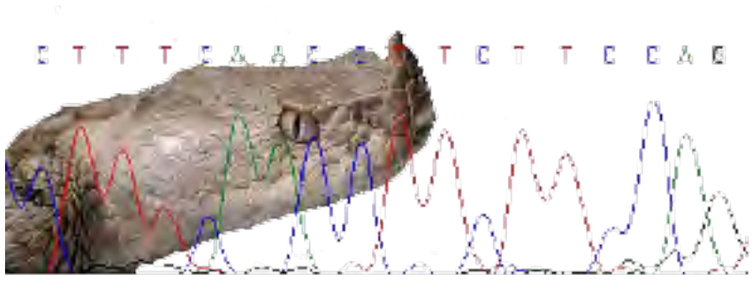
Phylogeography
of European reptiles



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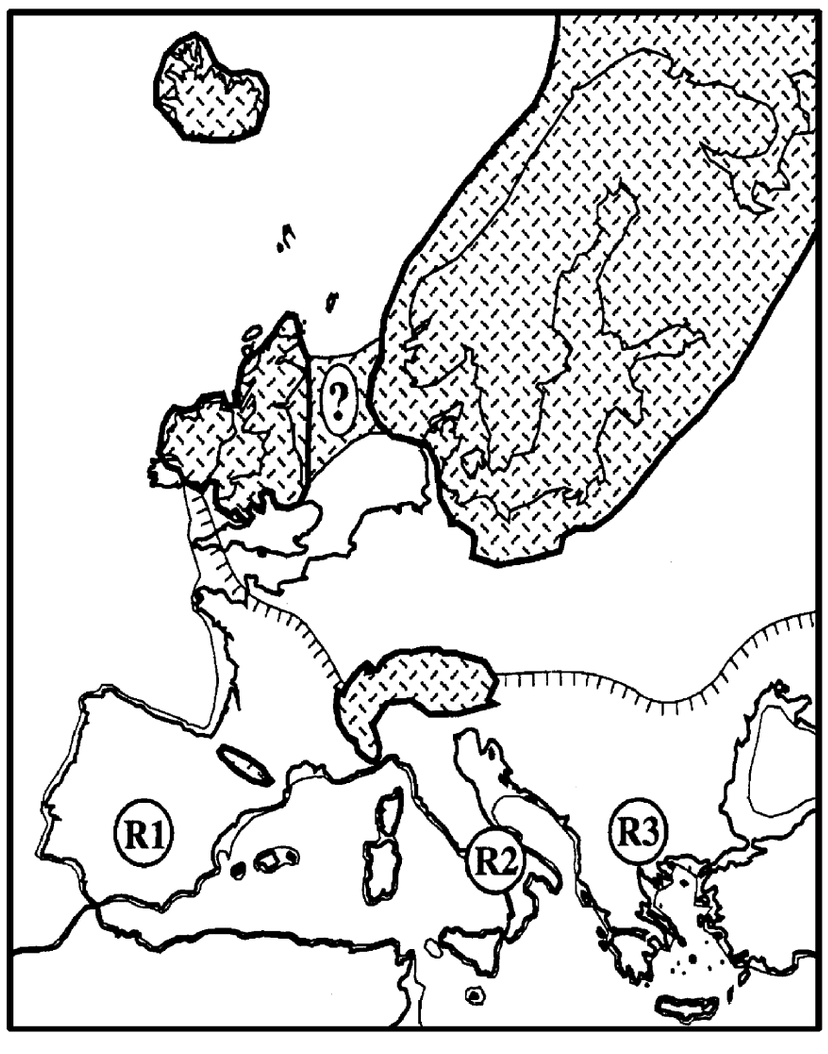
Phylogeography and DNA

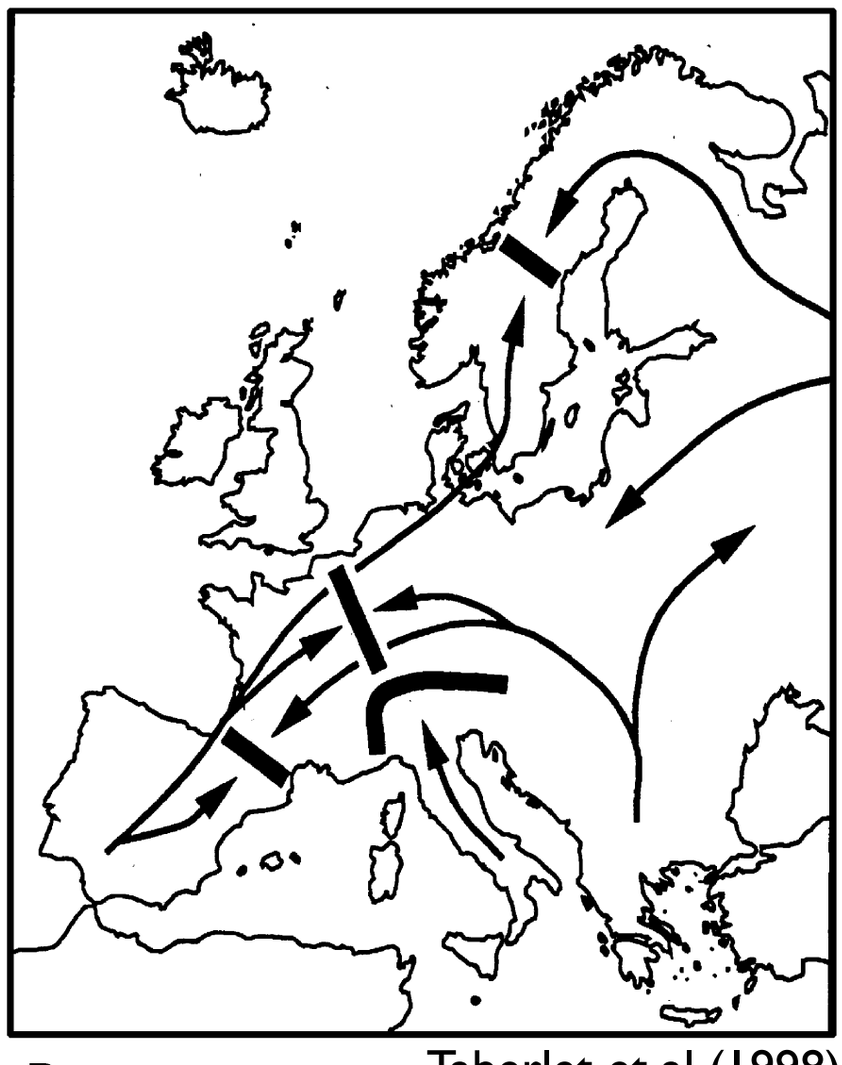
- Phylogeography: historical processes that may be responsible for the contemporary geographic distributions of individuals
- previously based on morphology (but coevolution)
- with PCR: sequencing and genetic relationships
- using mtDNA
  only female genetic structure
- also introns or genetic diversity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

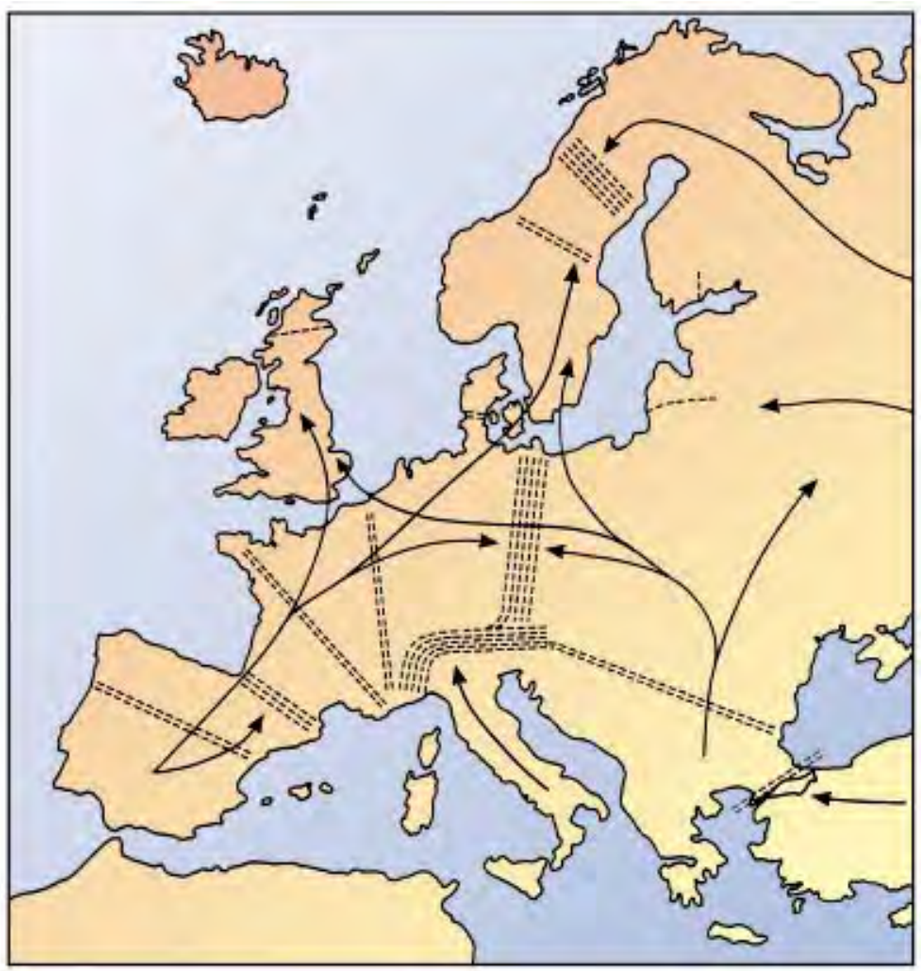


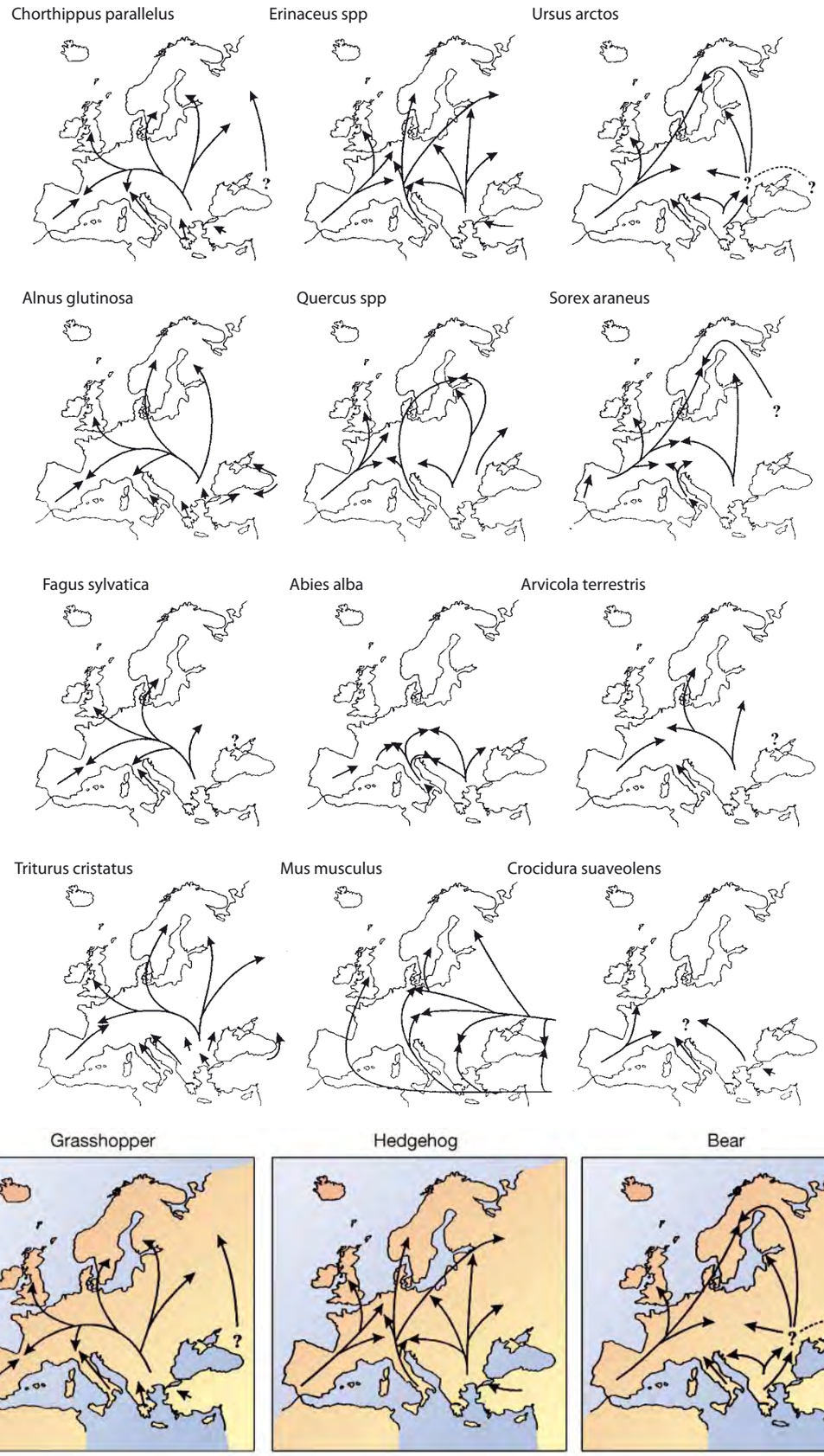
B

Taberlet et al (1998)

Phylogeography in Europe: *introduction*

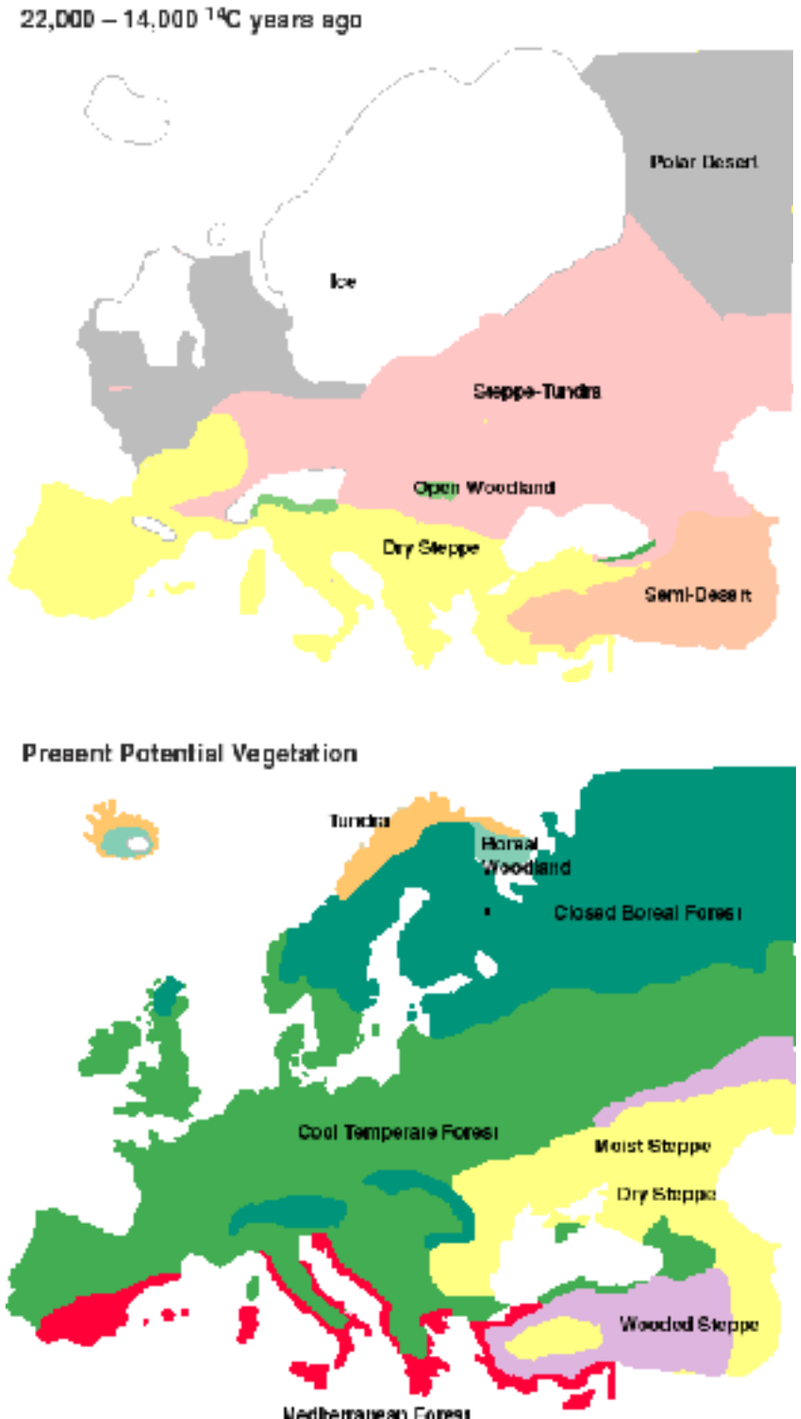
- Hewitt (1999, 2000)

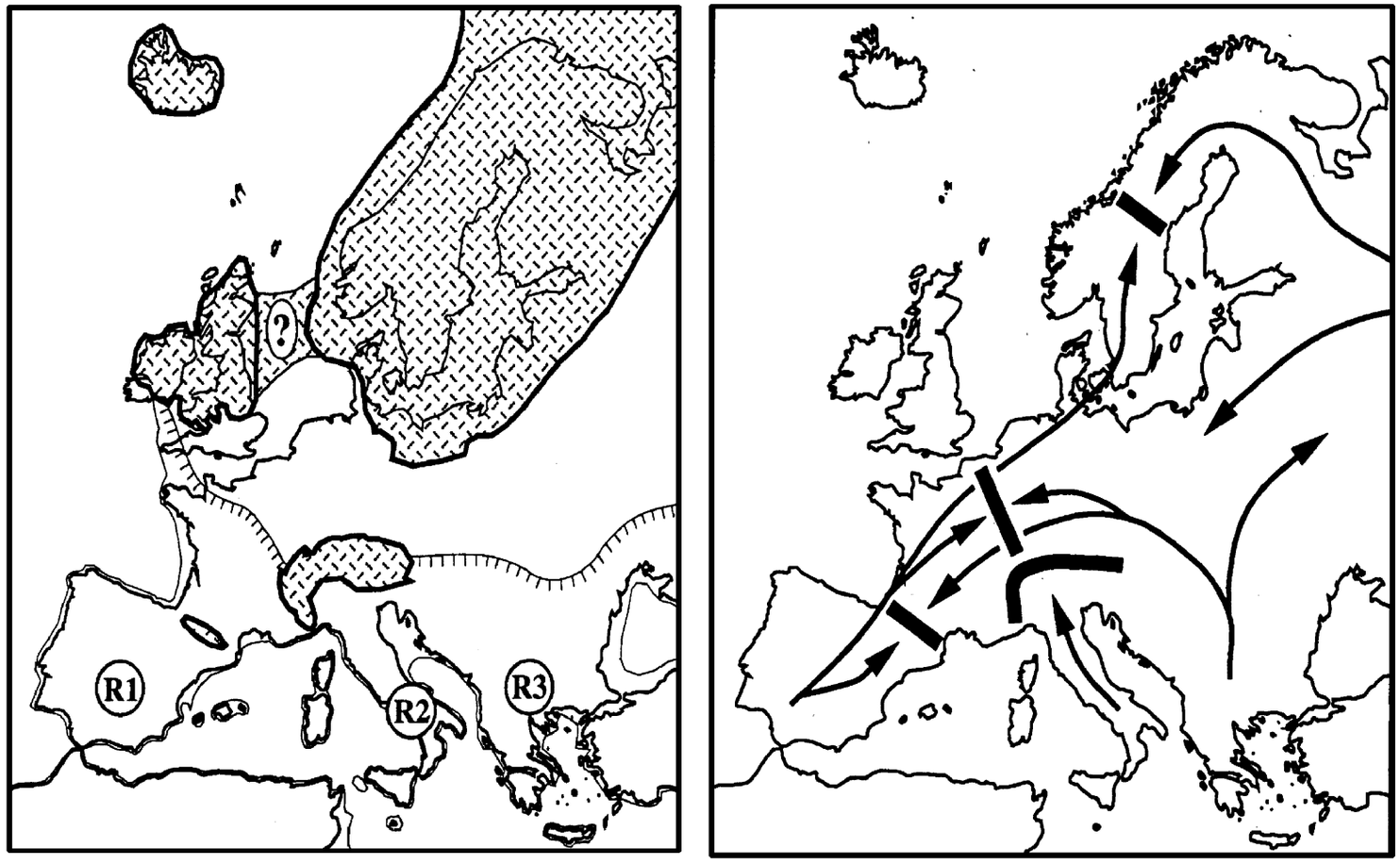




Phylogeography in Europe: *introduction*

- southern refugia for temperate species



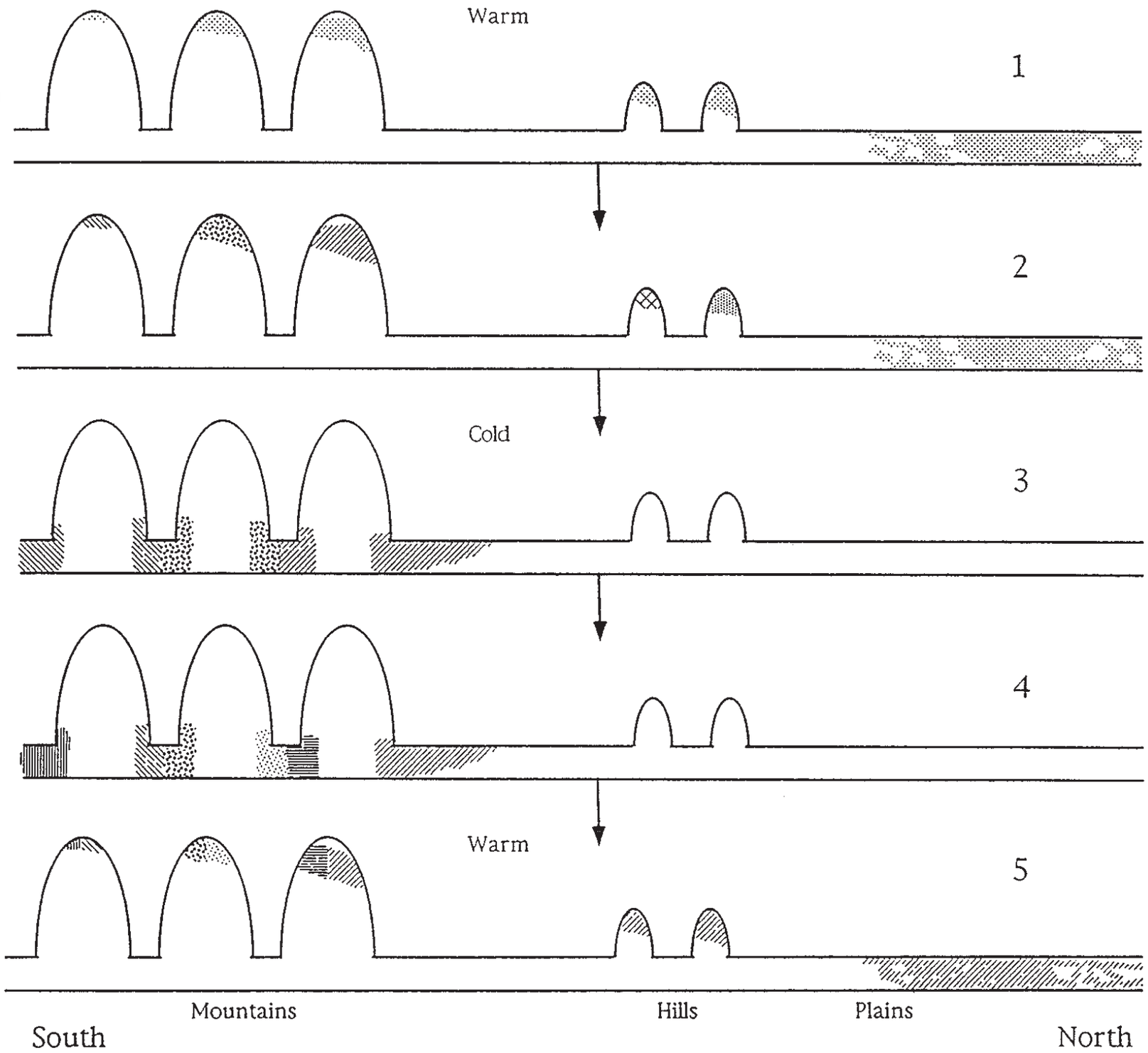


A

B

Phylogeography in Europe: *introduction*

- Differentiati

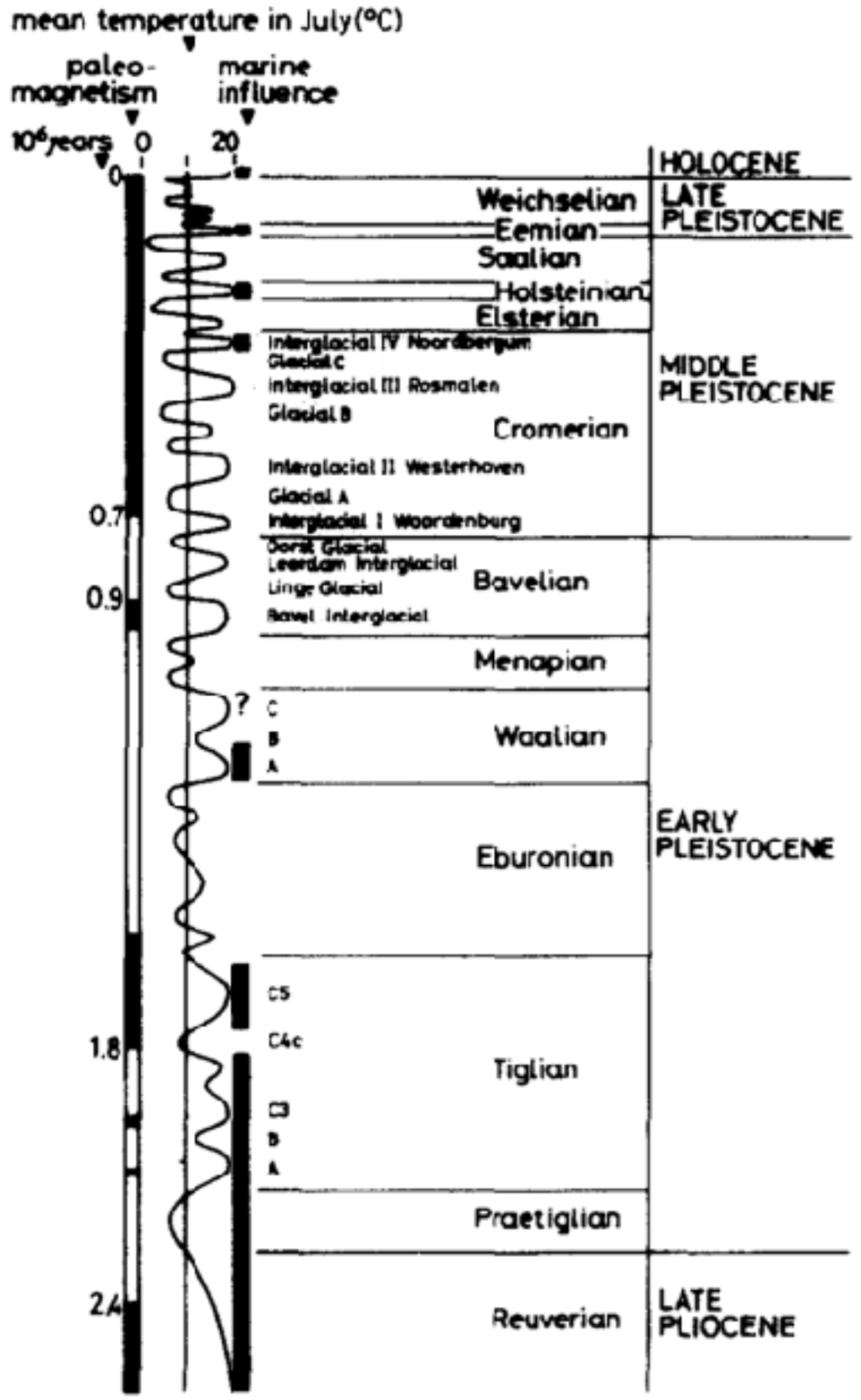


Hewitt, 1996

Phylogeography in Europe: *introduction*

- timing: based on molecular clock
  complex bayesian methods
  estimated e.g. with fossils on islar
  historical split between species, ..

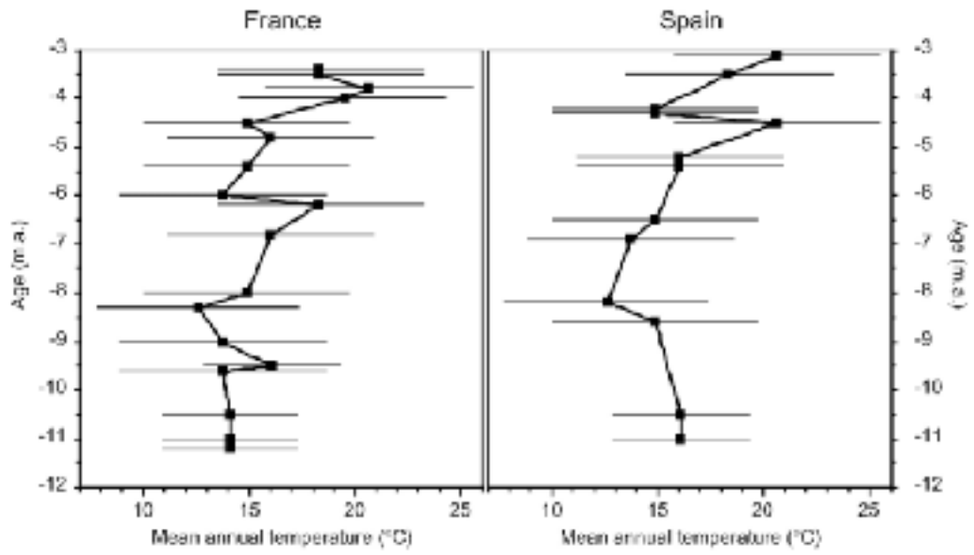
- for most mammals: only Pleistoce
  (max. 1.5 mya)



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)

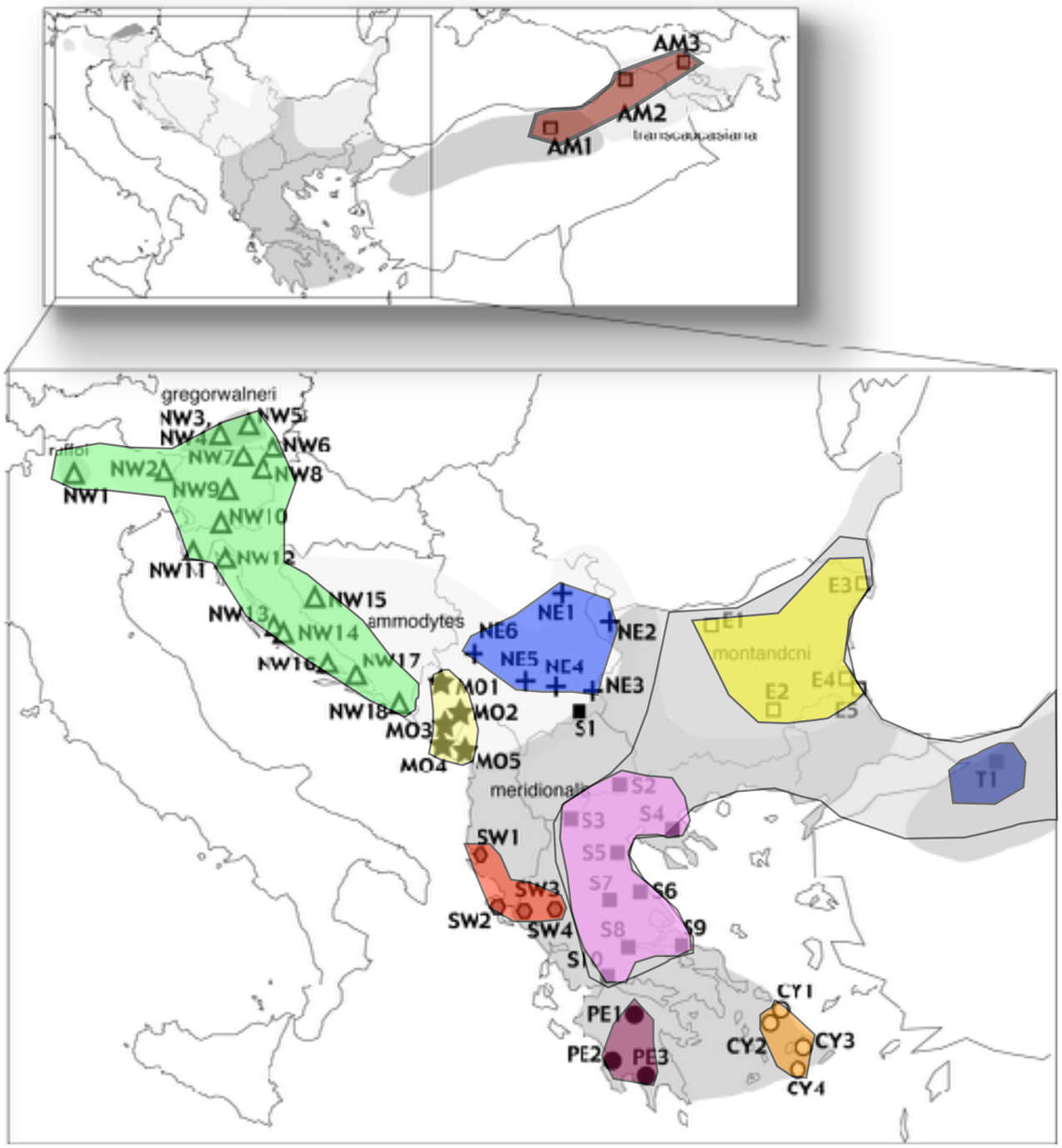
“warm” species: *Vipera ammodytes*

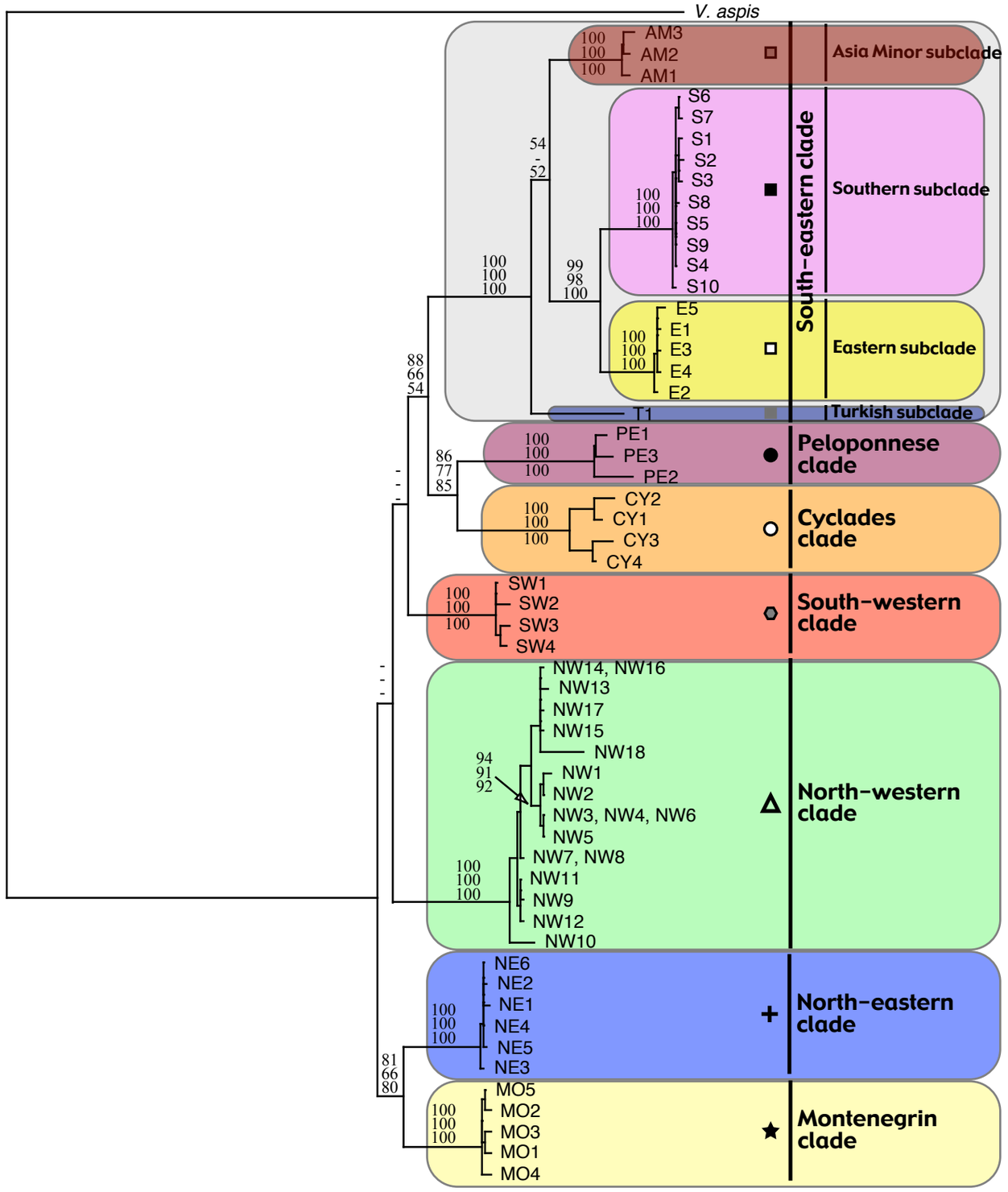
- (GB) nose-horned or sand viper
- (D) Sandotter, hornotter

"warm" species: *Vipera ammodytes*

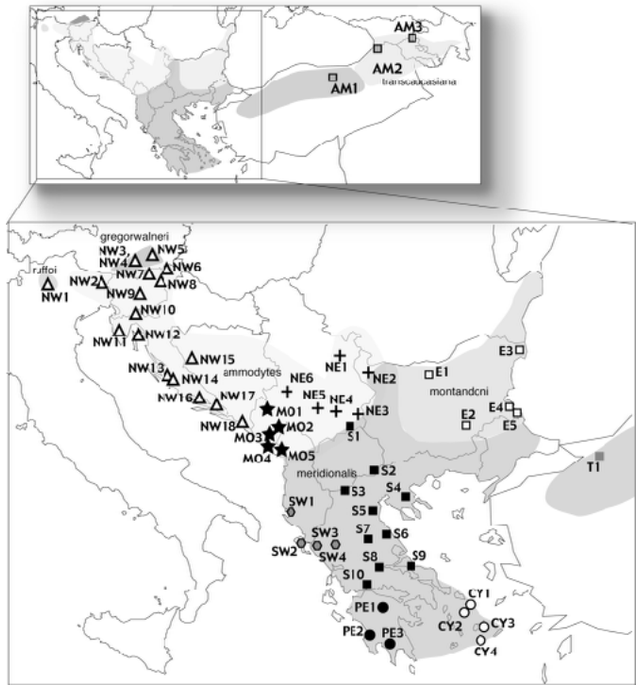
Ursenbacher et al. 2008

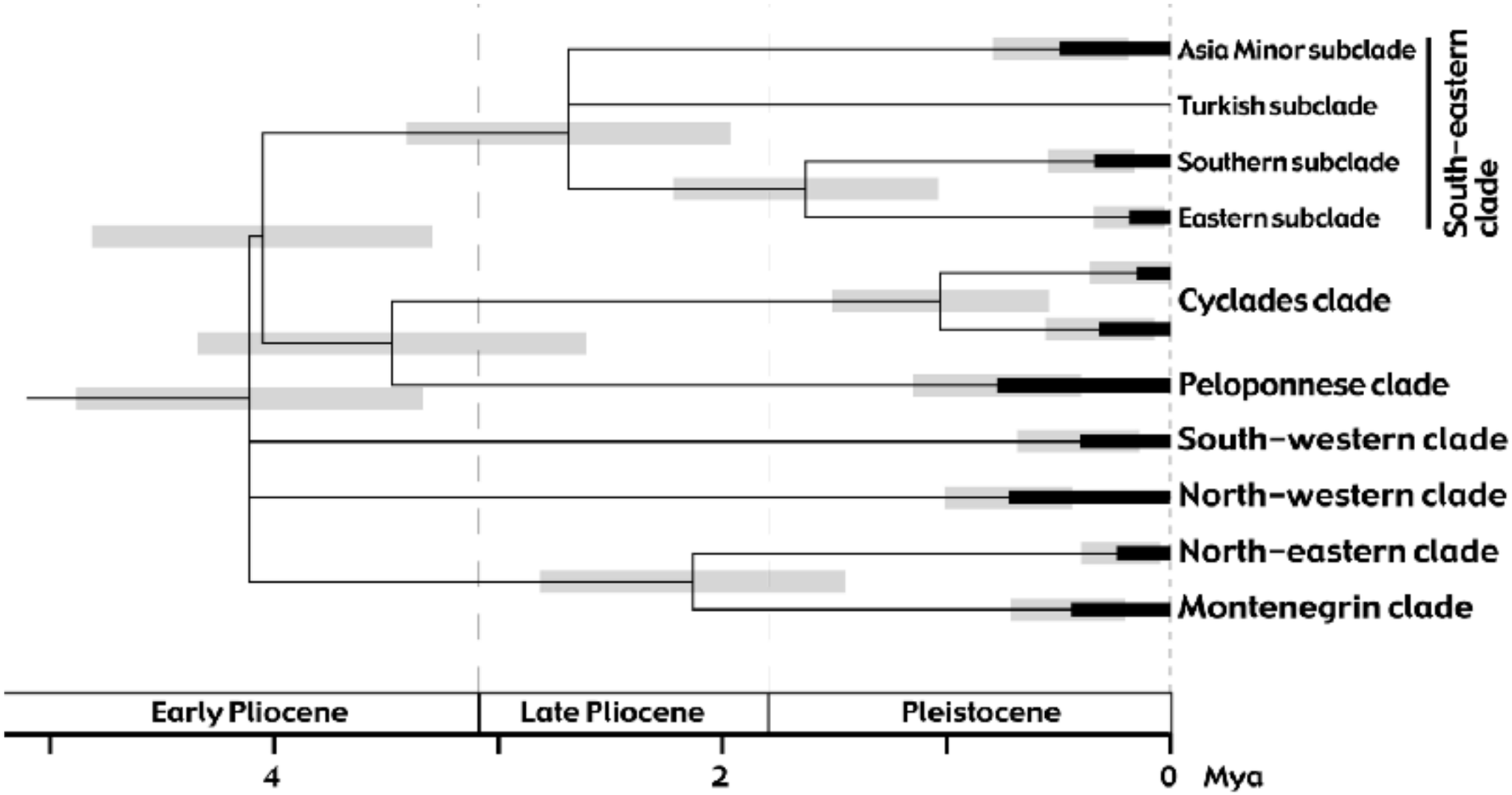
59 samples; cytochrome *b*, 16S and Control region, 2308 bp.





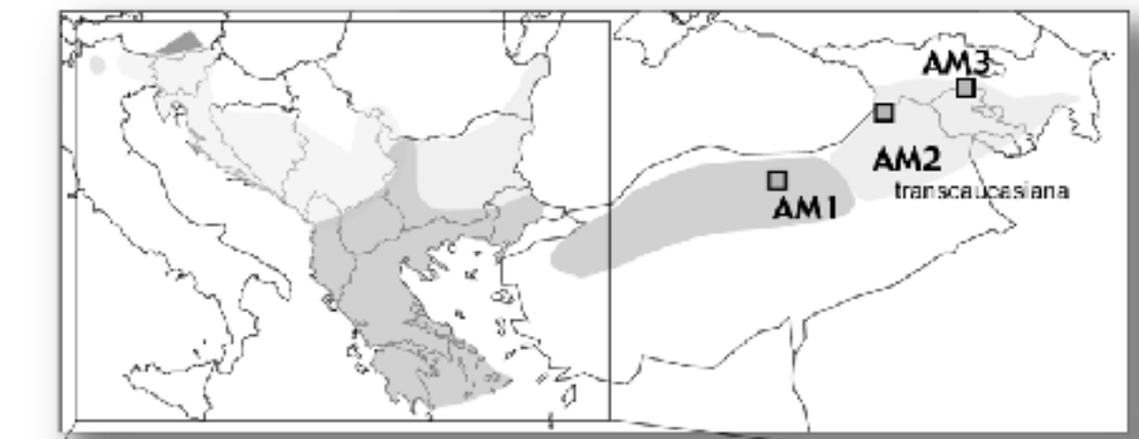
“warm” species: *Vipera ammodytes*

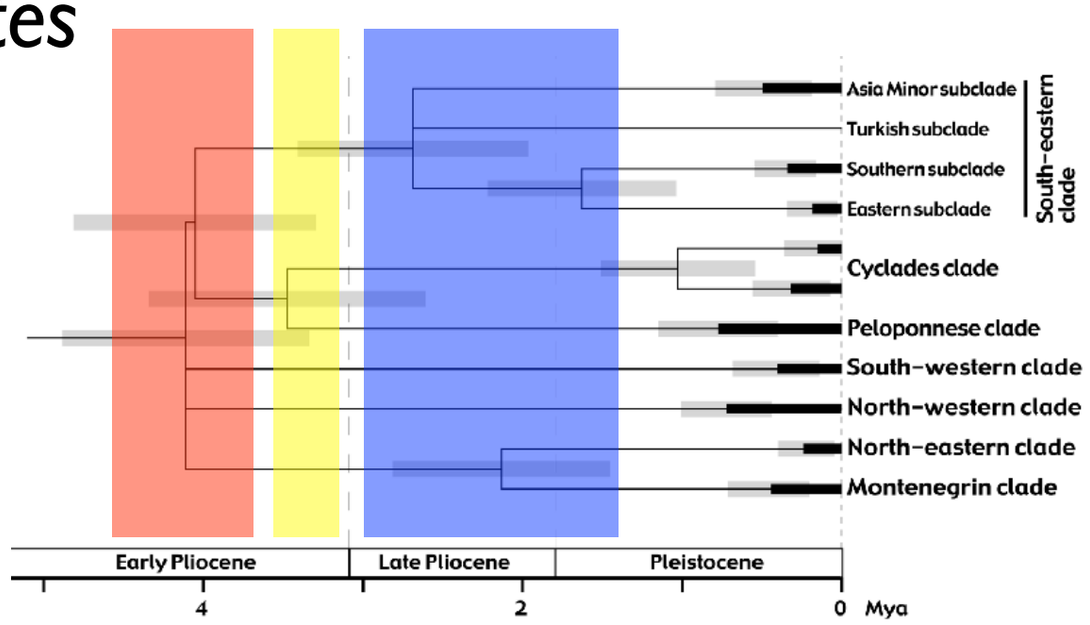


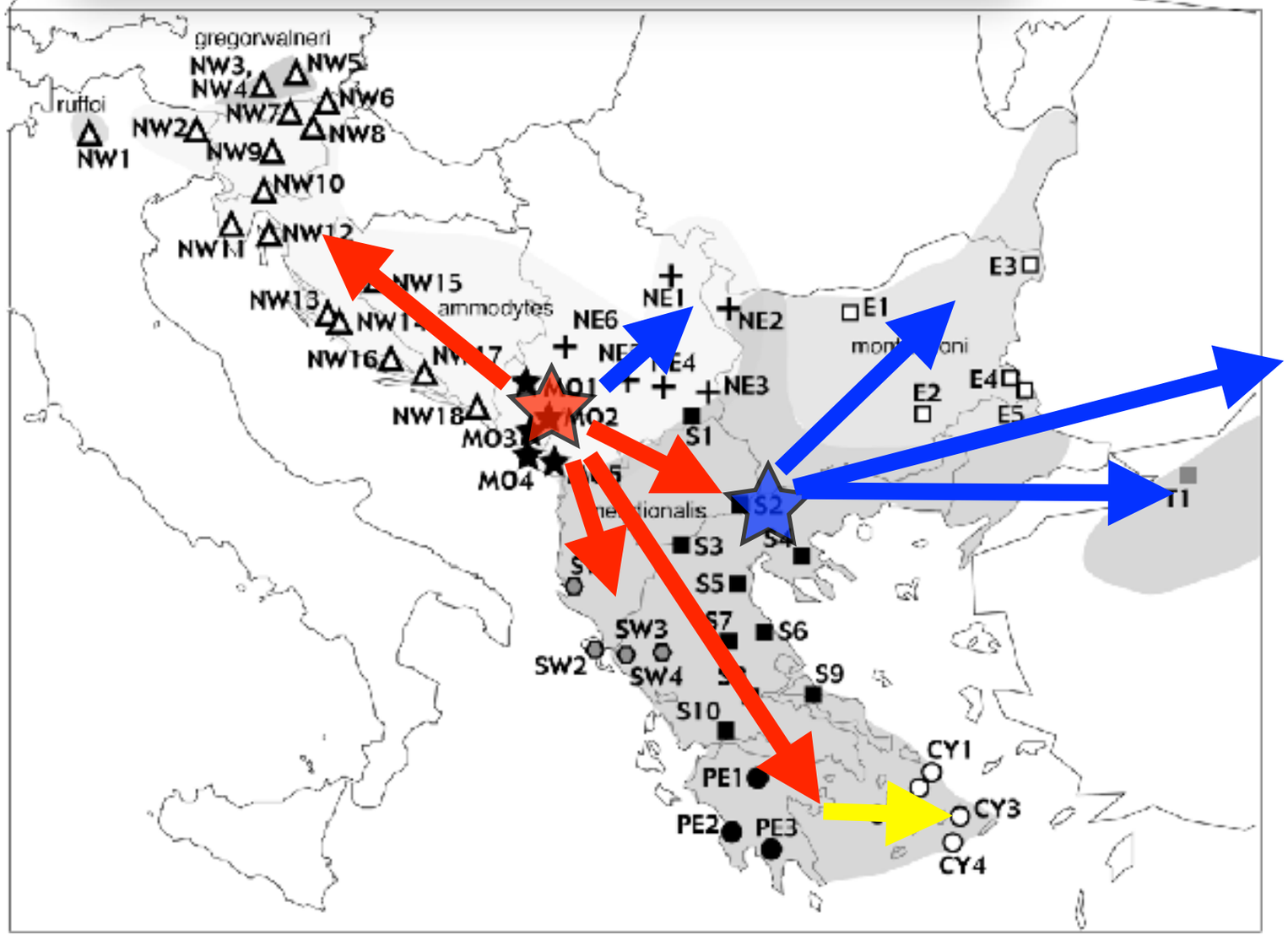


timing estimated with BEAST (Drummond and Rambaut, 2002)

“warm” species: *Vipera ammodytes*







“warm” species: *Vipera ammodytes*

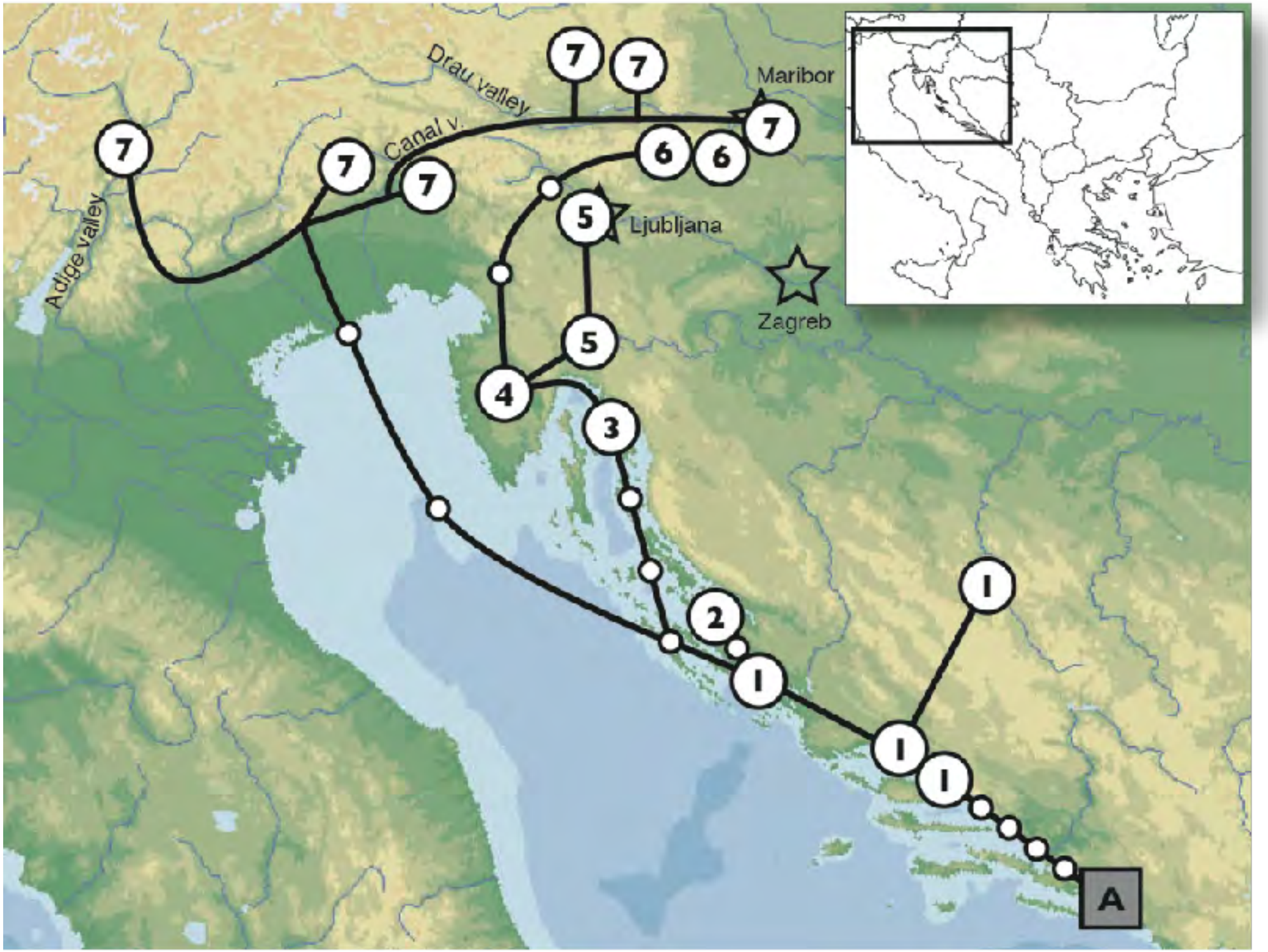


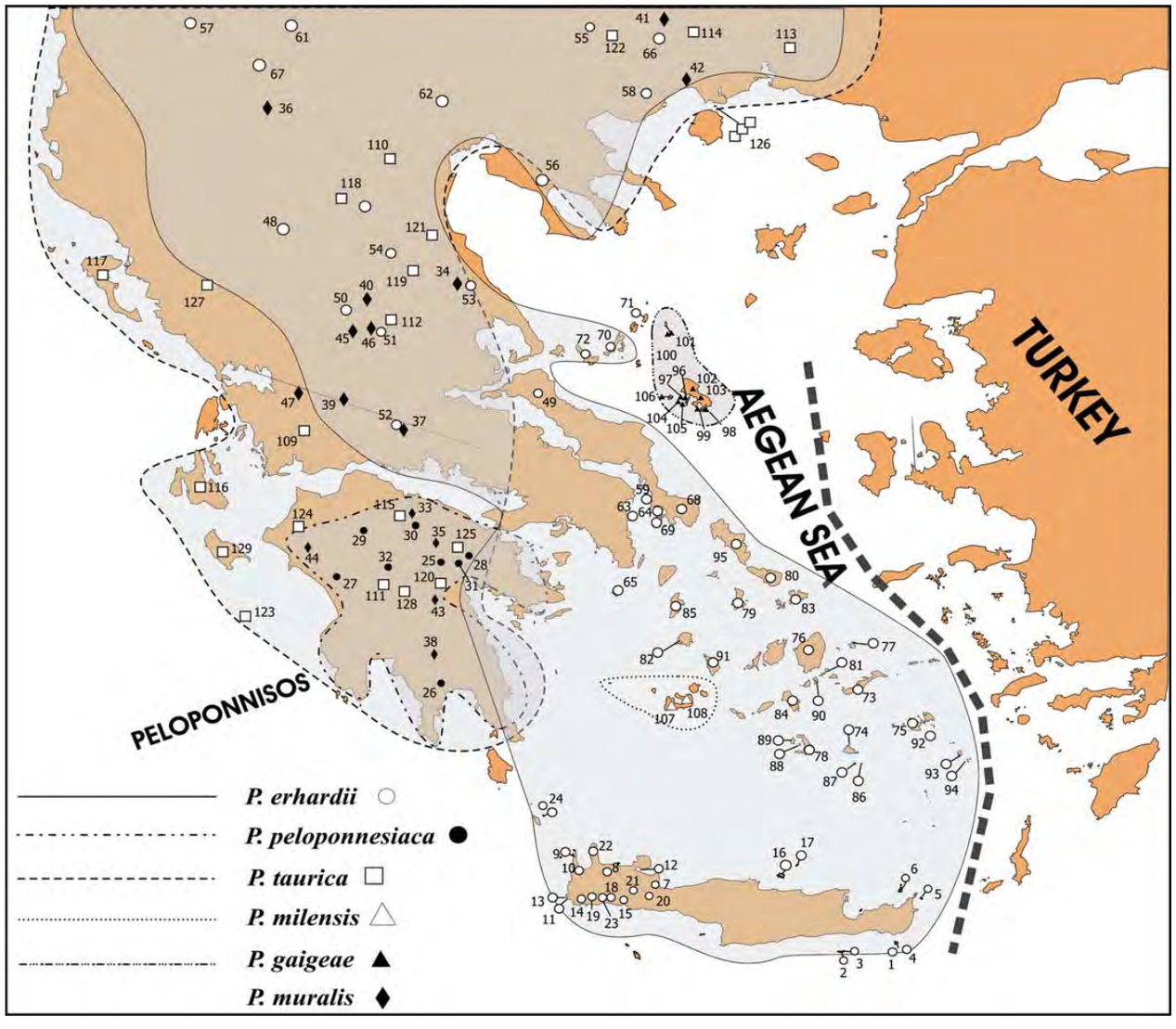
Figure 3. Parsimony network of cytochrome b haplotypes. Numbered circles: recorded haplotypes. Small circles stand for missing haplotypes. A: The haplotype assumed as ancient for postglacial spread to the north

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

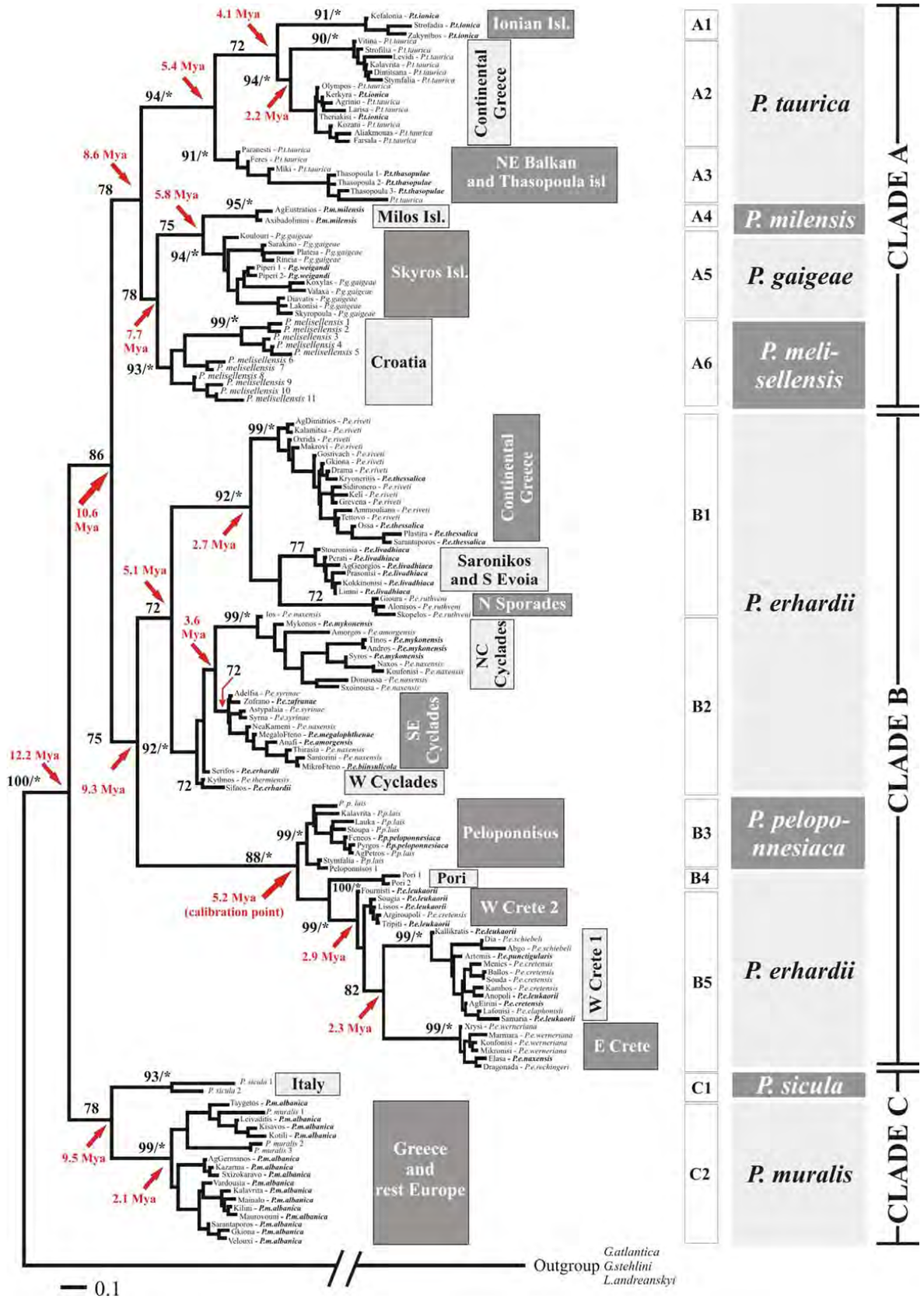
- (GB) Balkan wall lizard group
- (D) Mauereidechse Gruppe

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

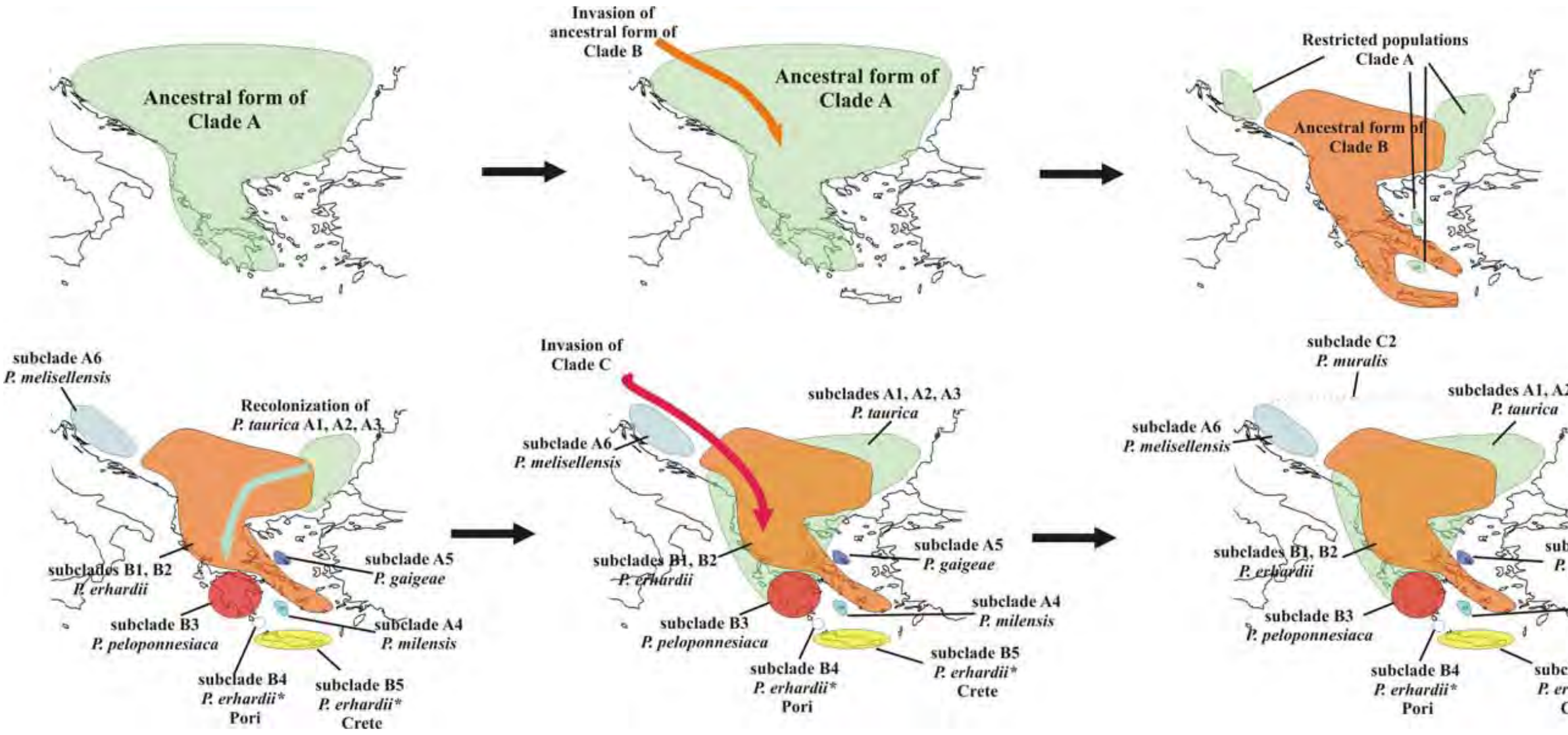
129 samples; cytochrome *b* and 16S, 927 bp.



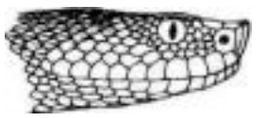
Poulakakis et al. 2005



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



“medium temperate” species: *Vipera aspis*

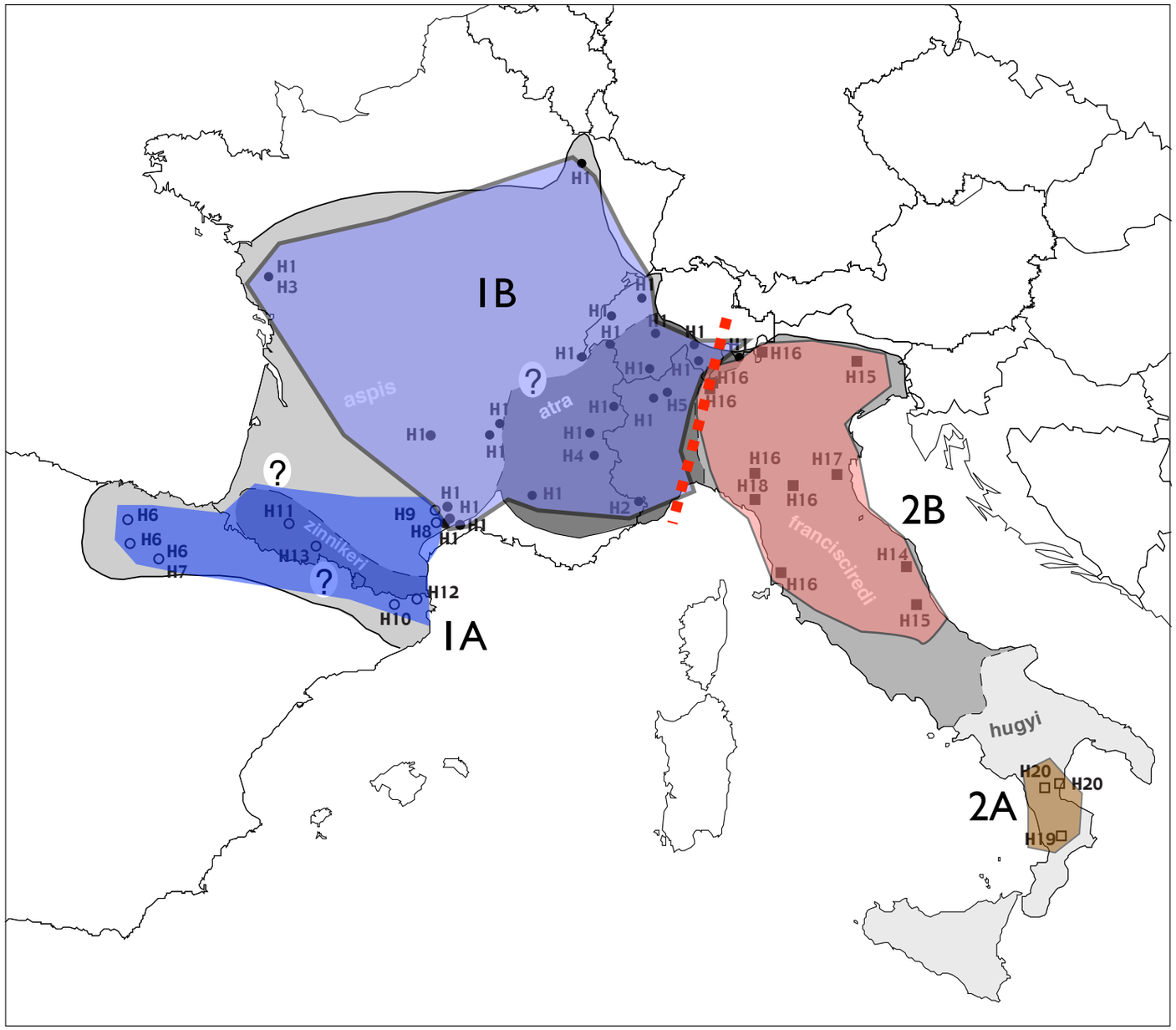


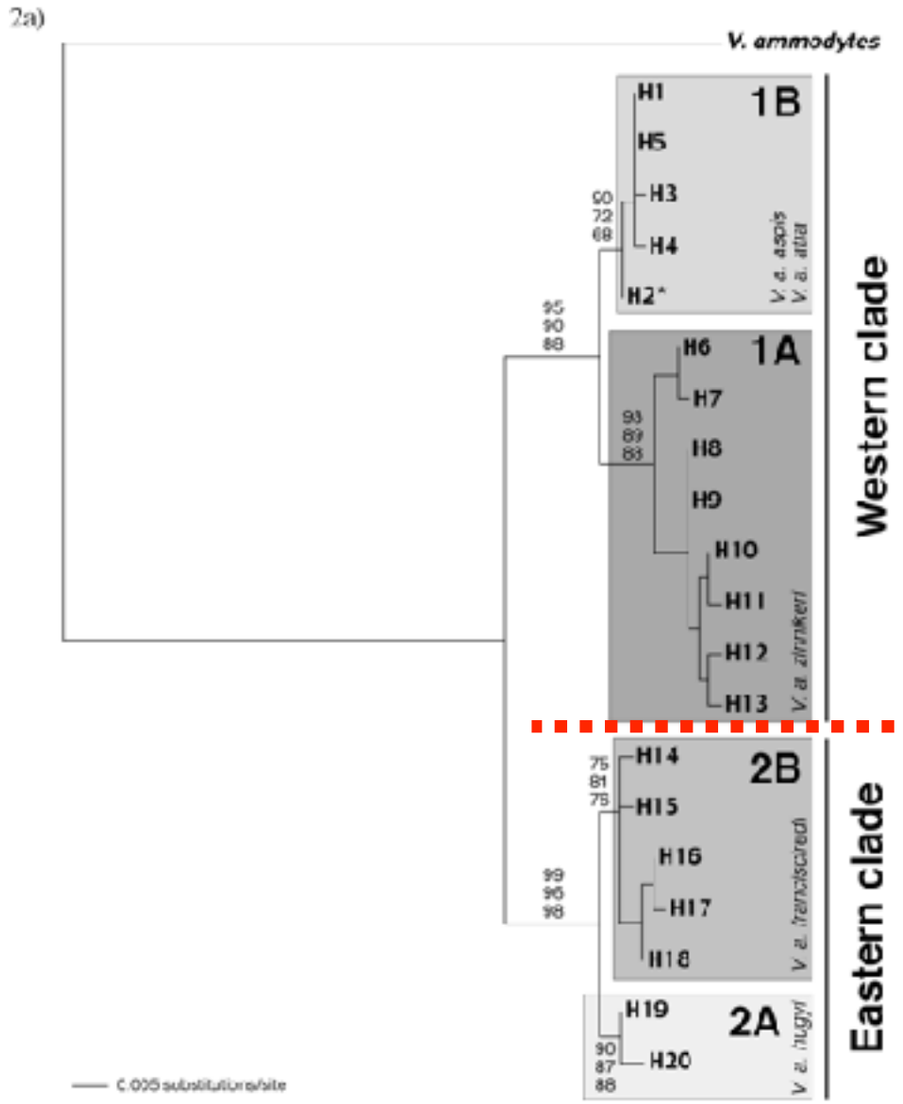
- (GB) Asp viper
- (D) Aspisviper / Juraviper

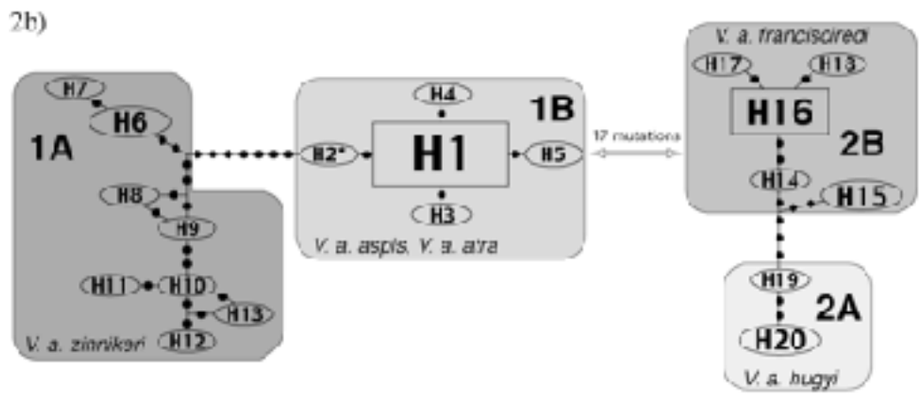
"medium temperate" species: *Vipera aspis*

Ursenbacher et al. 2006

53 samples; Control region, 671 bp.





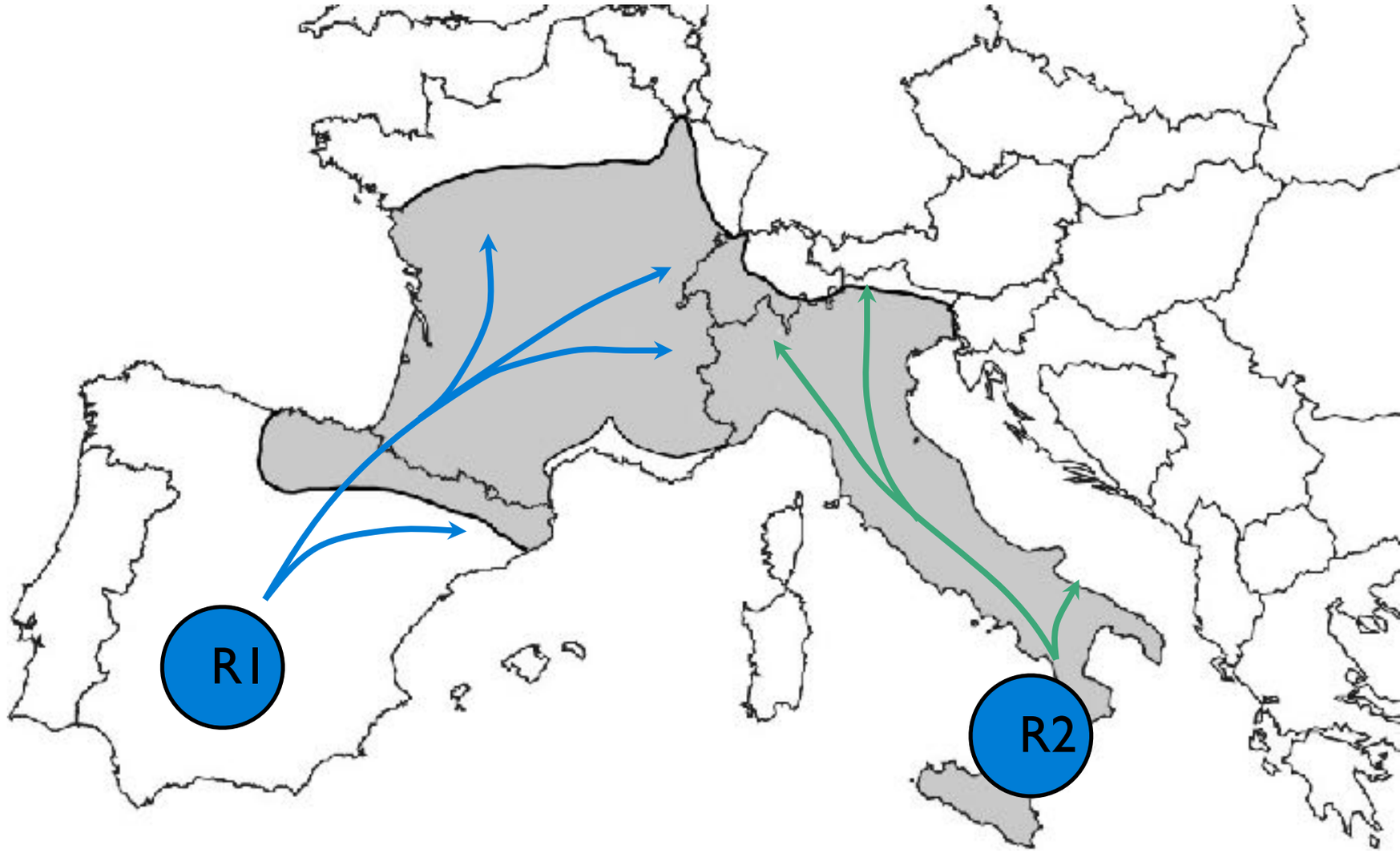


“medium temperate” species: *Vipera aspis*

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

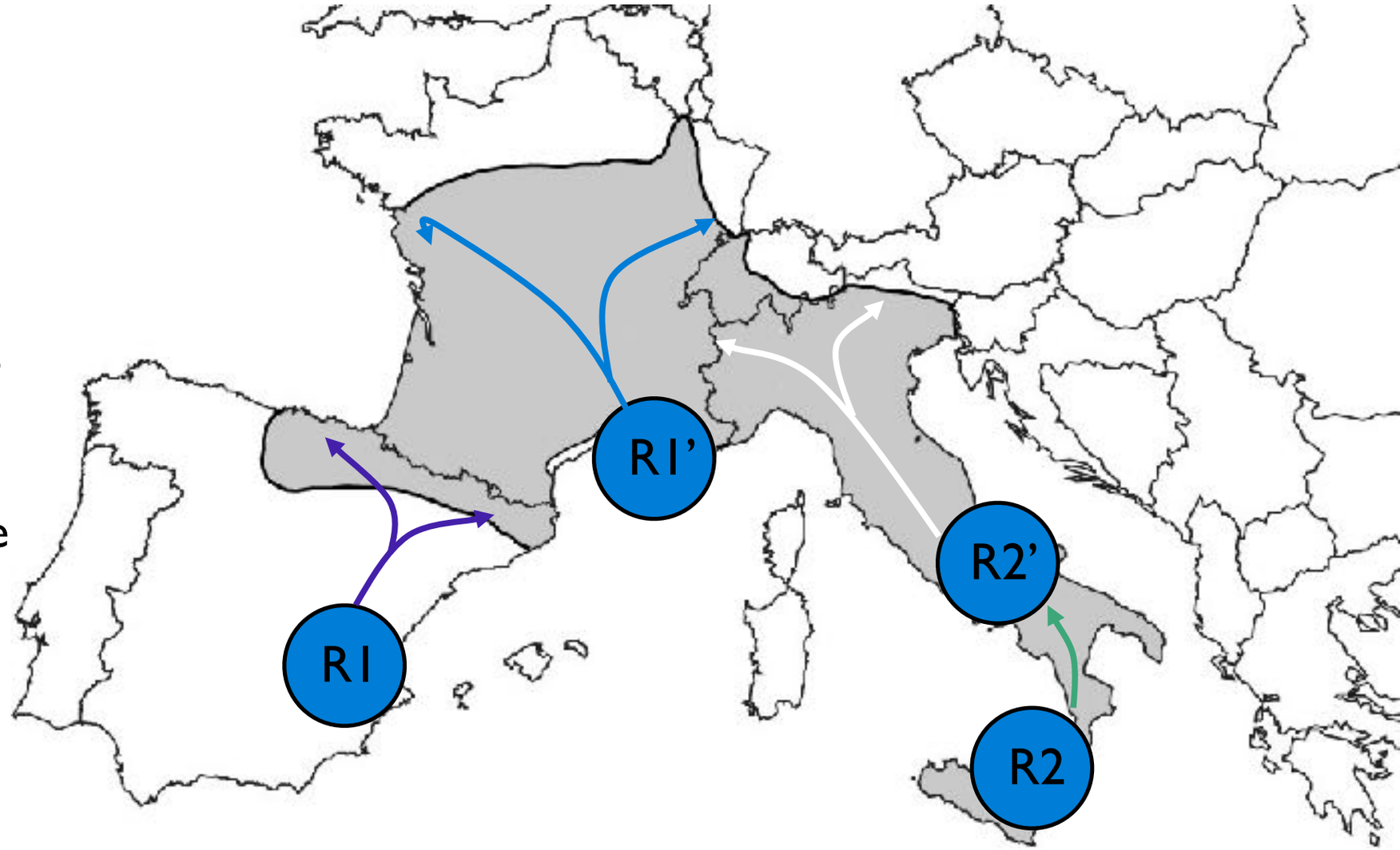
later: 4 refuges

Spain

France

Italy

Italy



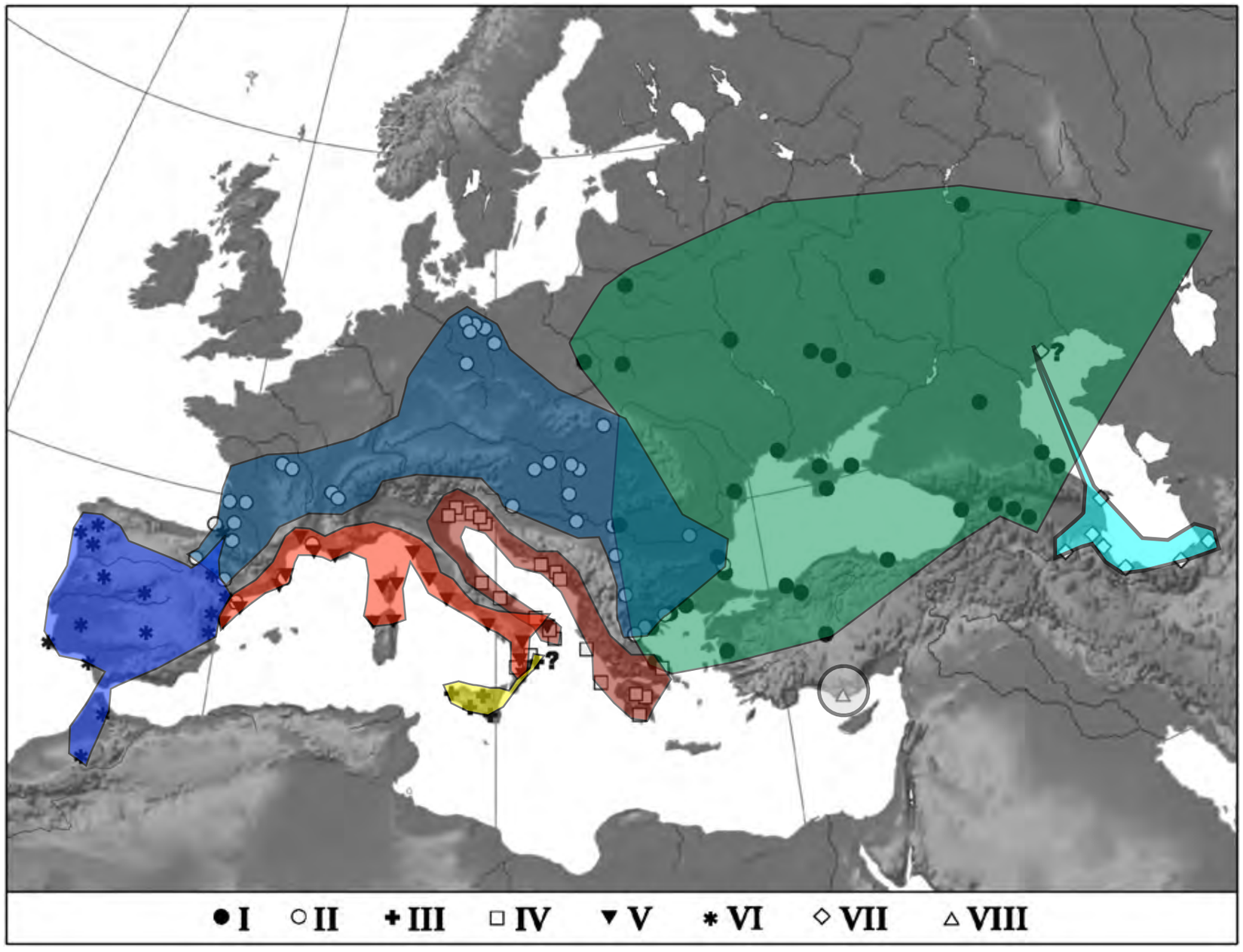
“medium temperate” species: *Emys orbicularis*

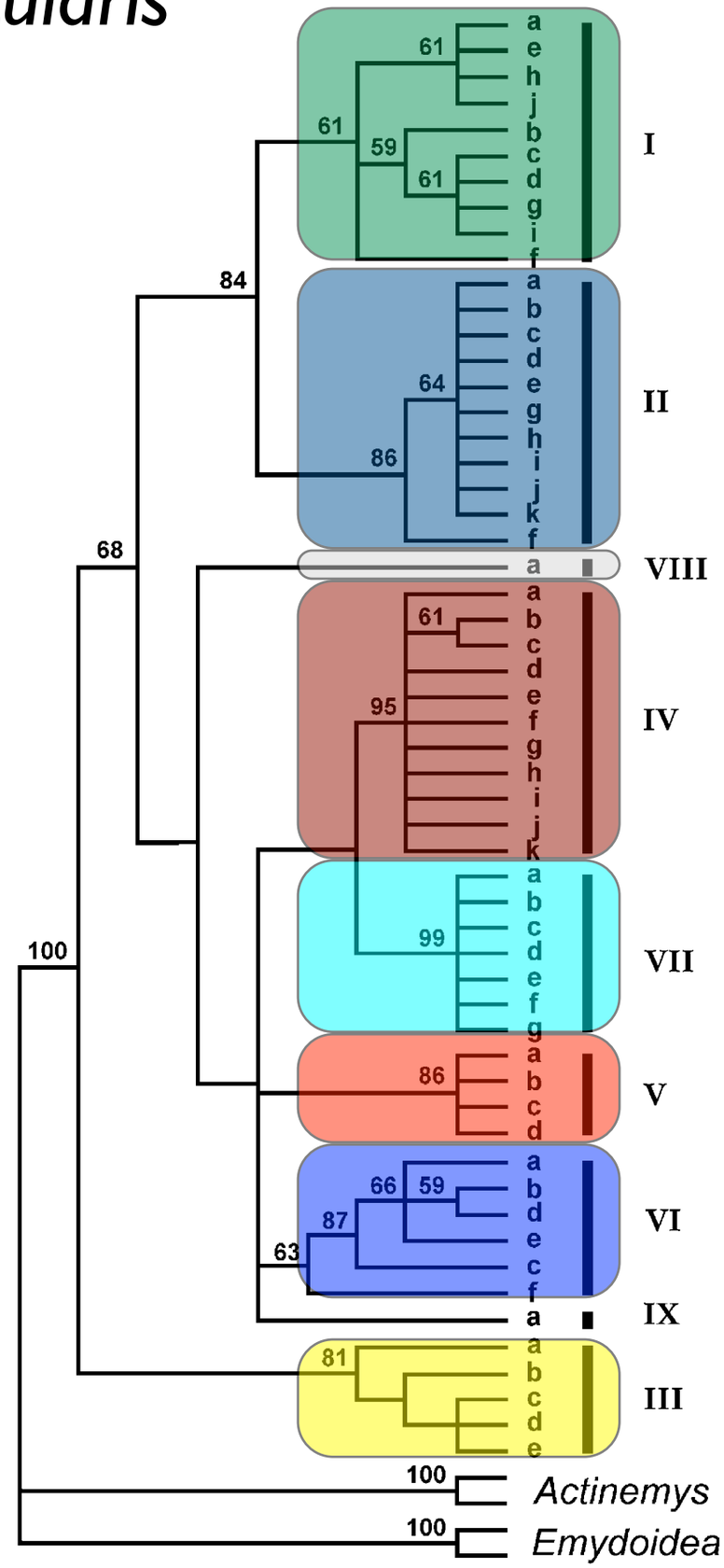
- (GB) European pond turtle / European pond tortoise
- (D) Europäische Sumpfschildkröte

“medium temperate” species: *Emys orbicularis*

Fritz et al. 2007

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



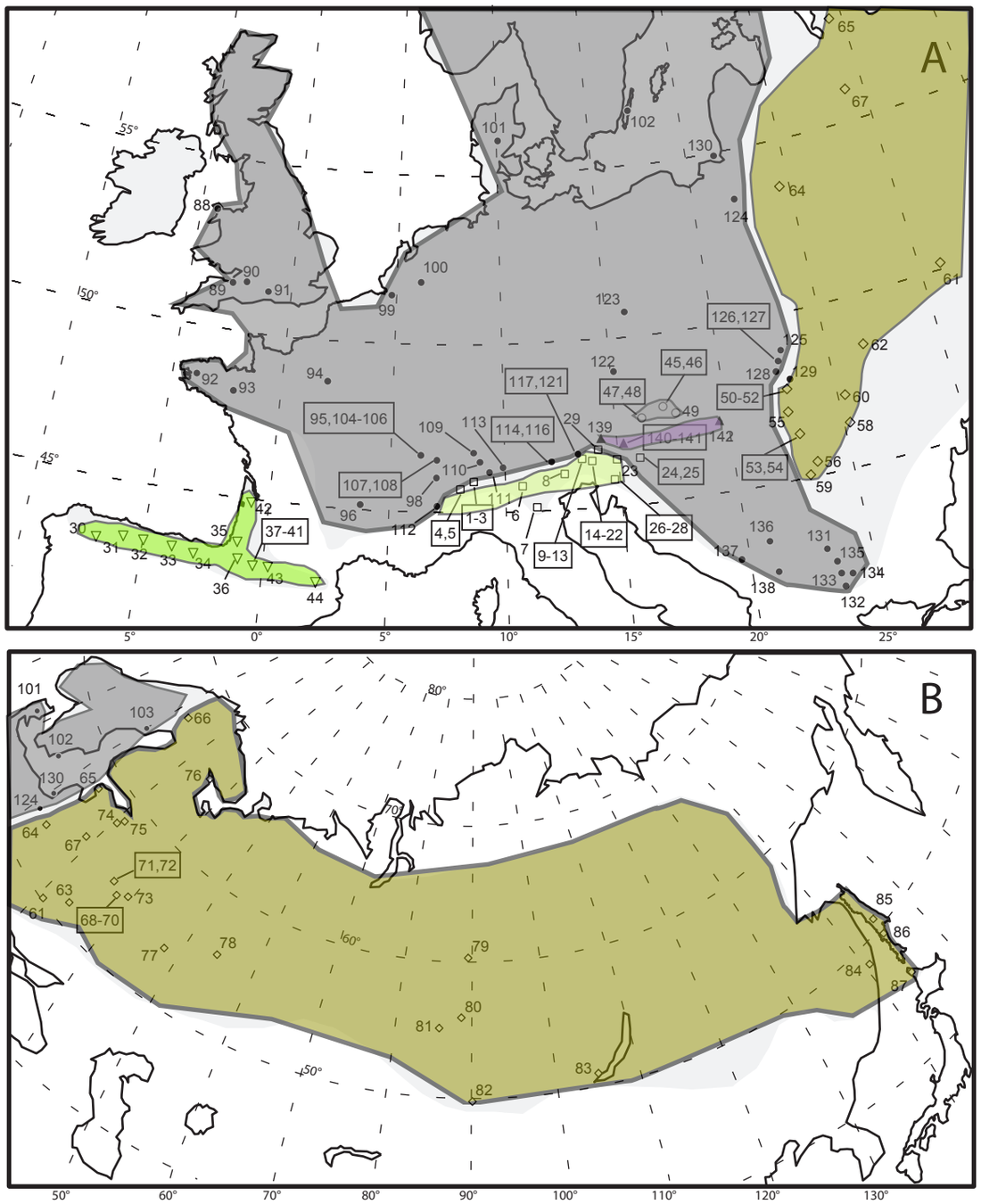


“cold-tolerant” species: *Zootoca (Lacerta) vivipara*

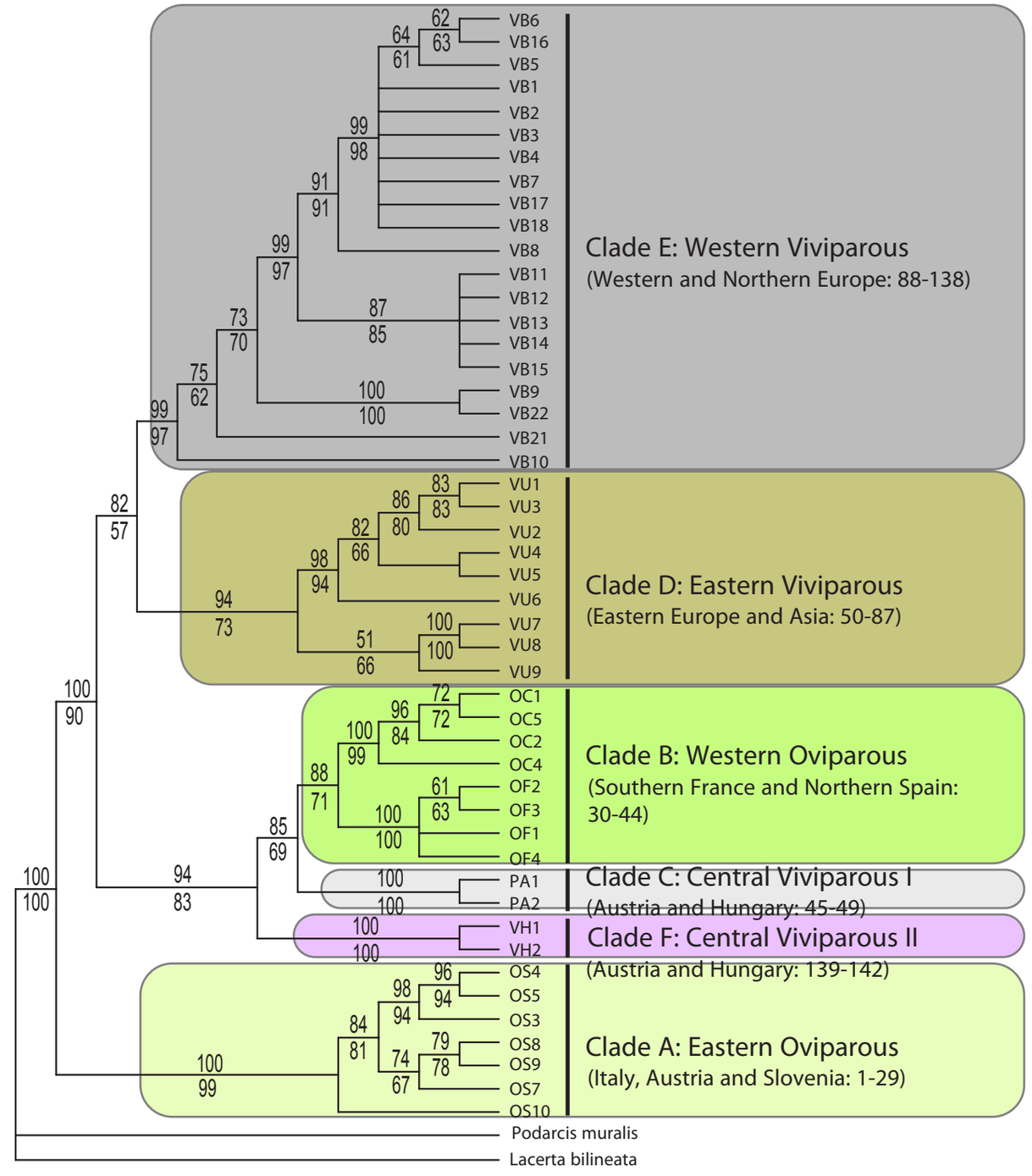
- (GB) European common lizard
- (D) Waldeidechse / Bergeidechse / Mooreidechse

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

522 samples; cytochrome b and 16S, 1660 bp

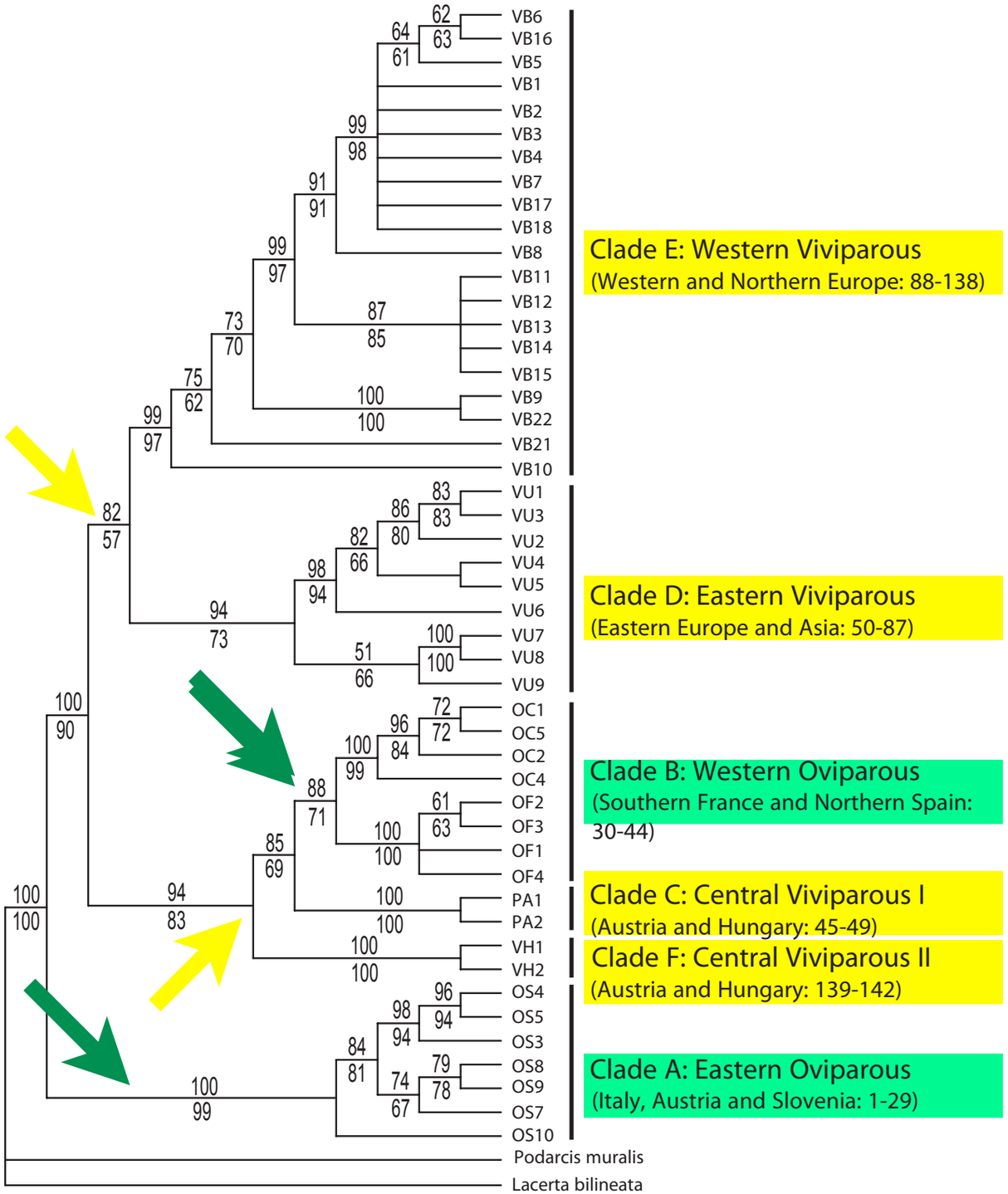


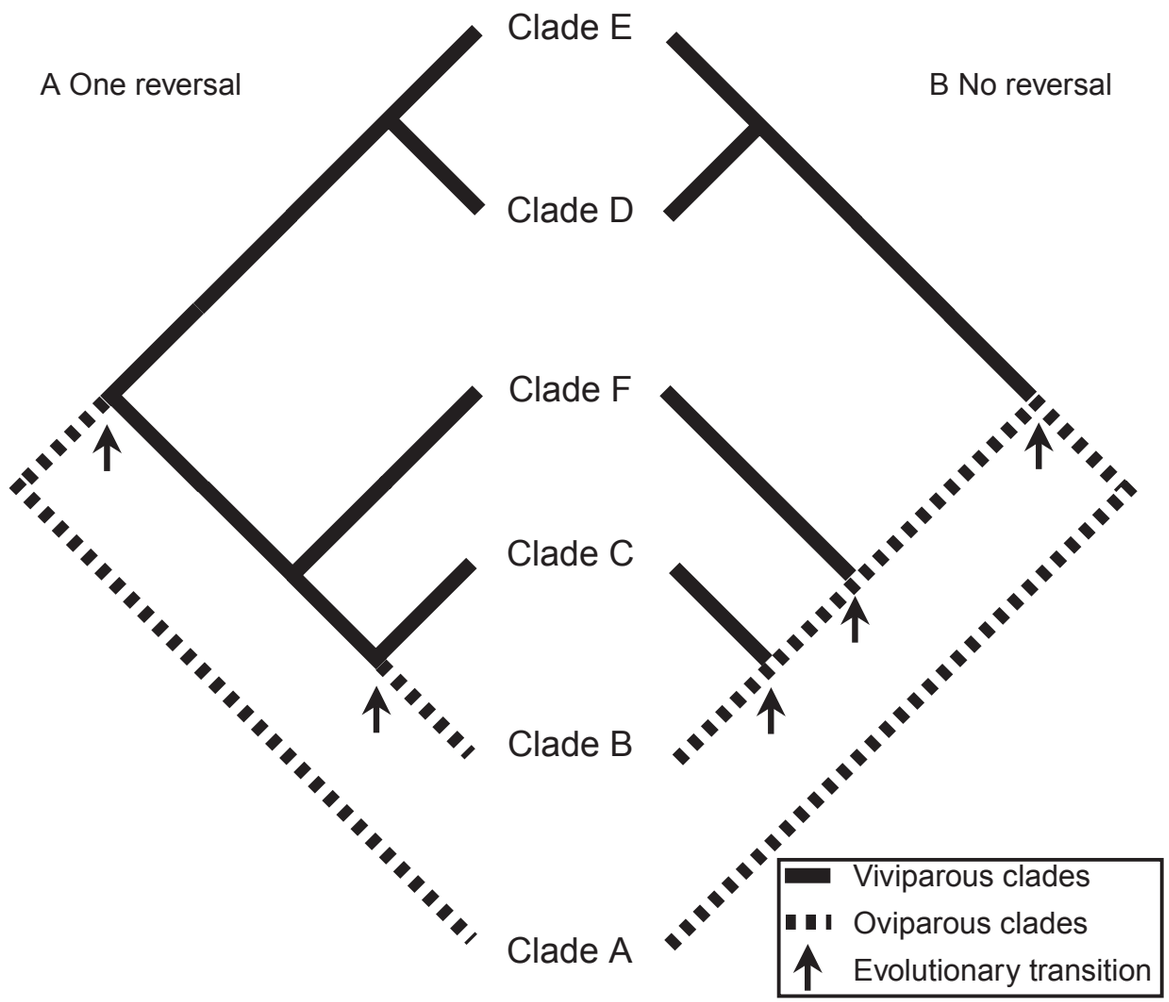
Surget-Groba et al (2006)



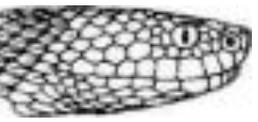
"cold-tolerant" species: *Zootoca (Lacerta) vivipara*

Surget-Groba et al (2006)



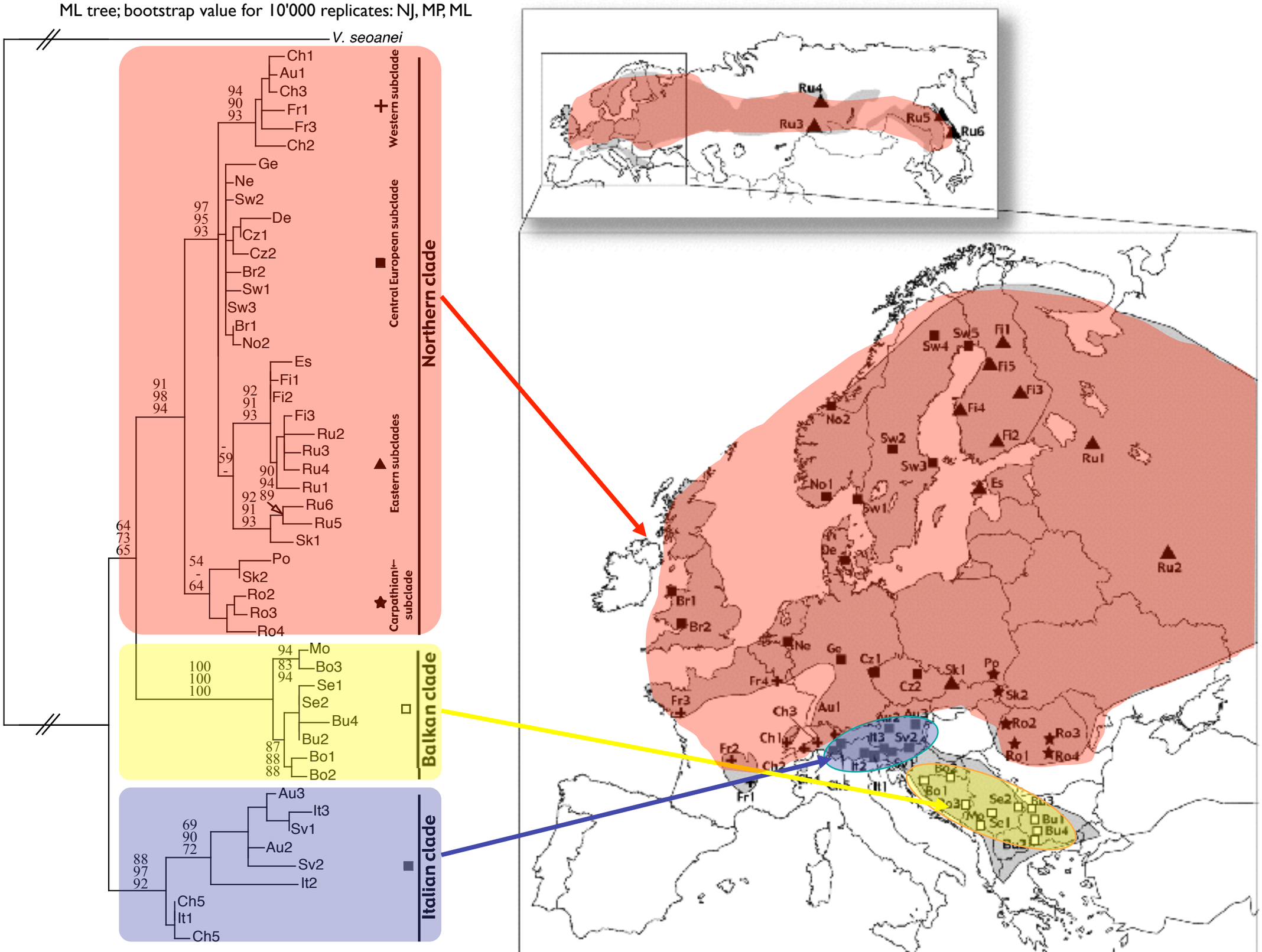


“cold-tolerant” species: *Vipera berus*



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

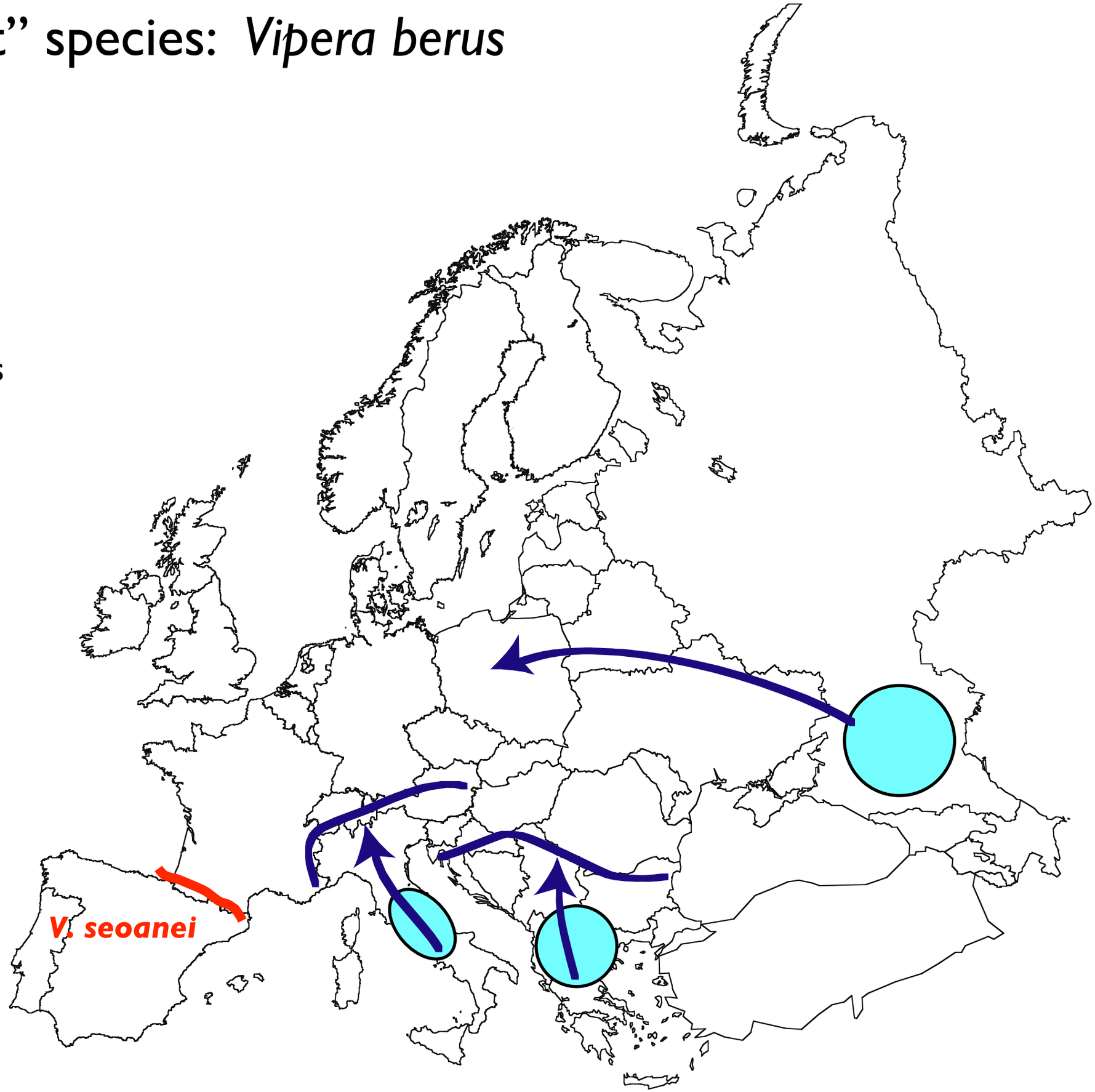
“cold-tolerant” species: *Vipera berus*



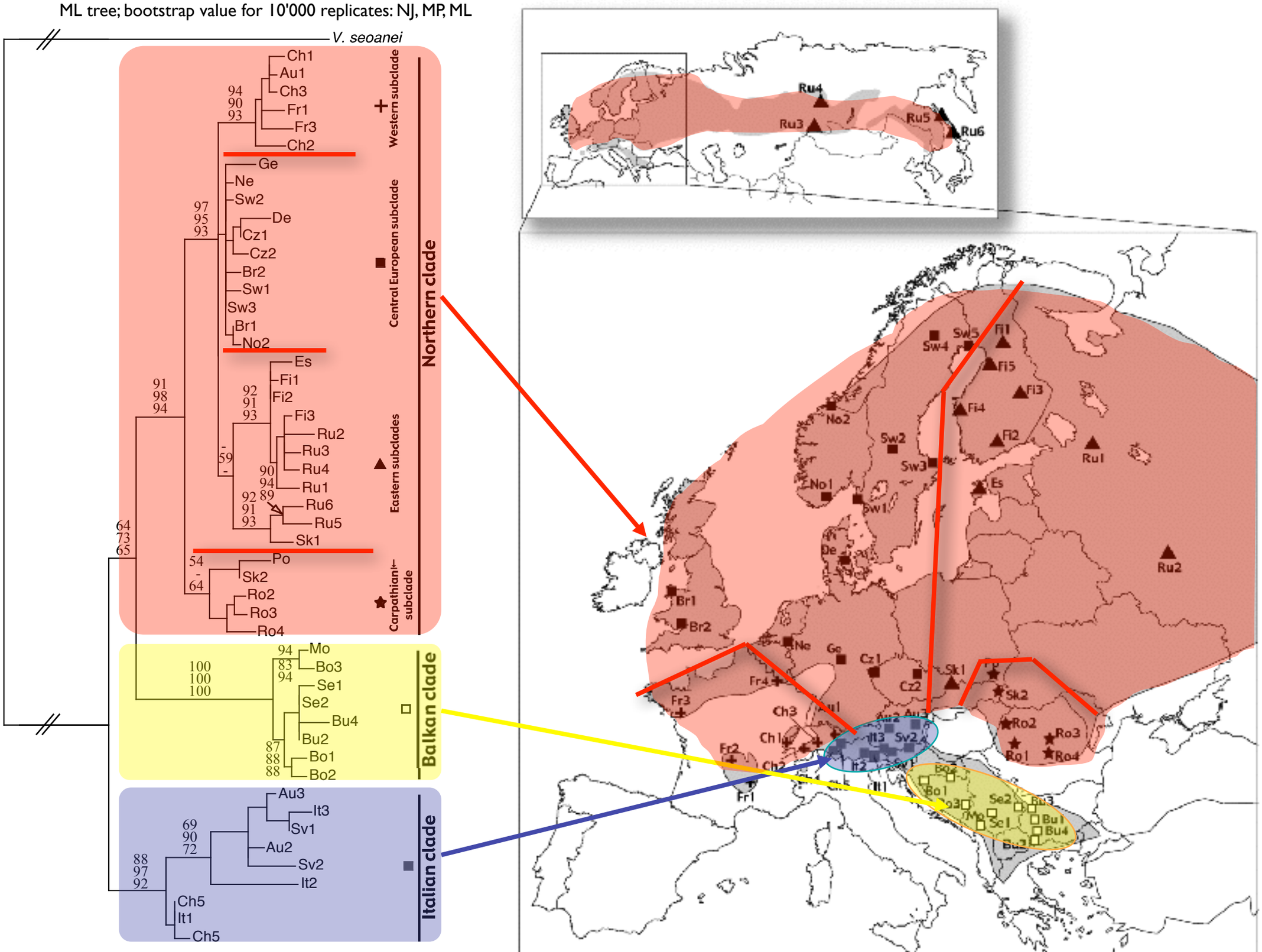
“cold-tolerant” species: *Vipera berus*

3 Refugial areas

- Italy
- Balkan peninsula
- Caucasus Mountains



“cold-tolerant” species: *Vipera berus*



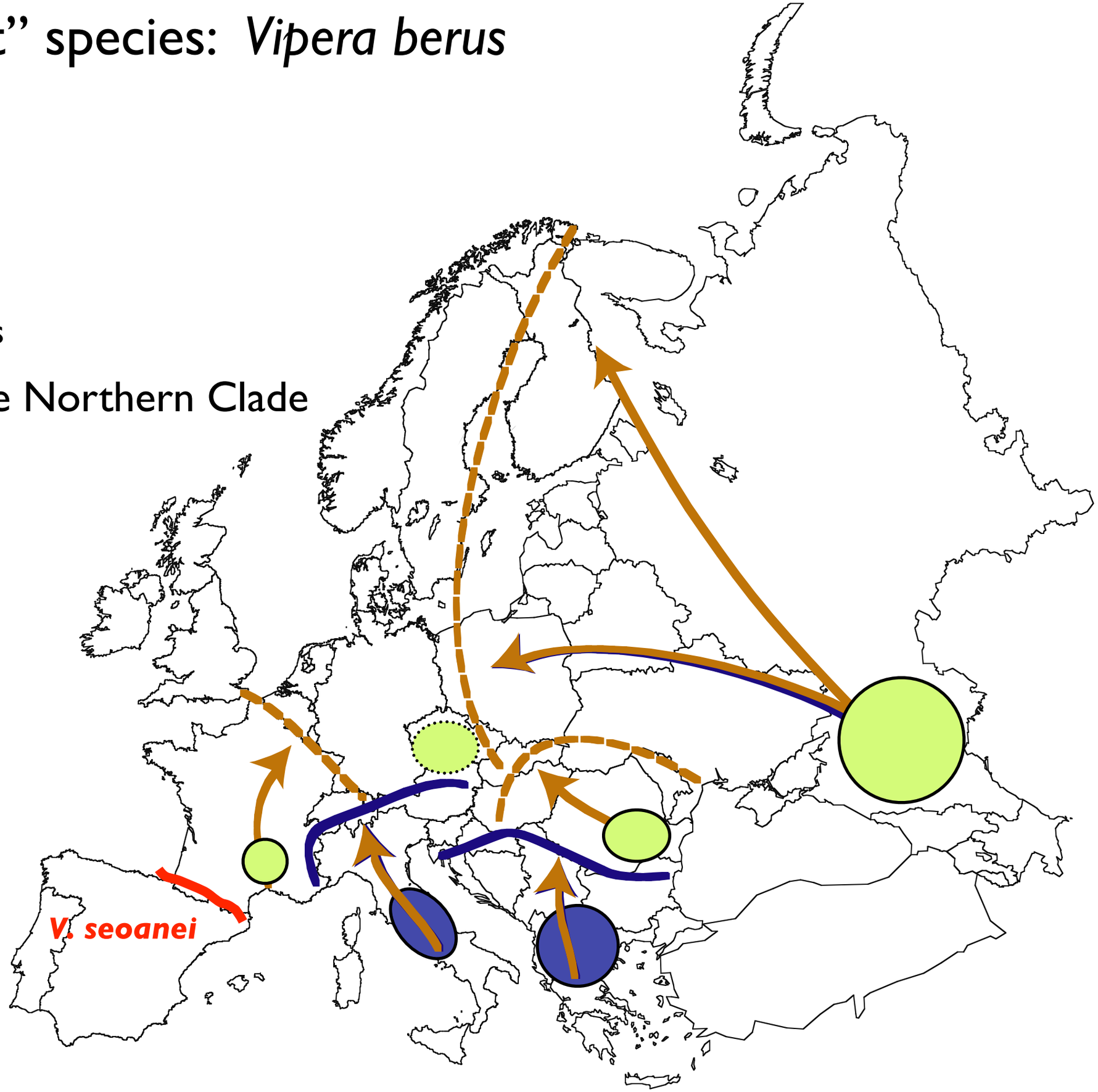
“cold-tolerant” species: *Vipera berus*

3 Refugial areas

- Italy
- Balkan peninsula
- Caucasus Mountains

Sub-structure in the Northern Clade

- France
- Central Europe
- Romania
- Russia



"cold-tolerant" species: *Vipera berus*

3 Refugial areas

- Italy
- Balkan peninsula
- Caucasus Mountains

Sub-structure in the Northern Clade

- France
- Central Europe
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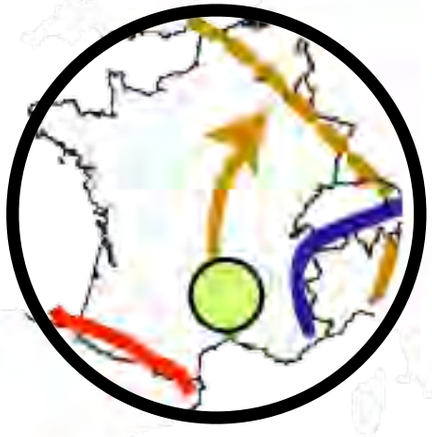
- Russia

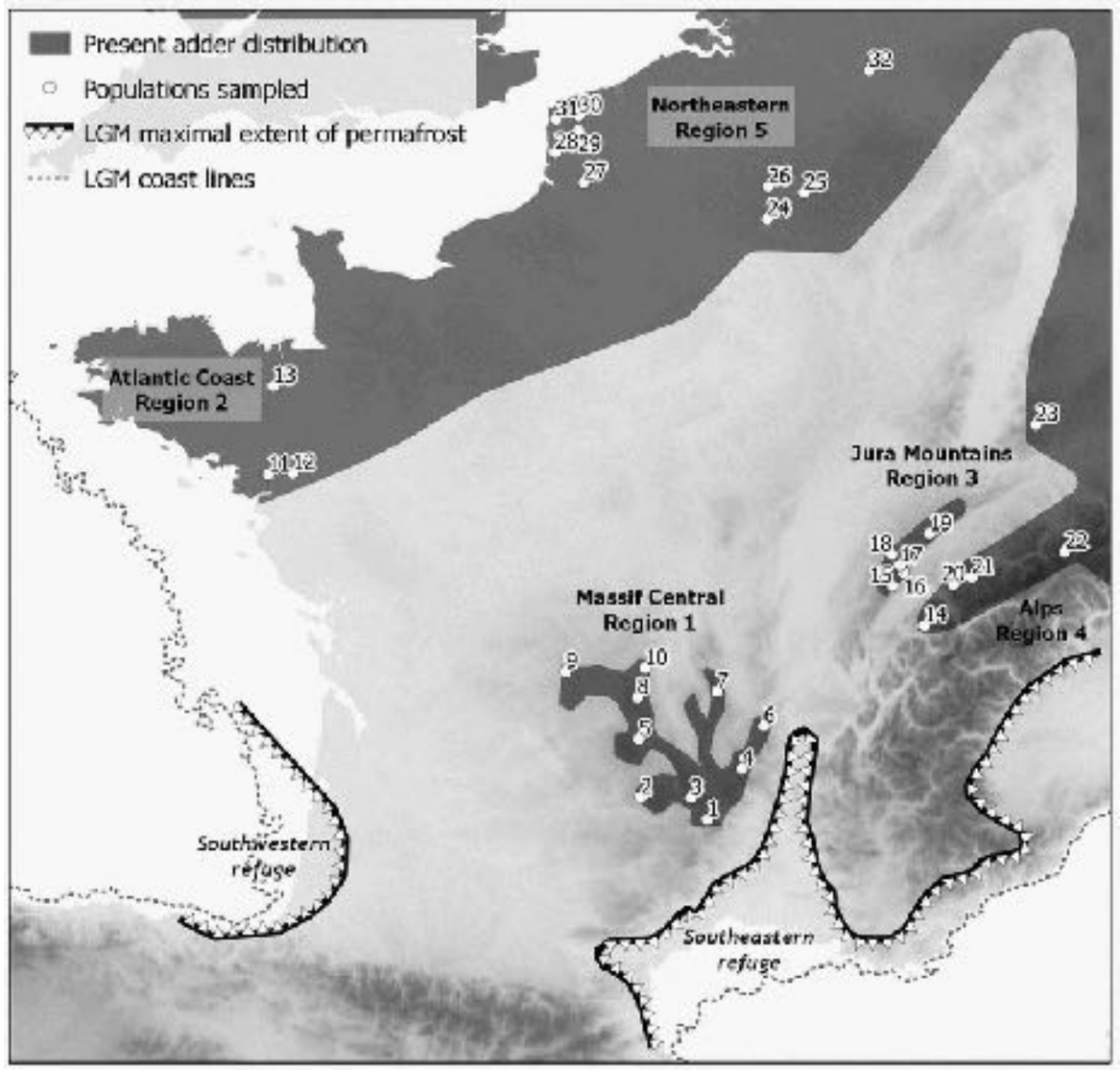


“cold-tolerant” species: *Vipera berus*

Ursenbacher et al. 2015

V. berus in the western subclade

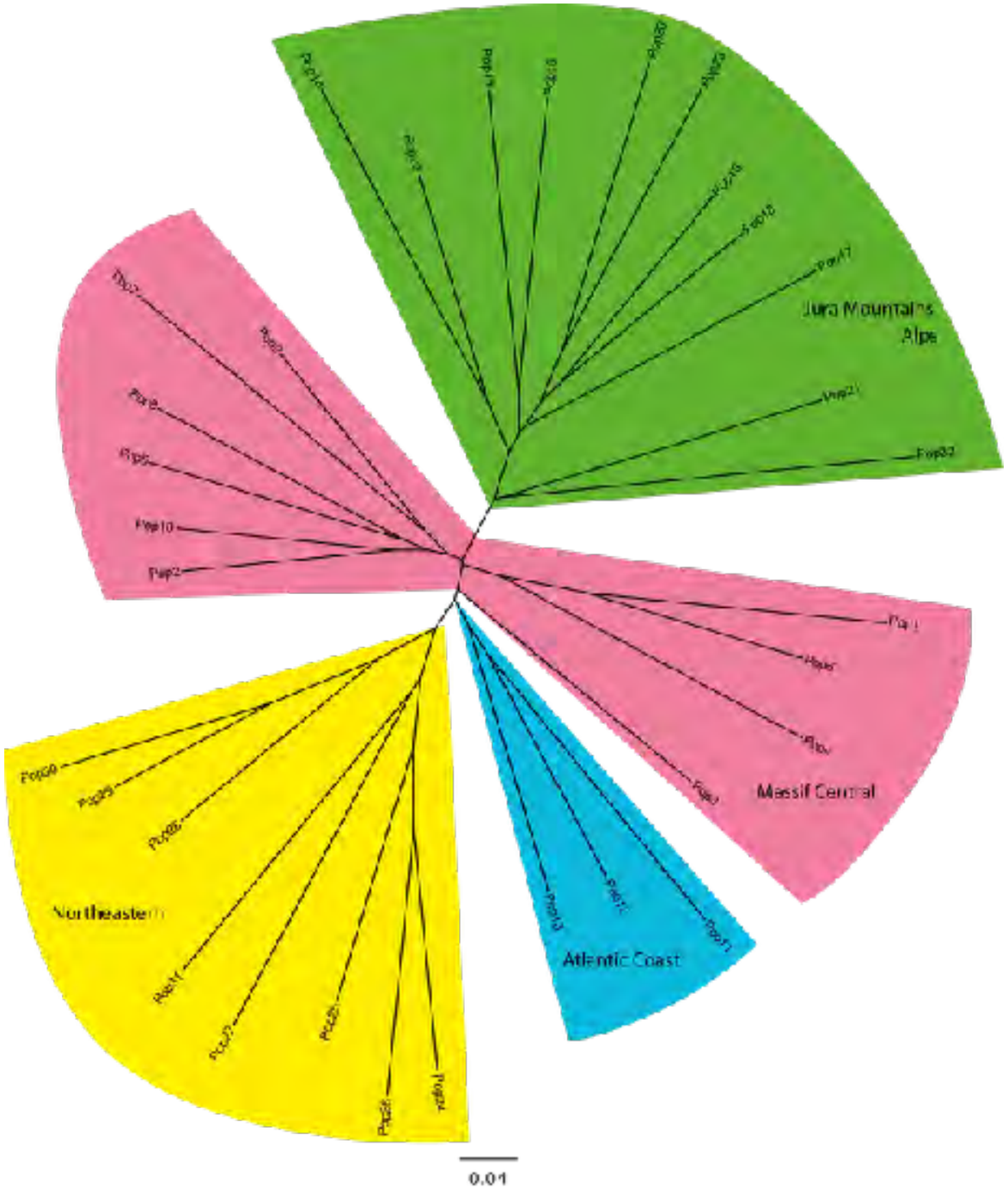
- samples
  - 32 populations (N=602)
- microsatellites
  - 6 microsatellites analysed

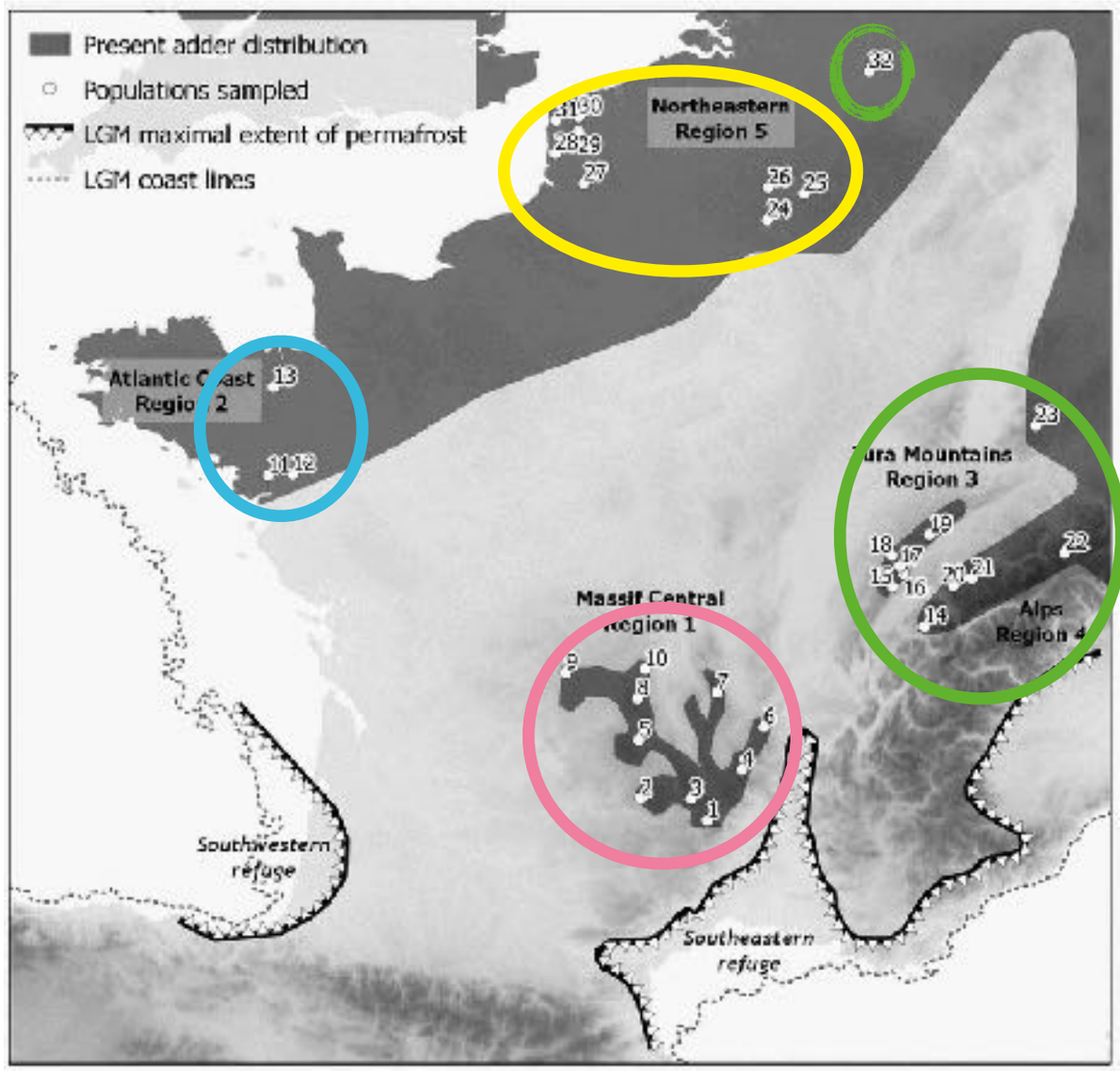


"cold-tolerant" species: *Vipera berus*

Ursenbacher et al. 2015

- Genetic distance

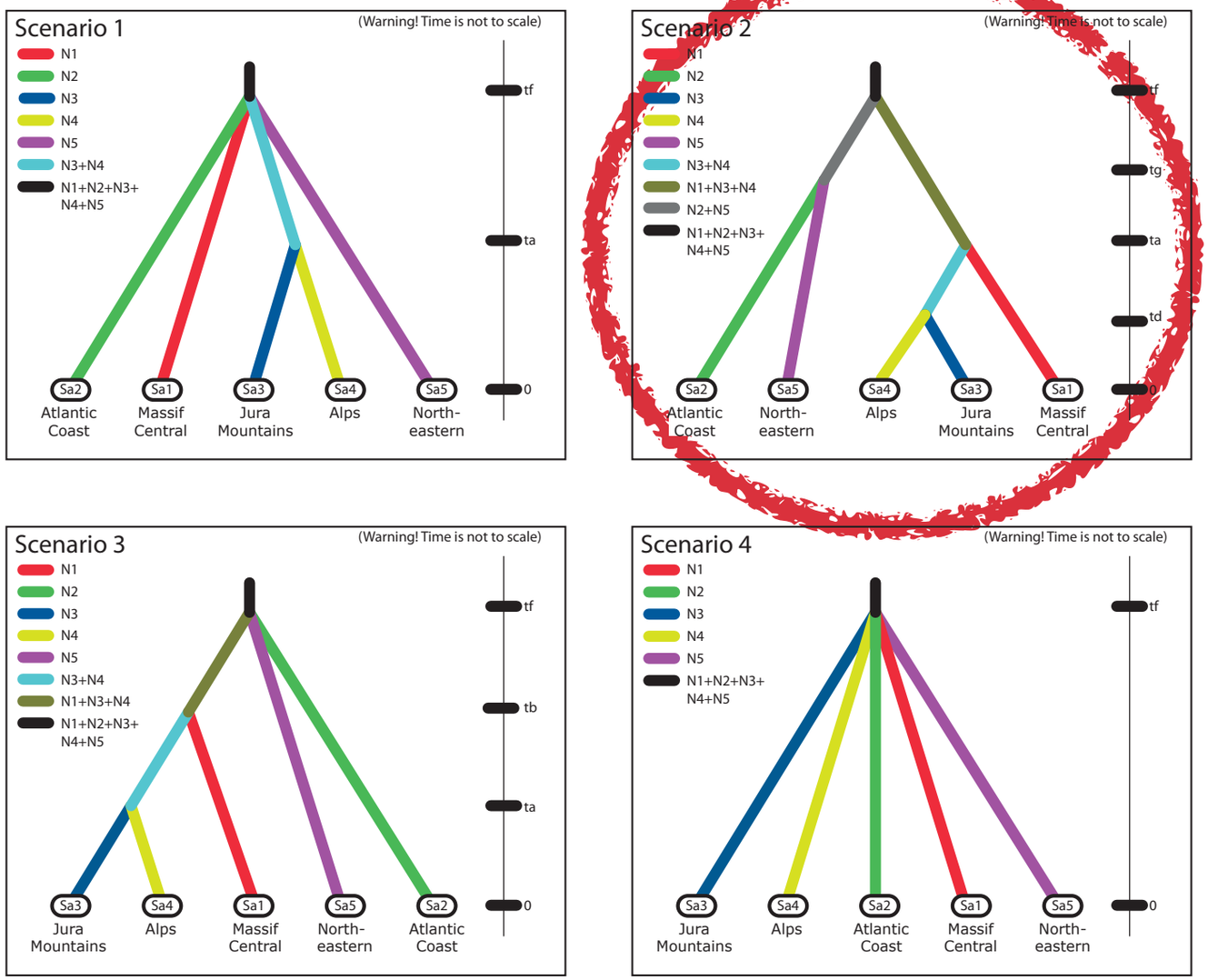


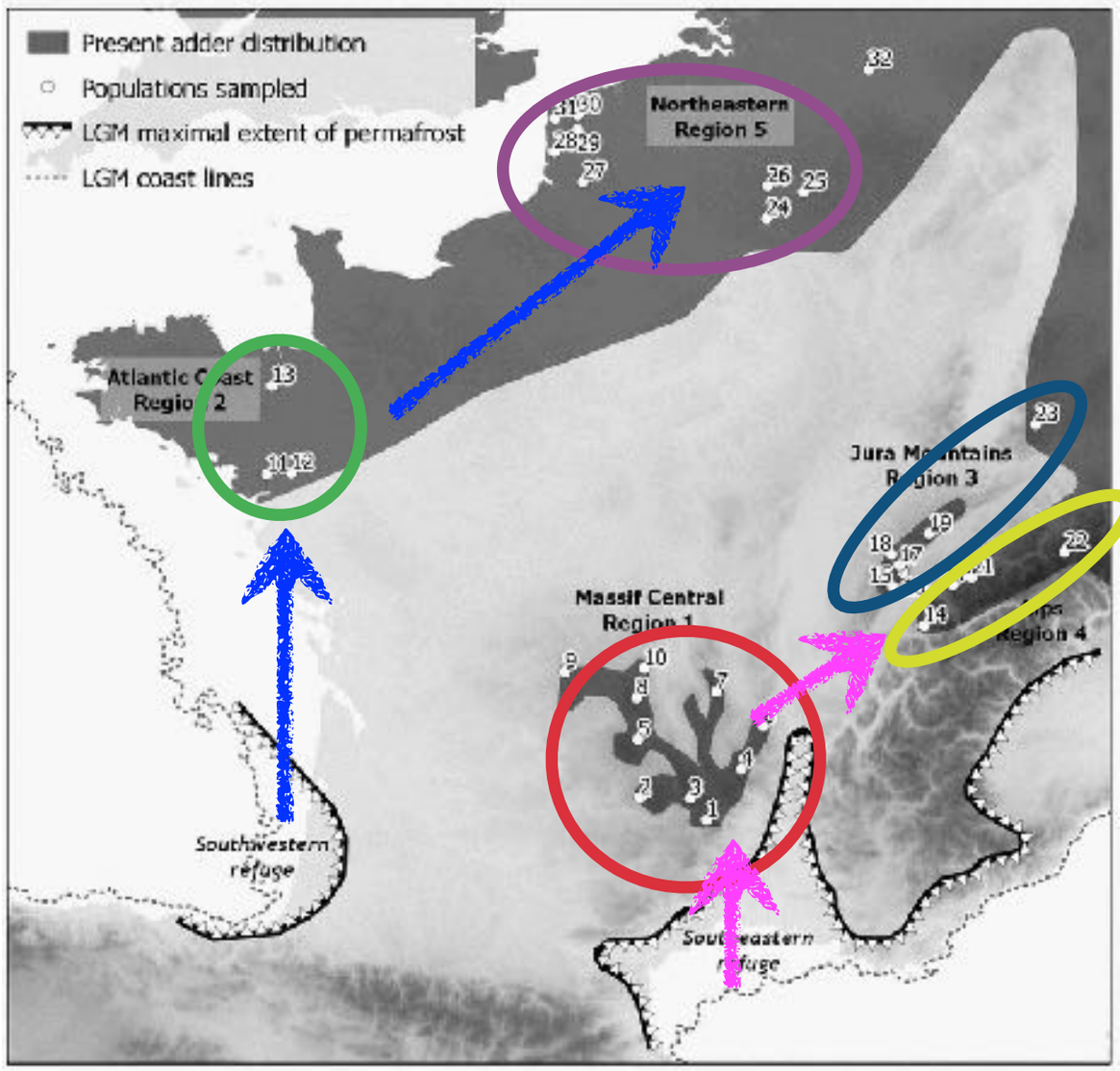


"cold-tolerant" species: *Vipera berus*

Ursenbacher et al. 2015

- Reconstruction of recolonisation routes with Approximate Bayesian Computation (ABC)





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)
  - numerous refugia around the Mediterranean Sea
- “cold-tolerant” species:
  - split during Pleistocene
  - numerous splits, numerous refugia (northern refugia)

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