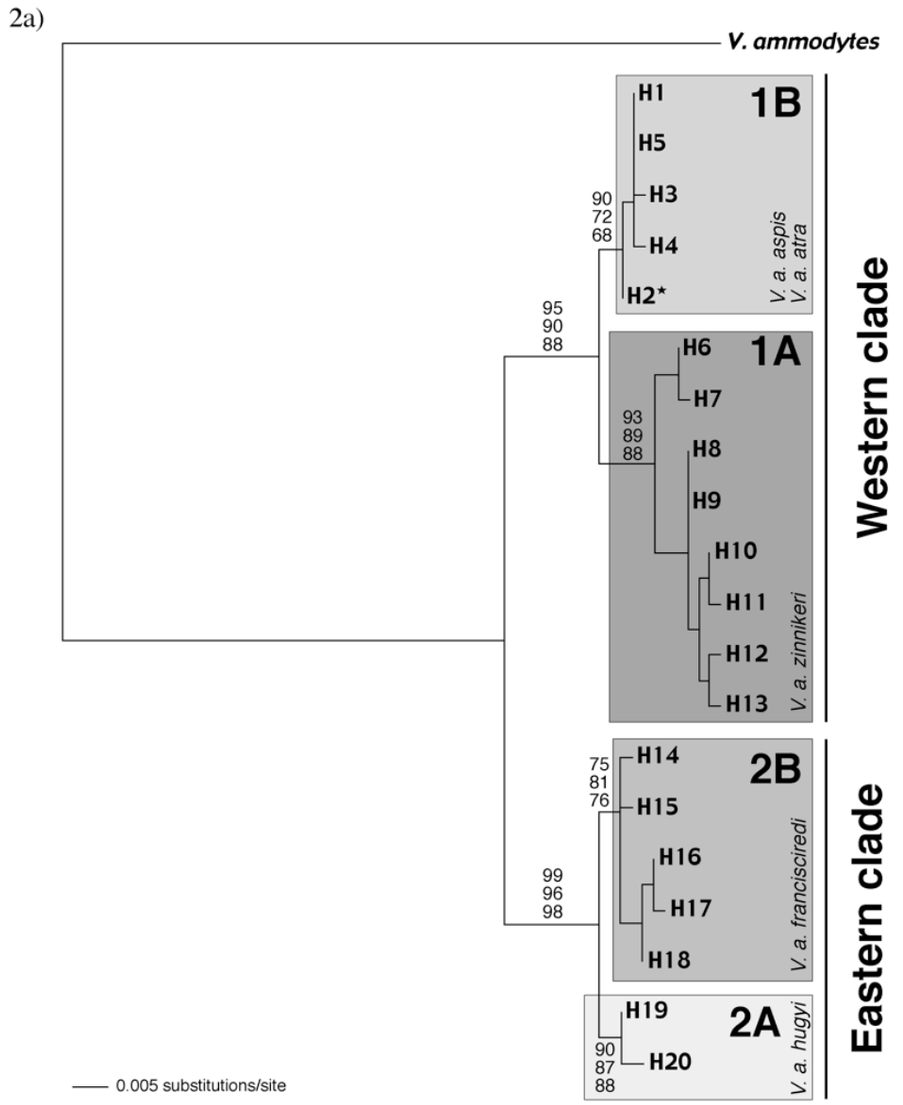
- (GB) Asp viper
- (D) Aspisviper / Juraviper

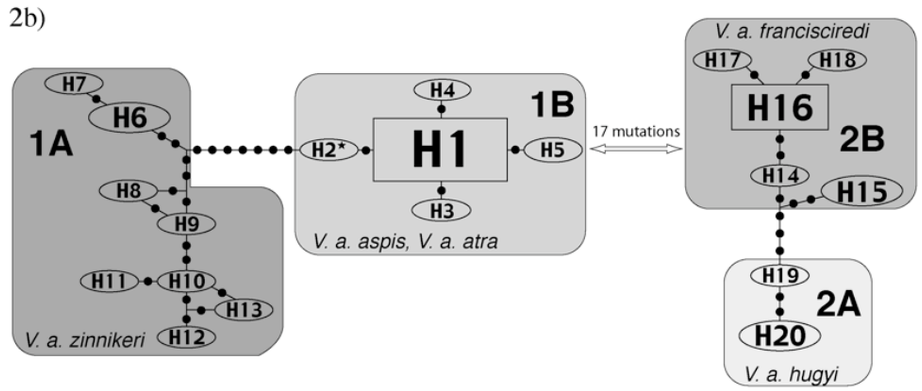
"medium temperate" species: *Vipera aspis*

Ursenbacher et al. 2006

53 samples; Control region, 671 bp.





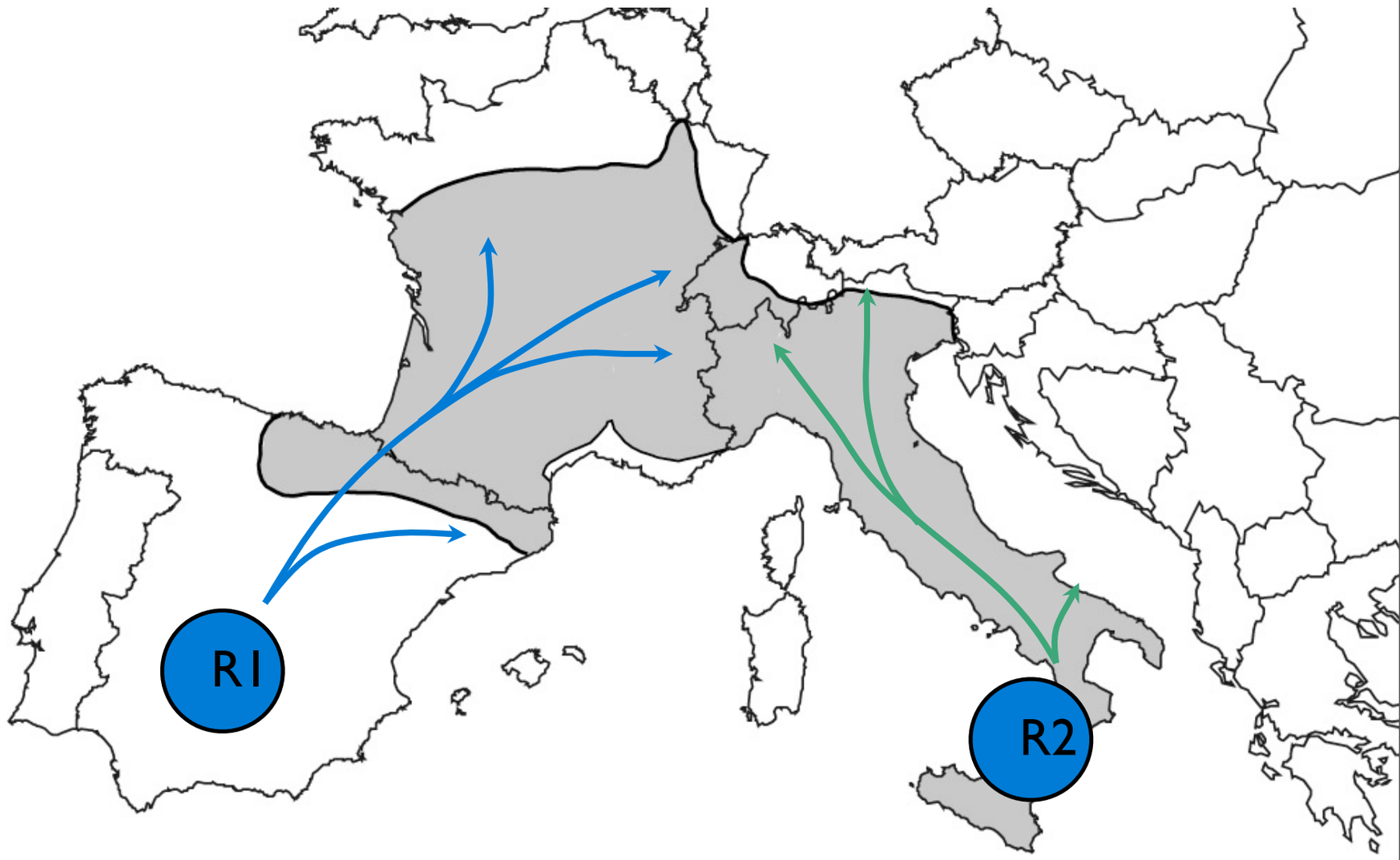


“medium temperate” species: *Vipera aspis*

first: 2 refuges

Spain

Italy



Alps are also a contact zone for several species

i.e.: *Sorex araneus*, *Arvicola terrestris*, *Triturus sp.*, *Salmo trutta*,

Apis mellifera, *Chorthippus parallelus*, ...

“medium temperate” species: *Vipera aspis*

first: 2 refuges

Spain

Italy

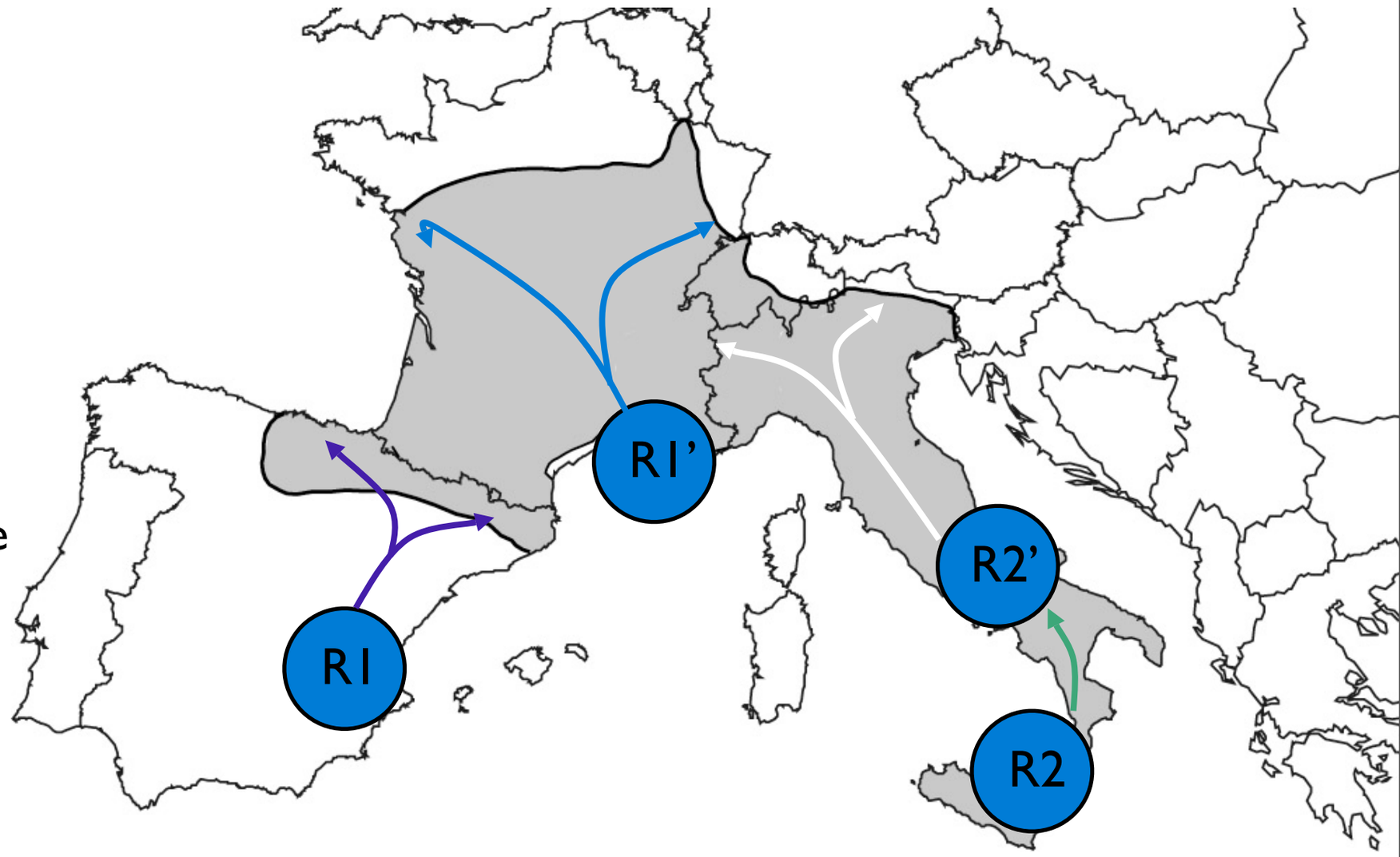
first: 4 refuges

Spain

France

Italy

Italy

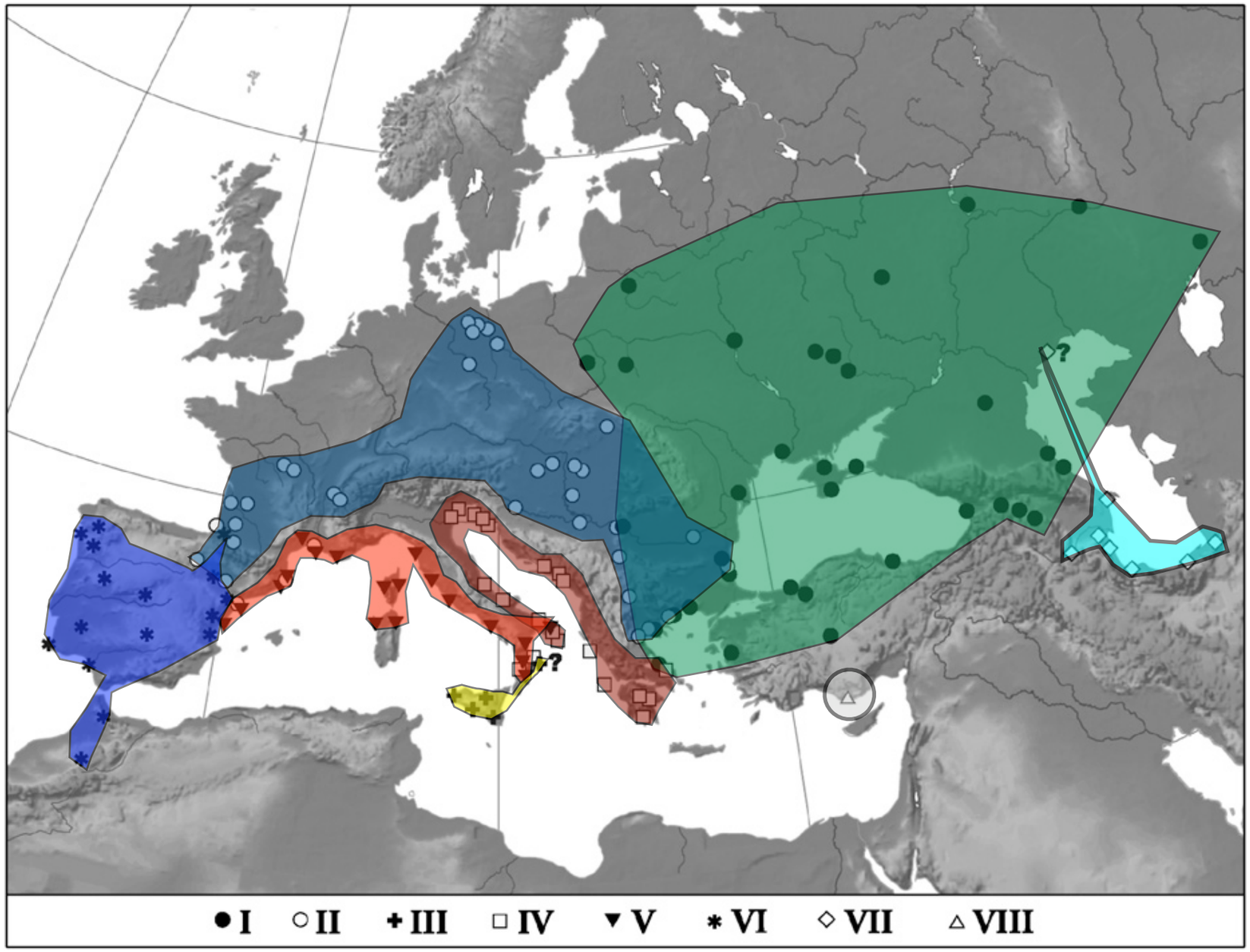


“medium temperate” species: *Emys orbicularis*

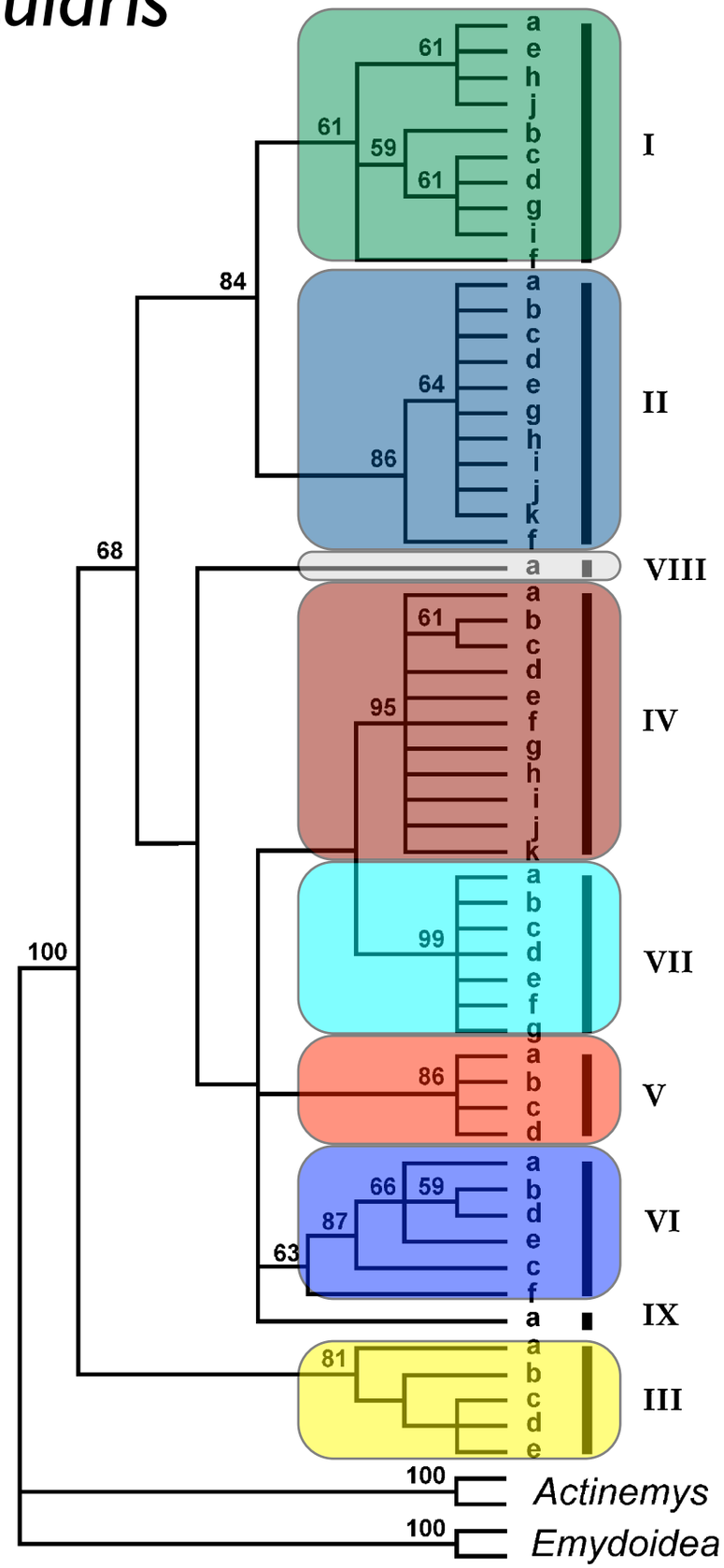
- (GB) European pond turtle / European pond tortoise
- (D) Europäische Sumpfschildkröte

“medium temperate” species: *Emys orbicularis*

>1100 samples; cytochrome *b*, 1031 bp.



Fritz et al. 2007

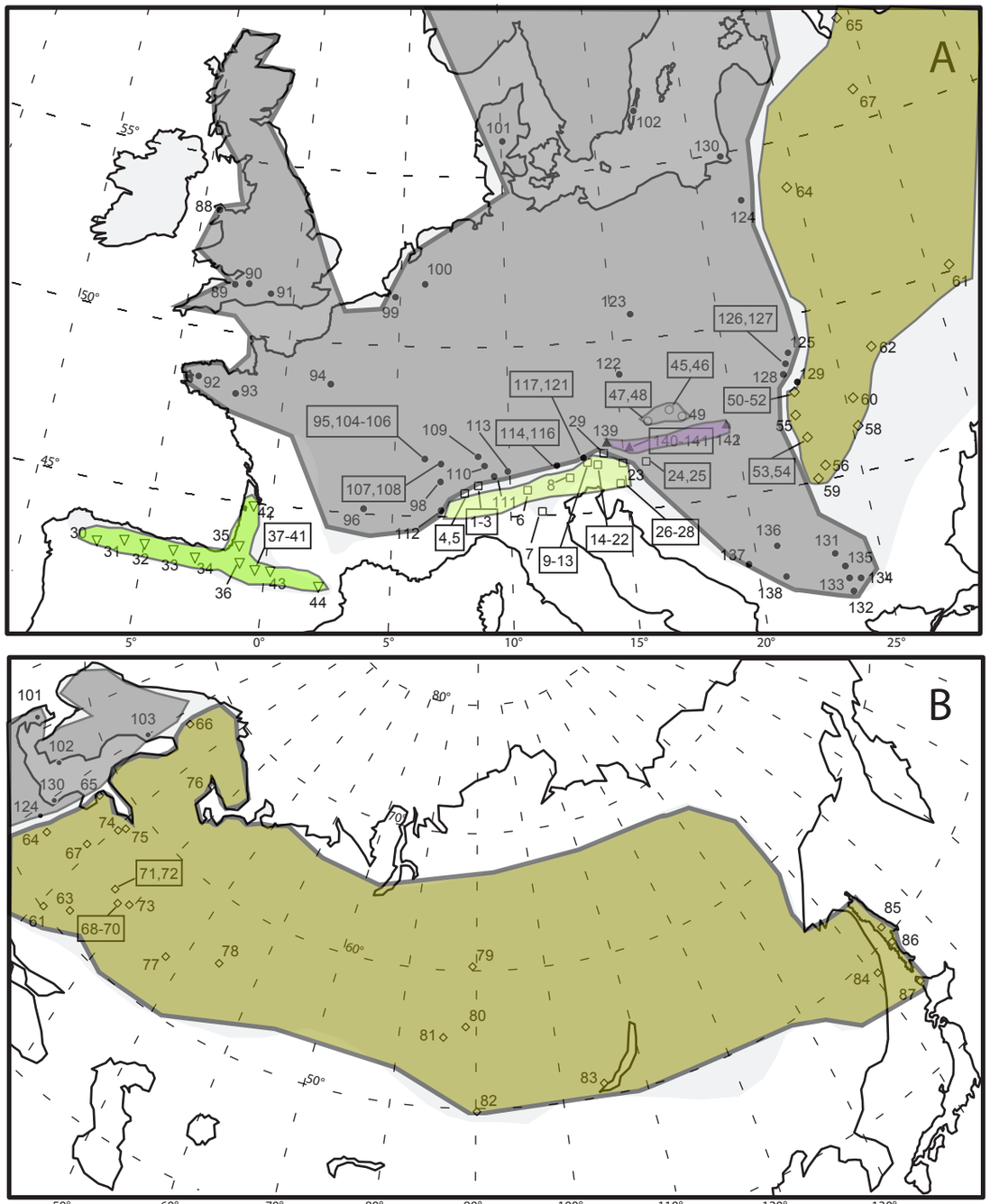


“cold-tolerant” species: *Zootoca (Lacerta) vivipara*

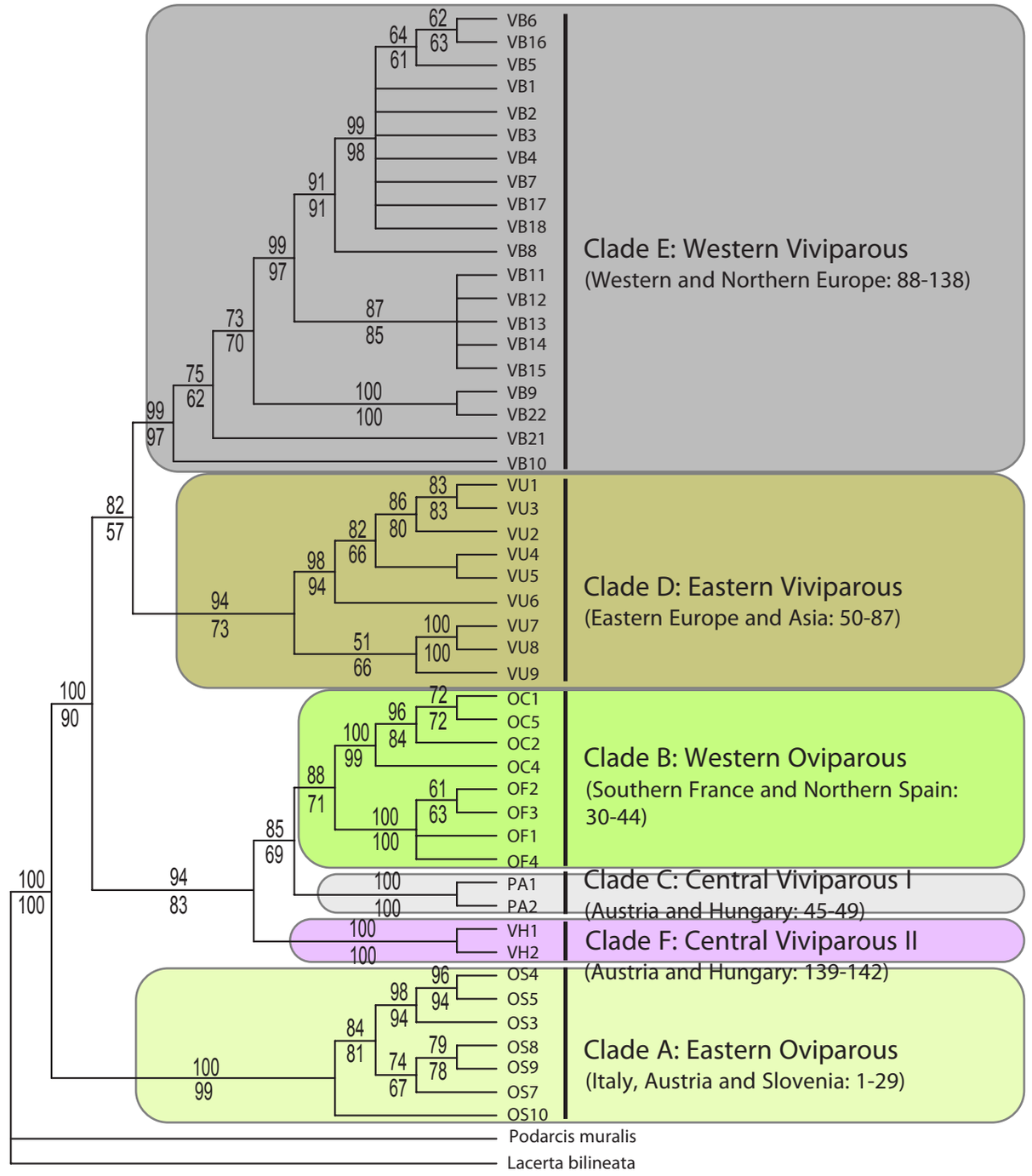
- (GB) European common lizard
- (D) Waldeidechse / Bergeidechse / Mooreidechse

"cold-tolerant" species: *Zootoca (Lacerta) vivipara*

522 samples; cytochrome b and 16S, 1660 bp

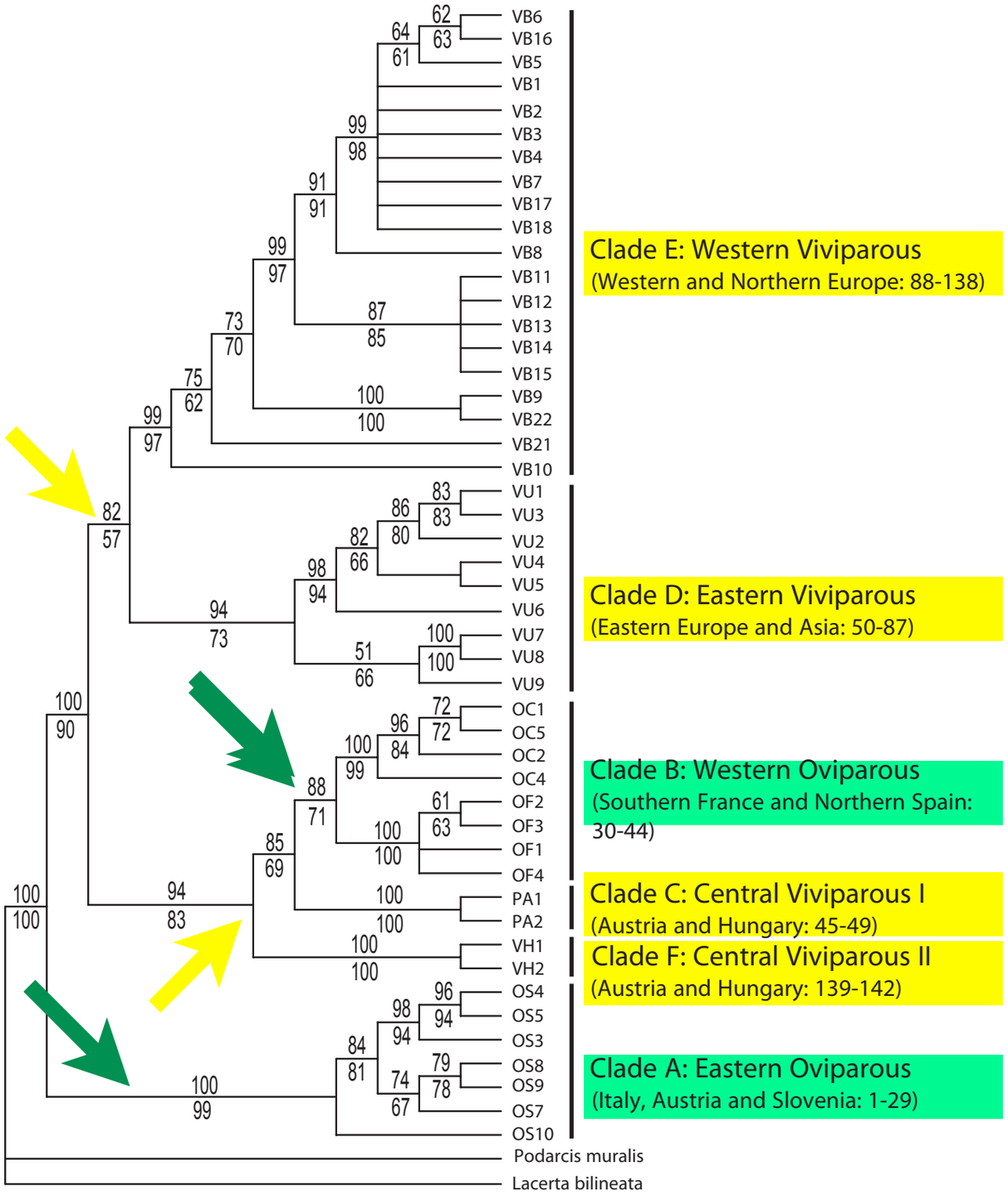


Surget-Groba et al (2006)



"cold-tolerant" species: *Zootoca (Lacerta) vivipara*

Surget-Groba et al (2006)



Clade E: Western Viviparous
(Western and Northern Europe: 88-138)

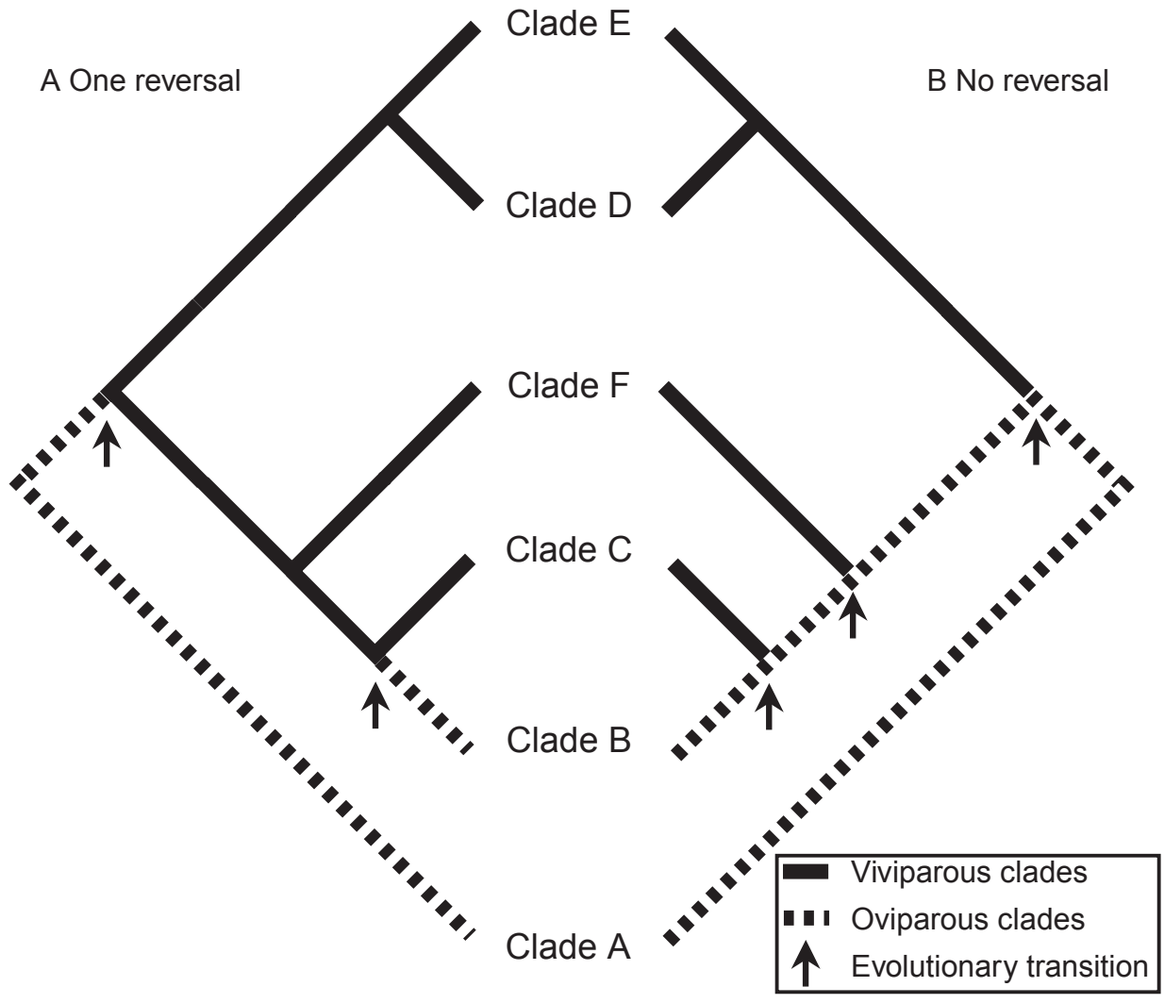
Clade D: Eastern Viviparous
(Eastern Europe and Asia: 50-87)

Clade B: Western Oviparous
(Southern France and Northern Spain: 30-44)

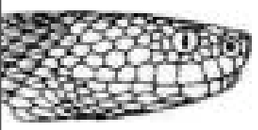
Clade C: Central Viviparous I
(Austria and Hungary: 45-49)

Clade F: Central Viviparous II
(Austria and Hungary: 139-142)

Clade A: Eastern Oviparous
(Italy, Austria and Slovenia: 1-29)



“cold-tolerant” species: *Vipera berus*



- (GB) adder / common adder
- (D) Kreuzotter

“cold-tolerant” species: *Vipera berus*

Ursenbacher et al. 2006

Material & Methods

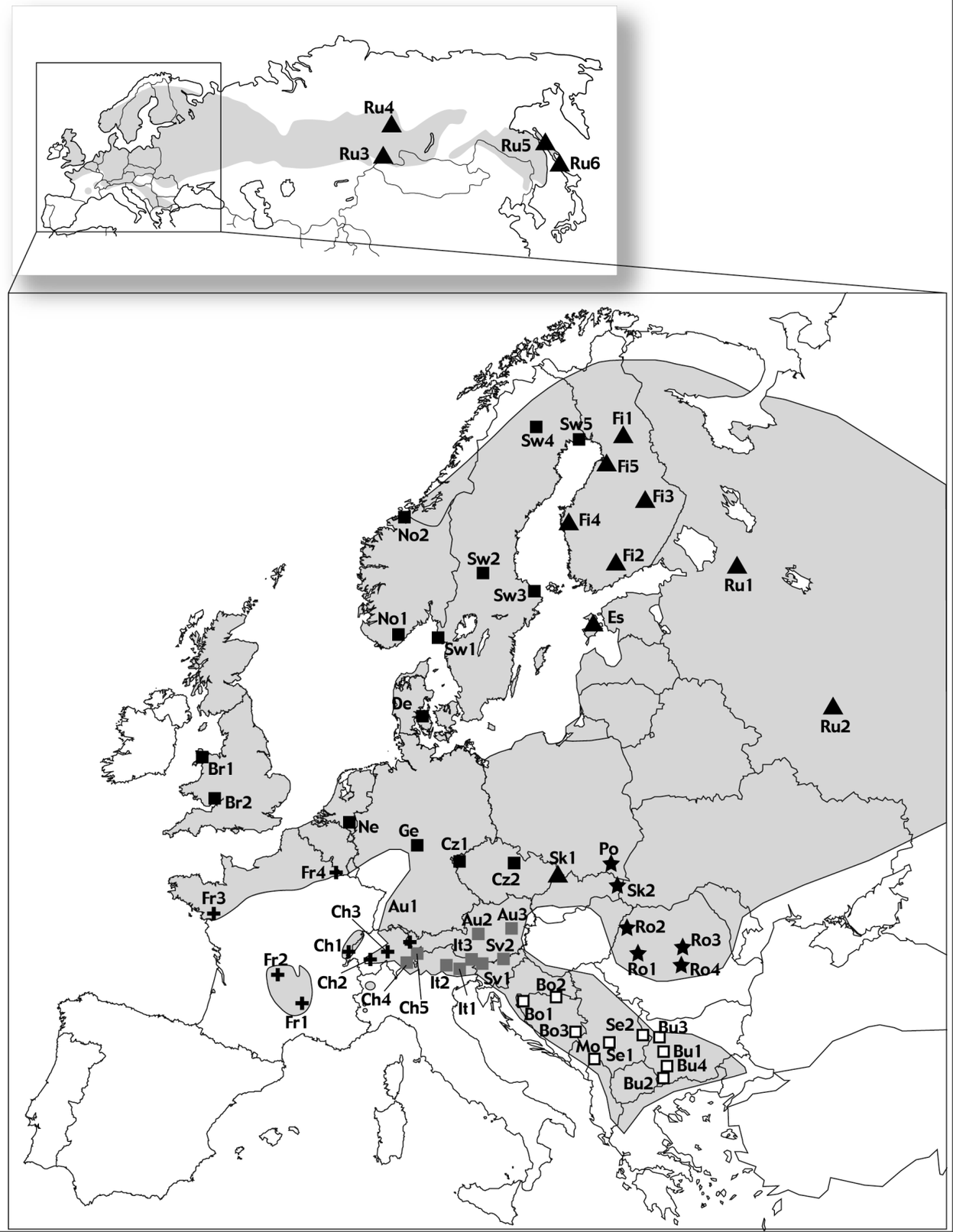
80 samples, 60 diff. populations

Blood, sloughed skin, scales, tip tail, tissues from different museums

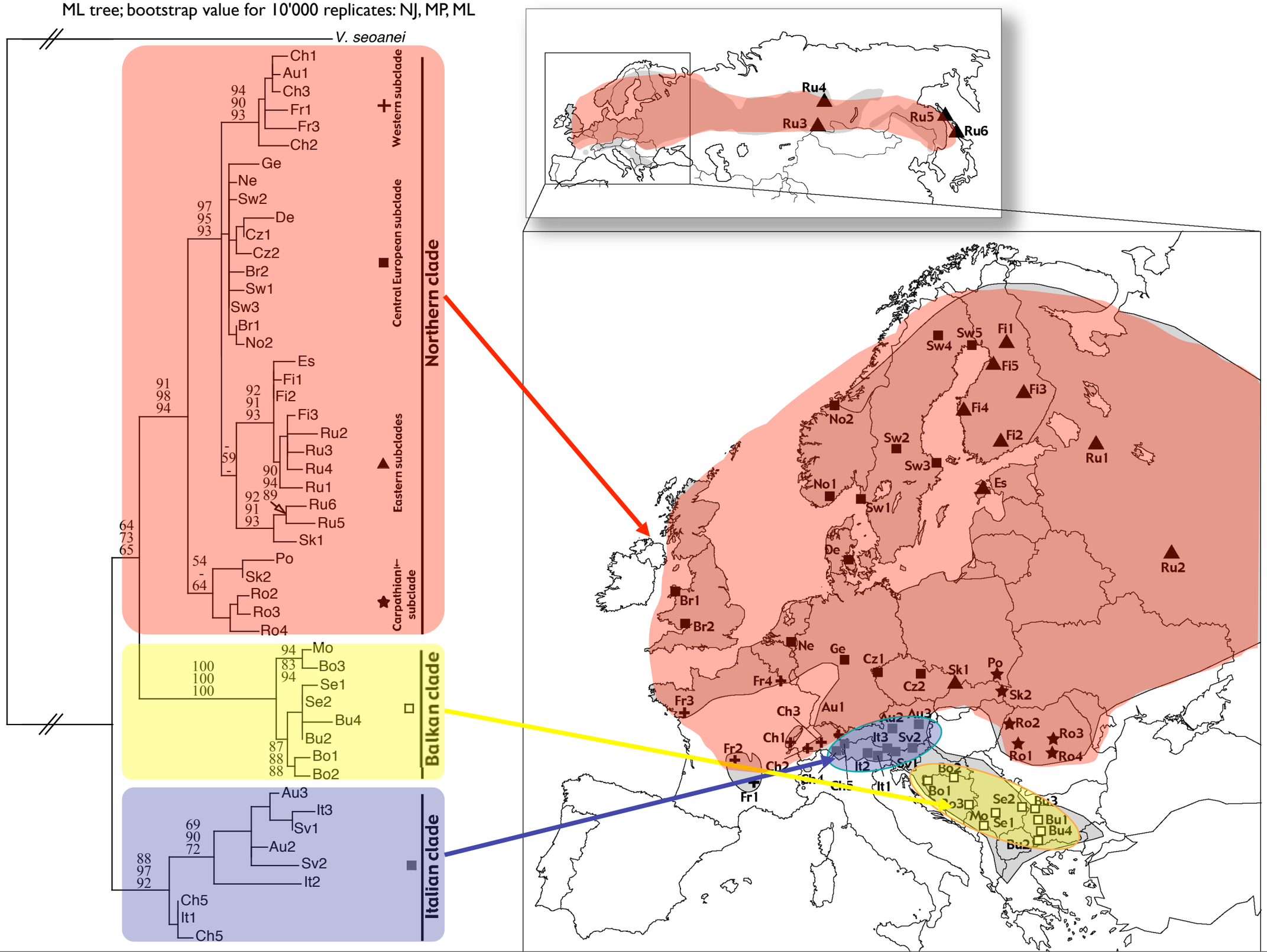
PCR, Sequencing (cyt *b* + CR)

cyt *b* + CR = 1981 bp.

45 haplotypes of the CR
50 samples sequenced (CR + cyt b)



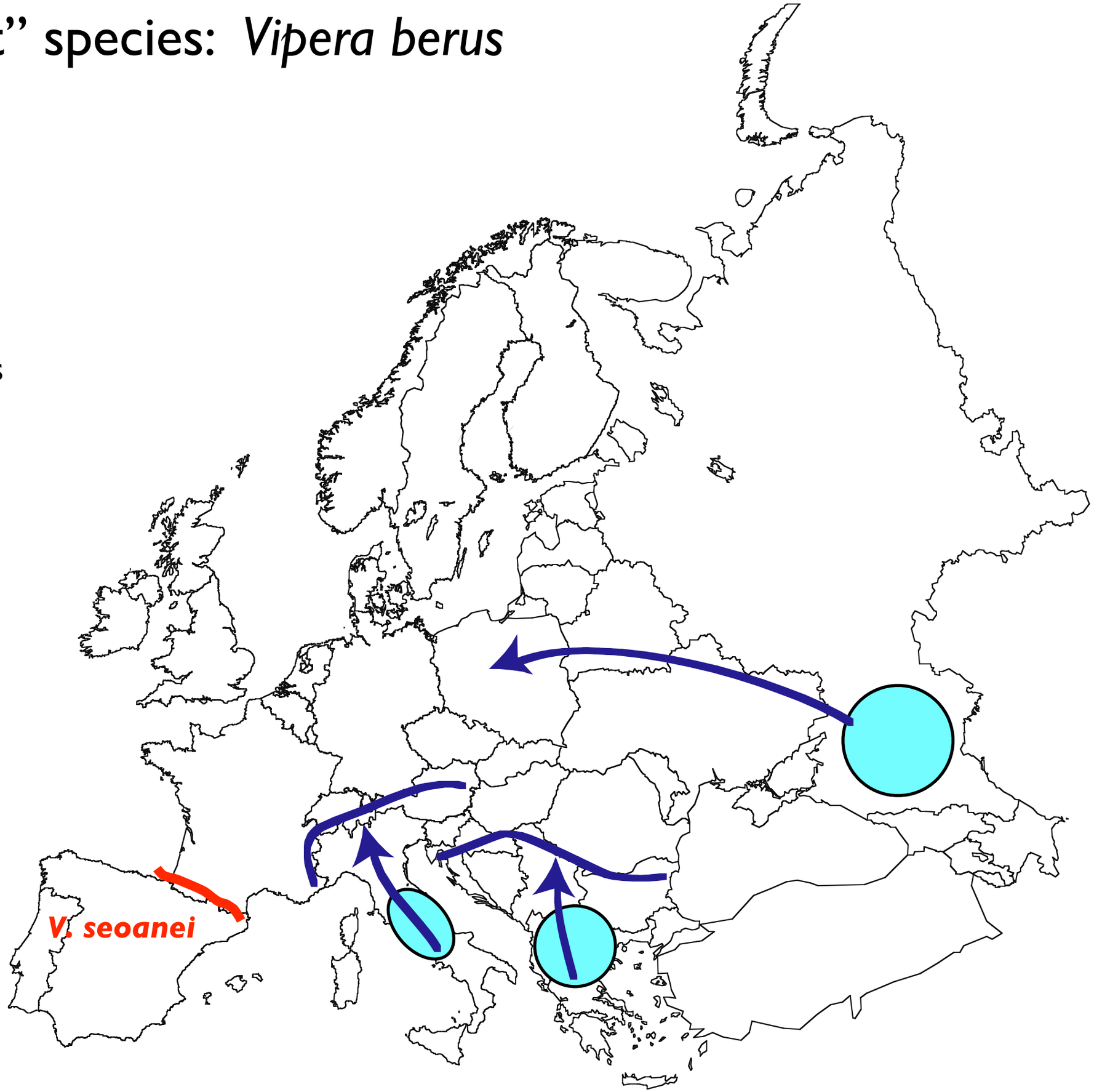
“cold-tolerant” species: *Vipera berus*



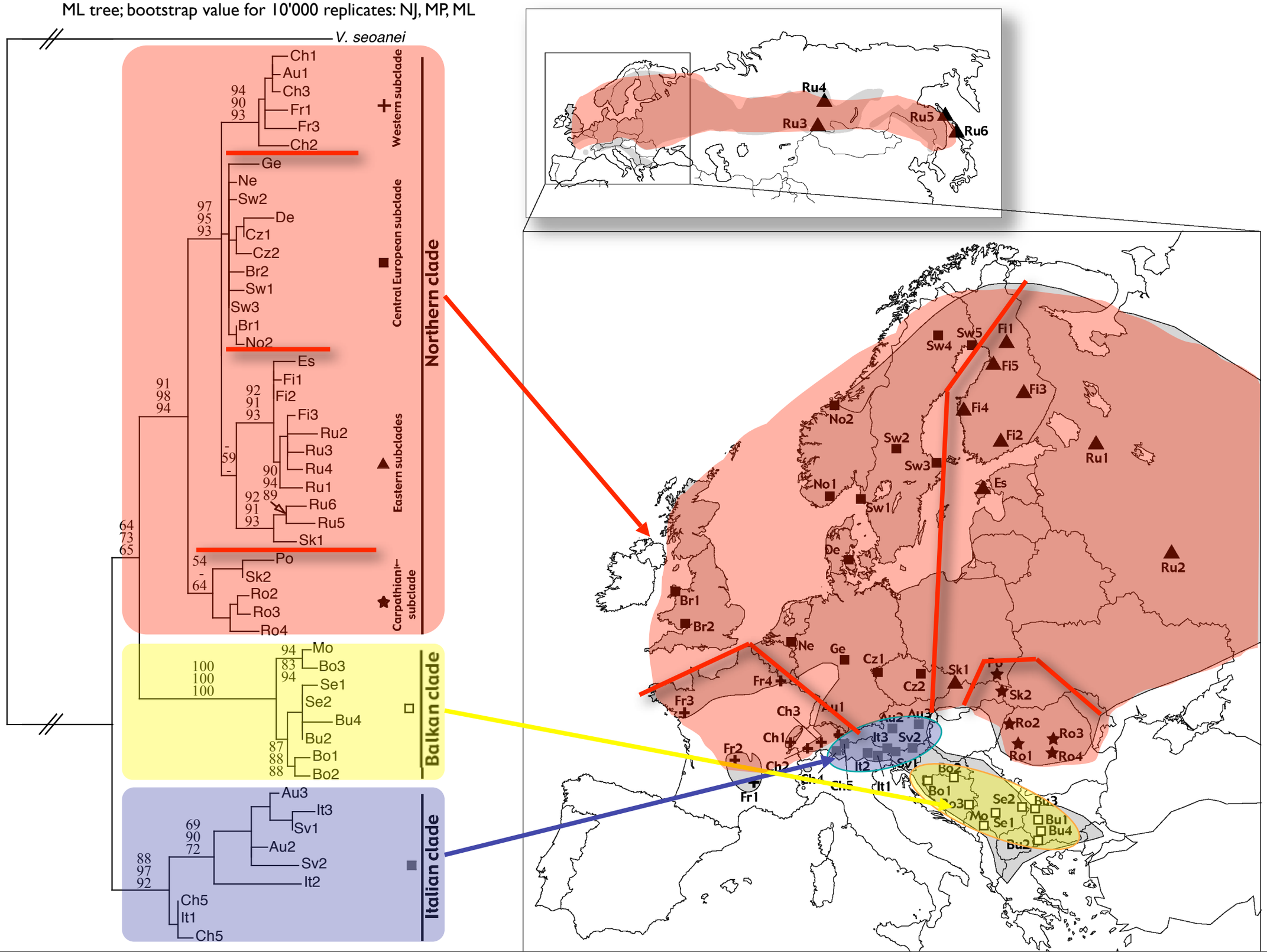
“cold-tolerant” species: *Vipera berus*

3 Refugial areas

- Italy
- Balkan peninsula
- Caucasus Mountains



“cold-tolerant” species: *Vipera berus*



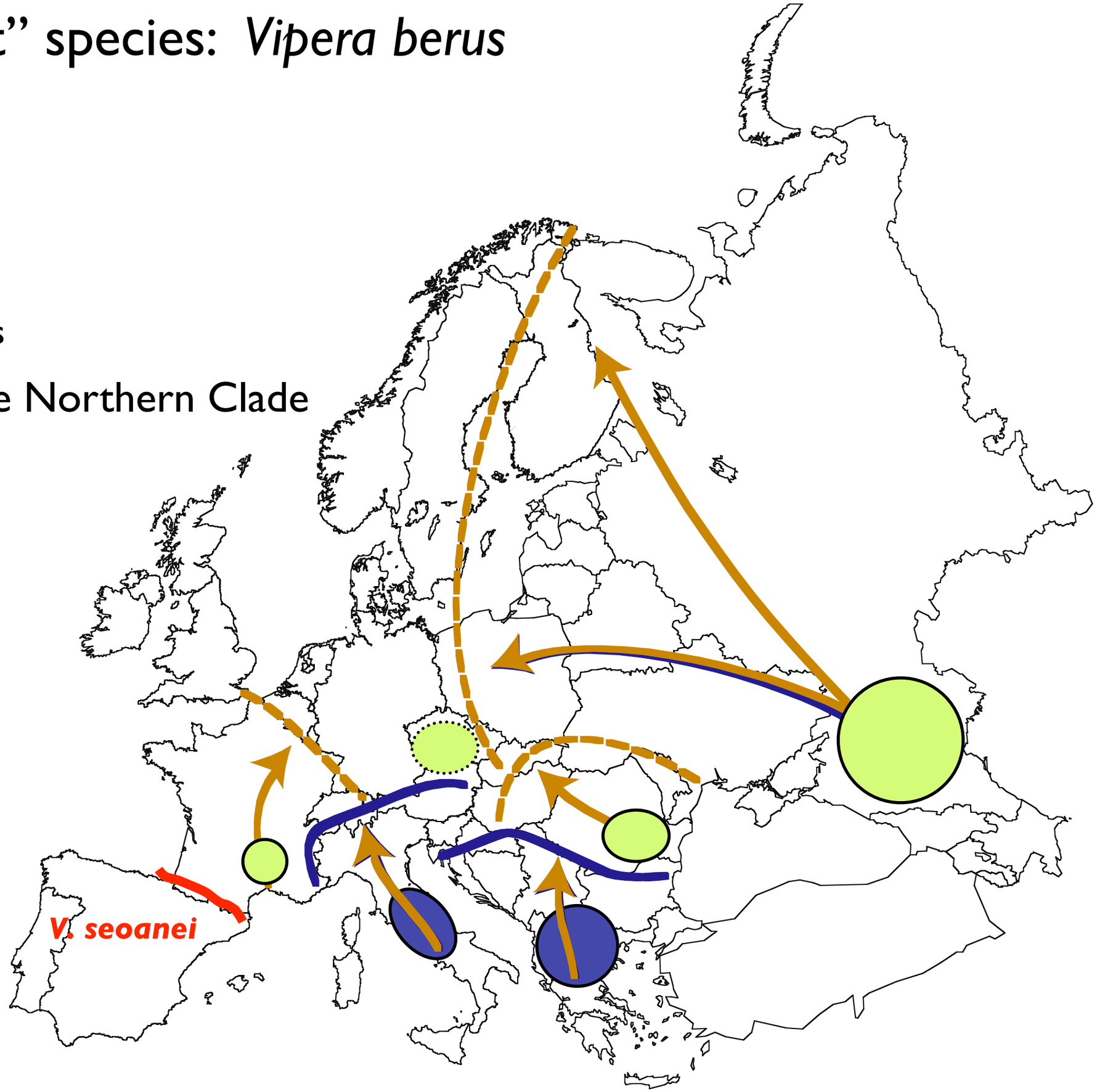
“cold-tolerant” species: *Vipera berus*

3 Refugial areas

- Italy
- Balkan peninsula
- Caucasus Mountains

Sub-structure in the Northern Clade

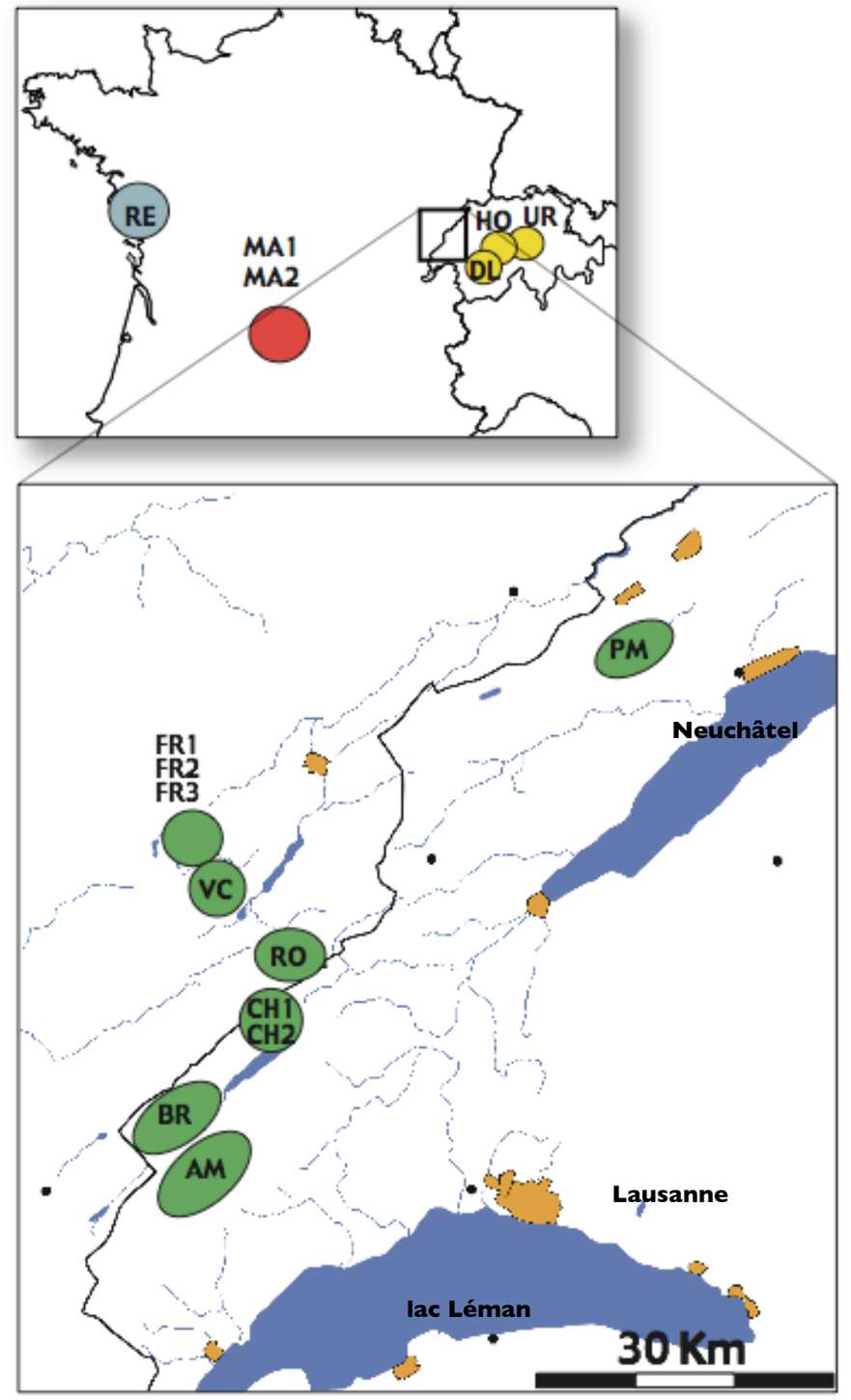
- France
- Central Europe
- Romania
- Russia



“cold-tolerant” species: *Vipera berus*

Ursenbacher et al. 2008

- *V. berus* in the Jura Mountains: isolated
- Samples
  - 10 populations in the Jura Mountains
  - 3 in the Alps, 2 Massif Central,
  - 1 Atlantic Coast
- Microsatellites
  - 13 microsatellites developed:
  - 7 without null alleles, follow Hardy-Weinberg, not linked, …



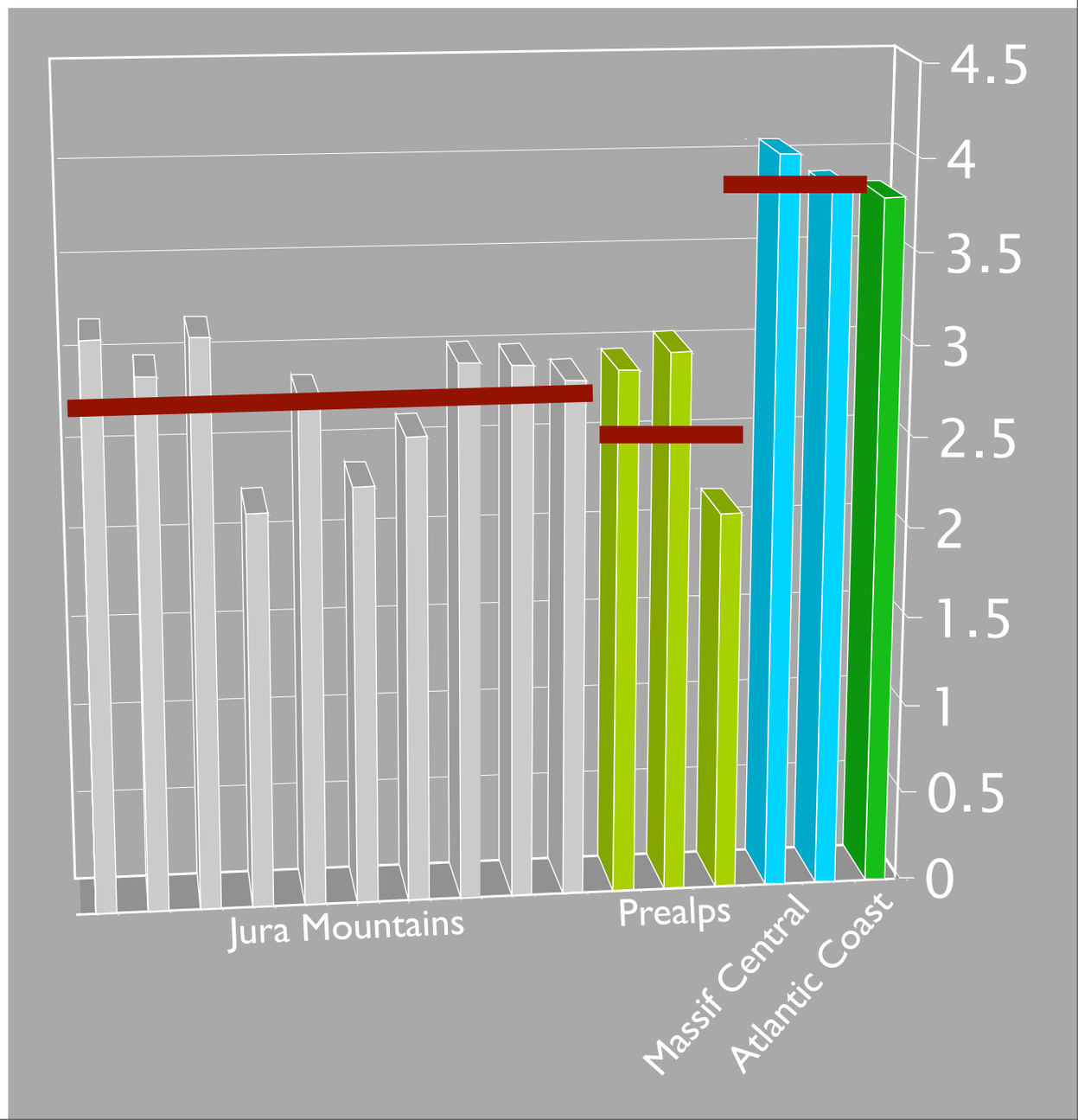
"cold-tolerant" species: *Vipera berus*

- Allelic richness

Jura Mountains + Alps:
$A_R \approx 2.8$ (2.11-3.14)

Massif Central + Atlantic Coast:
$A_R \approx 3.9$ (3.80-4.04)

Possible reasons:
- recent culling? (last centuries)
- bottleneck? not detected by BOTTLENECK (200-1500 years ago)
- Ne: populations not smaller in the Alps
- historical reasons: recolonisation after the last glaciation

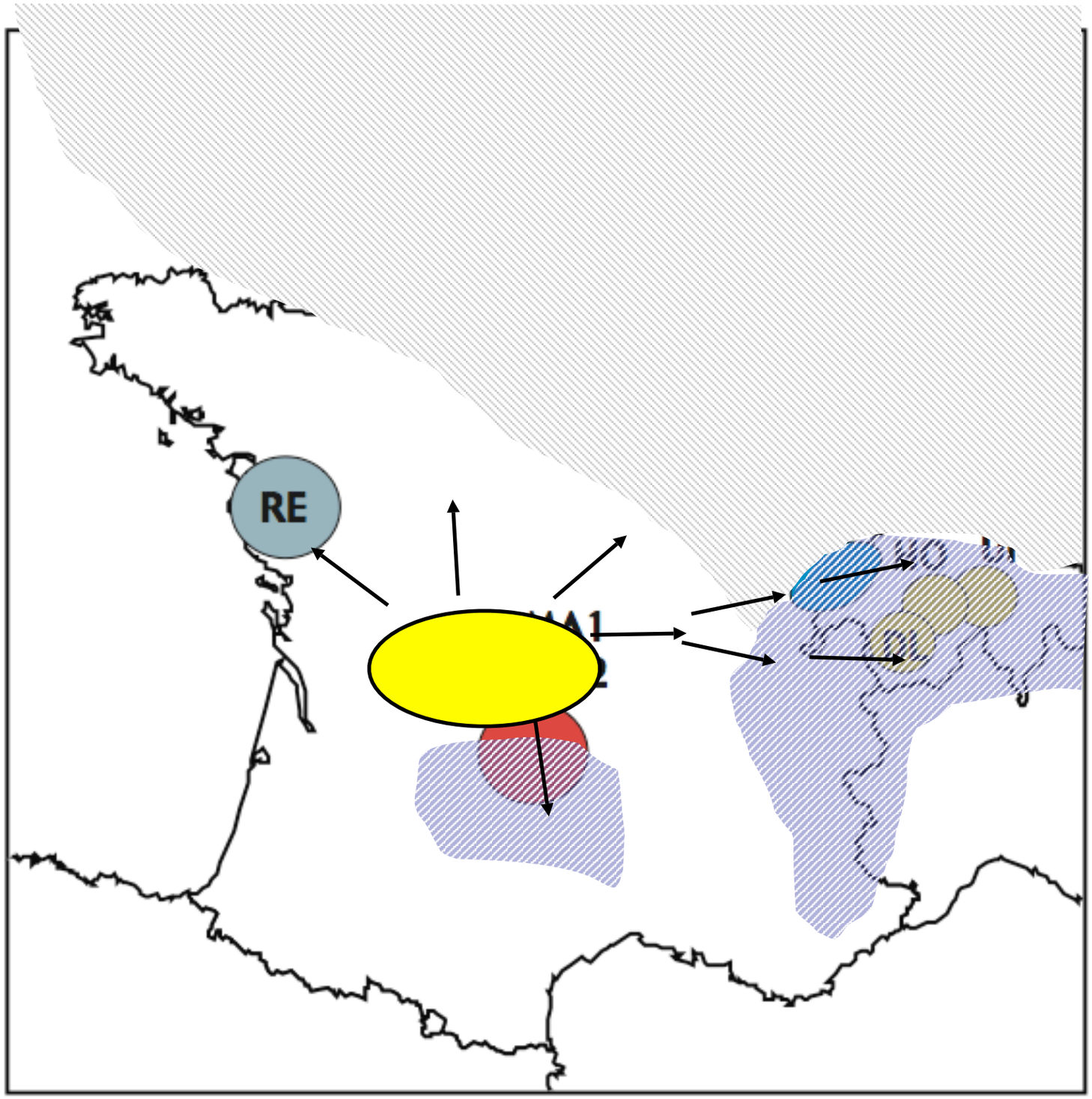


“cold-tolerant” species: *Vipera berus*

Jura Mountains + Alps:
$A_R \approx 2.8$ (2.11-3.14)

Massif Central + Atlantic Coast:
$A_R \approx 3.9$ (3.80-4.04)

Probable historical reasons:
recolonisation after last glaciation
(confirmed by the phylogeographic analysis)



Trends observed in reptiles

- "warm" species
  - split during the Pliocene (3-5 Myr)
  - subsequent split (Pleistocene/Eocene)
  - reduction of genetic diversity during Pleistocene cold periods
- "medium temperate" species
  - use of complementary refugia (not only Italy, Spain and Balkan Peninsula)
  - colonisation around drainage basins (species related to ponds - *Emys*)
- "cold-tolerant" species:
  - split during Pleistocene

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