

# Eem (MIS 5e) – poslední interglaciál



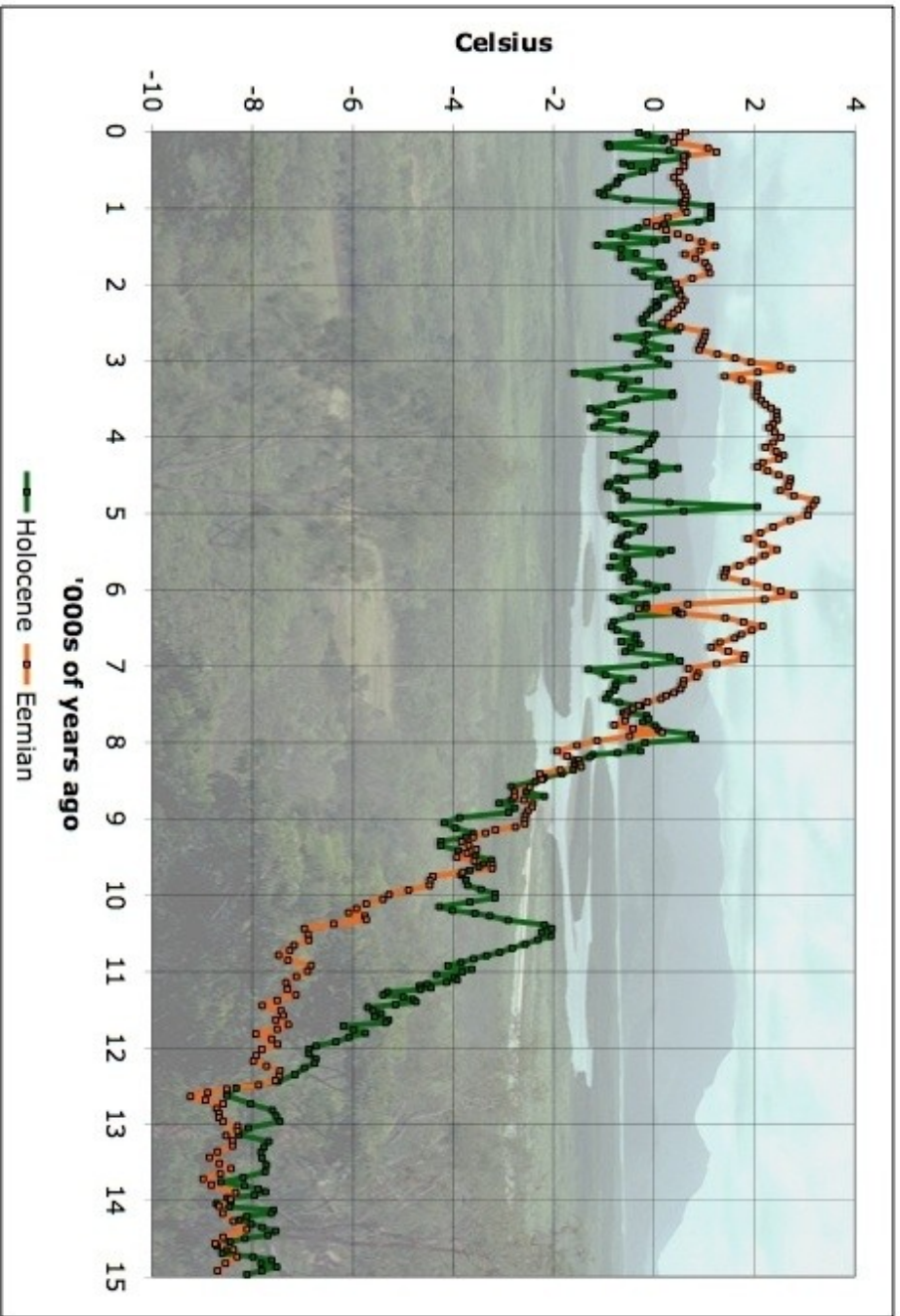
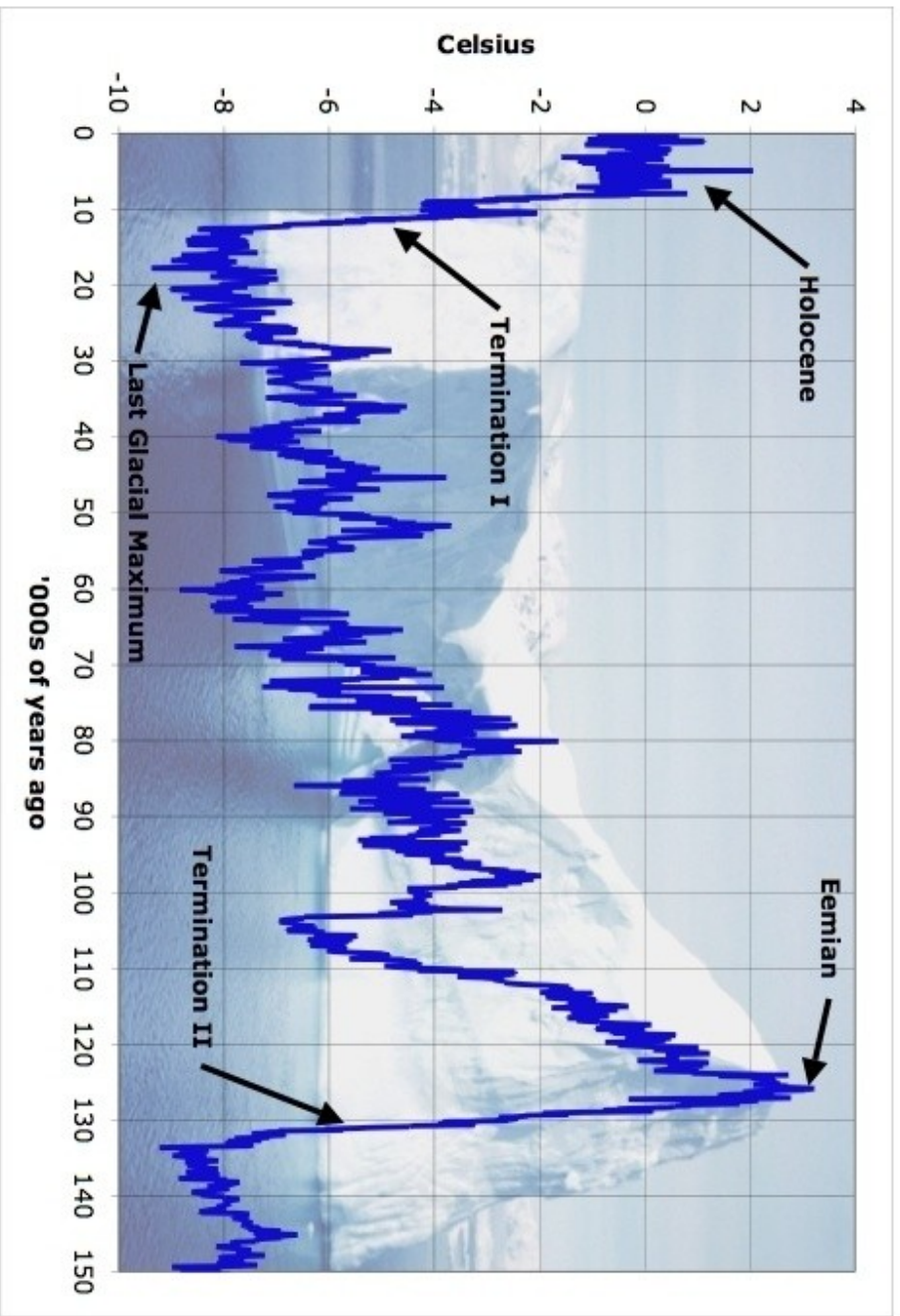
- Würm
- Riss
- Mindel



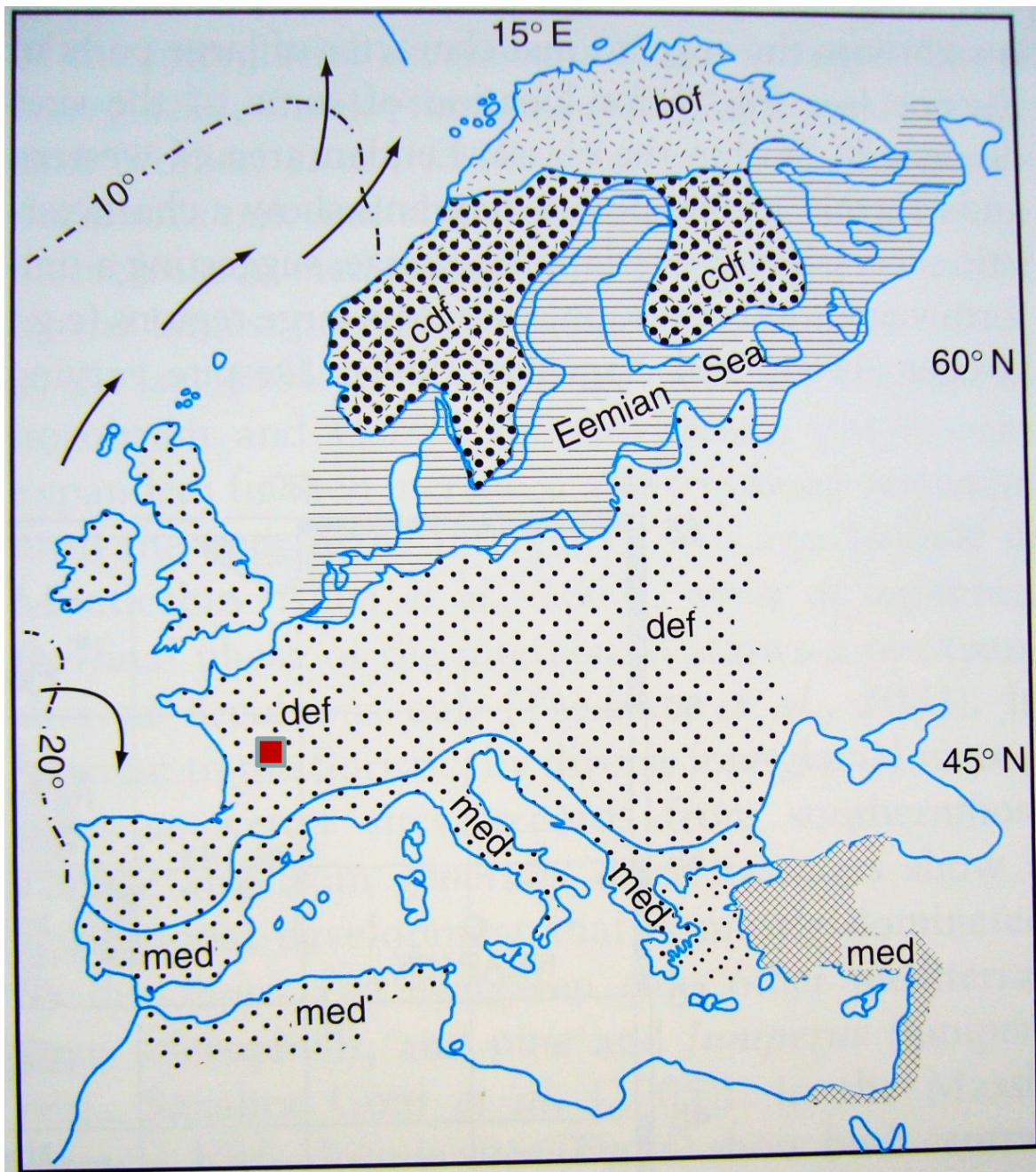
Poslední interglaciál bez podstatného vlivu člověka



Zajímavý pro srovnání s holocénem







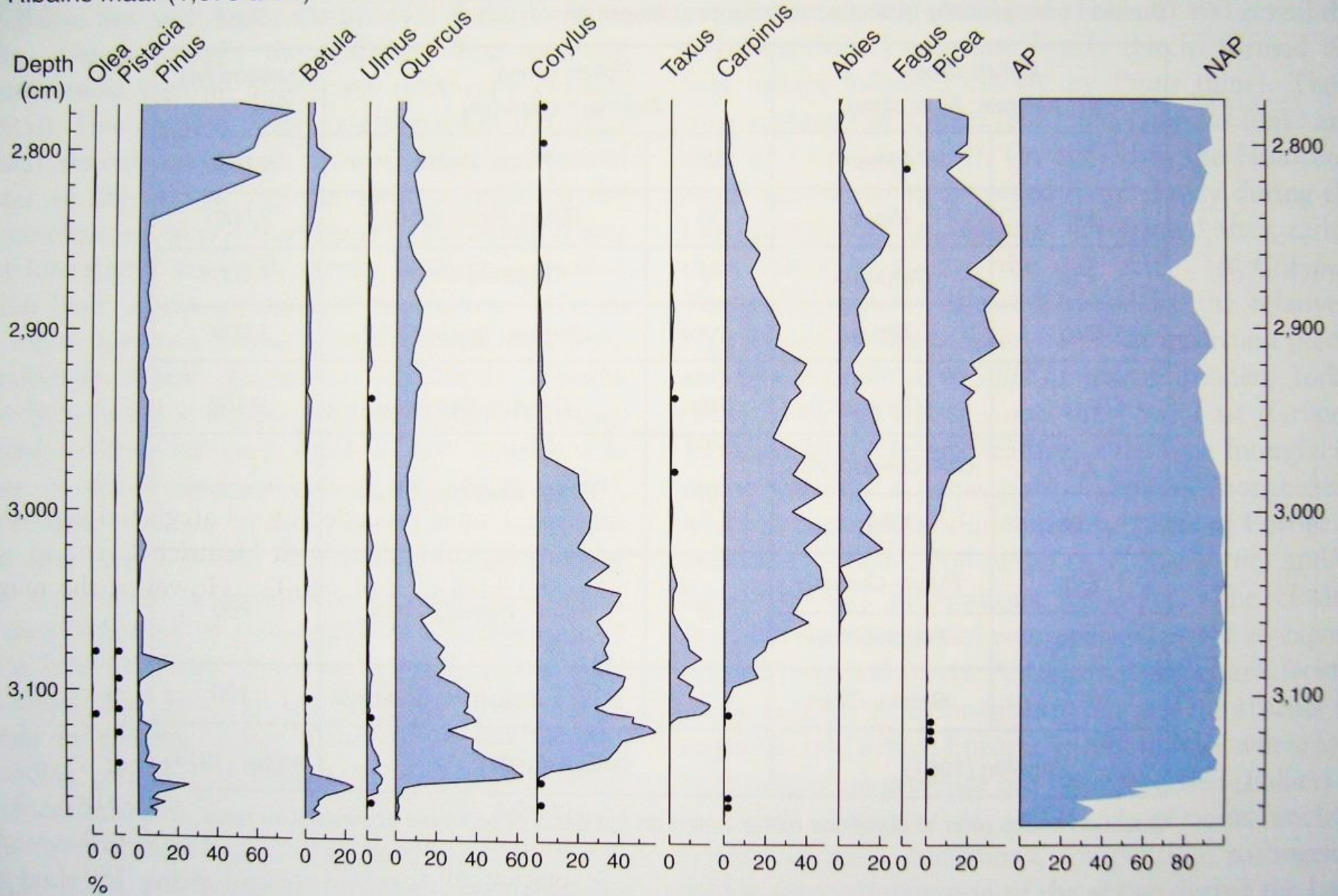
## Eemská transgrese

Uniformnější vegetační  
zonace oproti holocénu

- bof – boreální les (*Picea, Pinus, Betula*)
- cdf – jehličnato-listnatý les (*Corylus, Picea*, bez teplomilných prvků)
- def – opadavý temperátní les s teplomilnými prvky (*Cotinus, Buxus, Ilex, Vitis, ...*)
- med – neopadavé křoviny a mediteránní lesy (*Olea, Ostrya*, atd.)



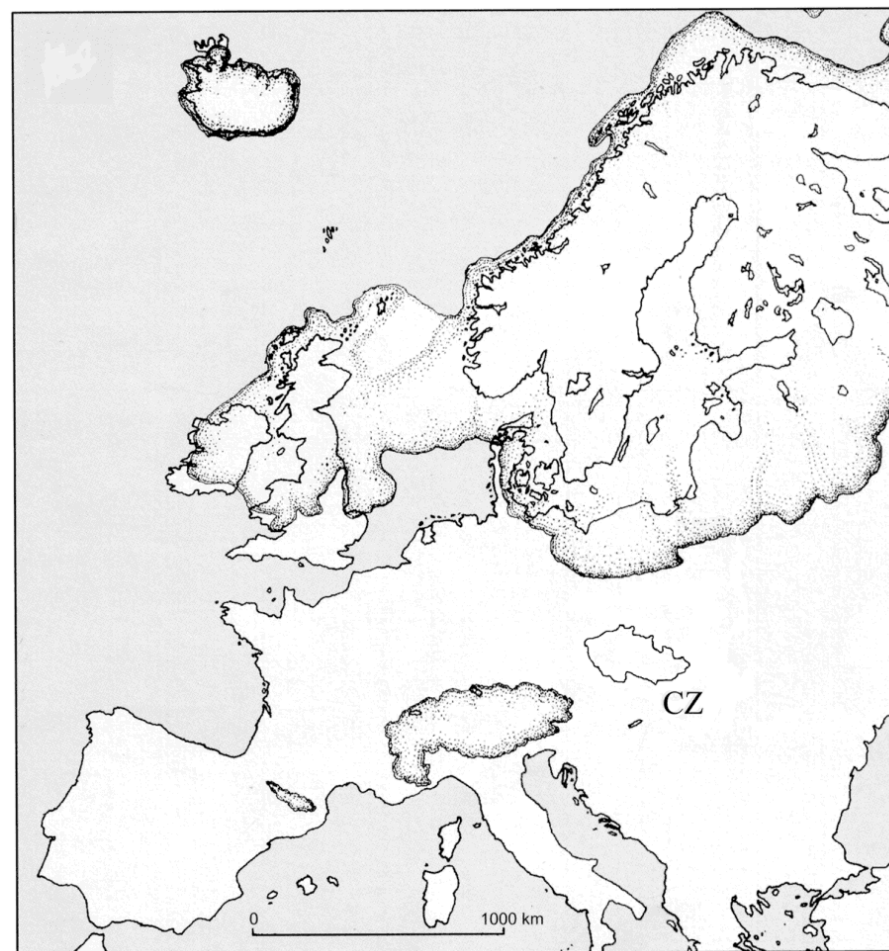
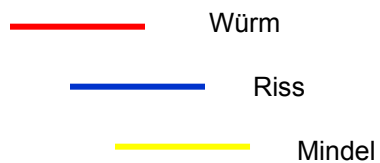
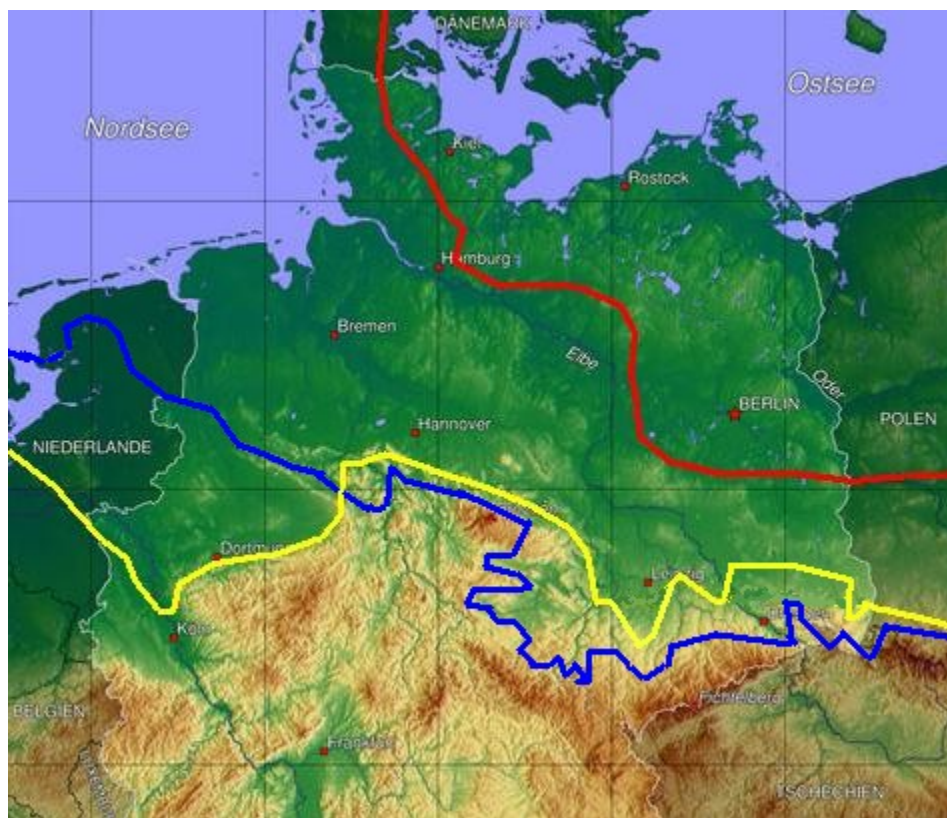
Ribains maar (1,075 a.s.l.)



**Figure 3** Last Interglacial pollen diagram of selected taxa from Ribains maar, Massif Central (de Beaulieu and Reille, 1992), displaying northern and southern European characteristics. Dots indicate pollen values below 2.5%.

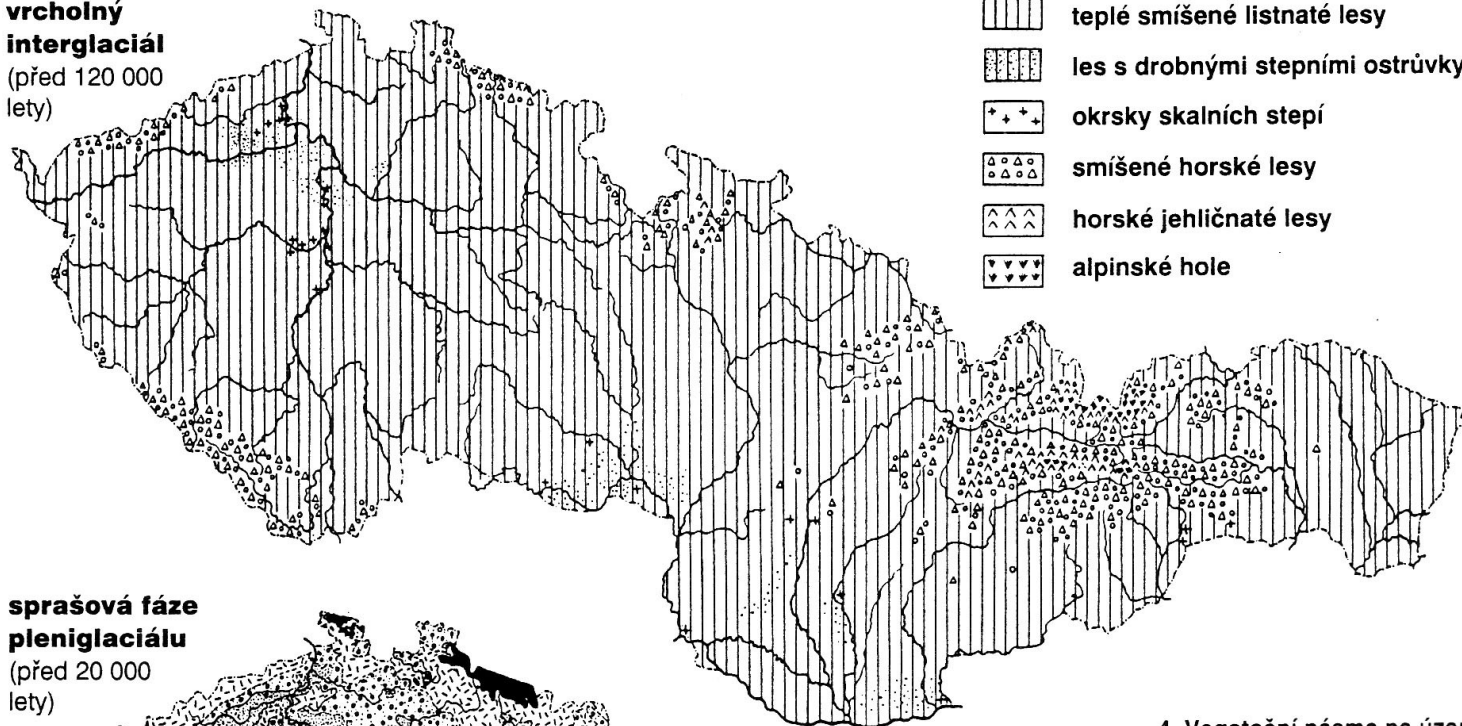








# Vrcholný a pozdní Würm. Situace v Evropě a moderní analogie.



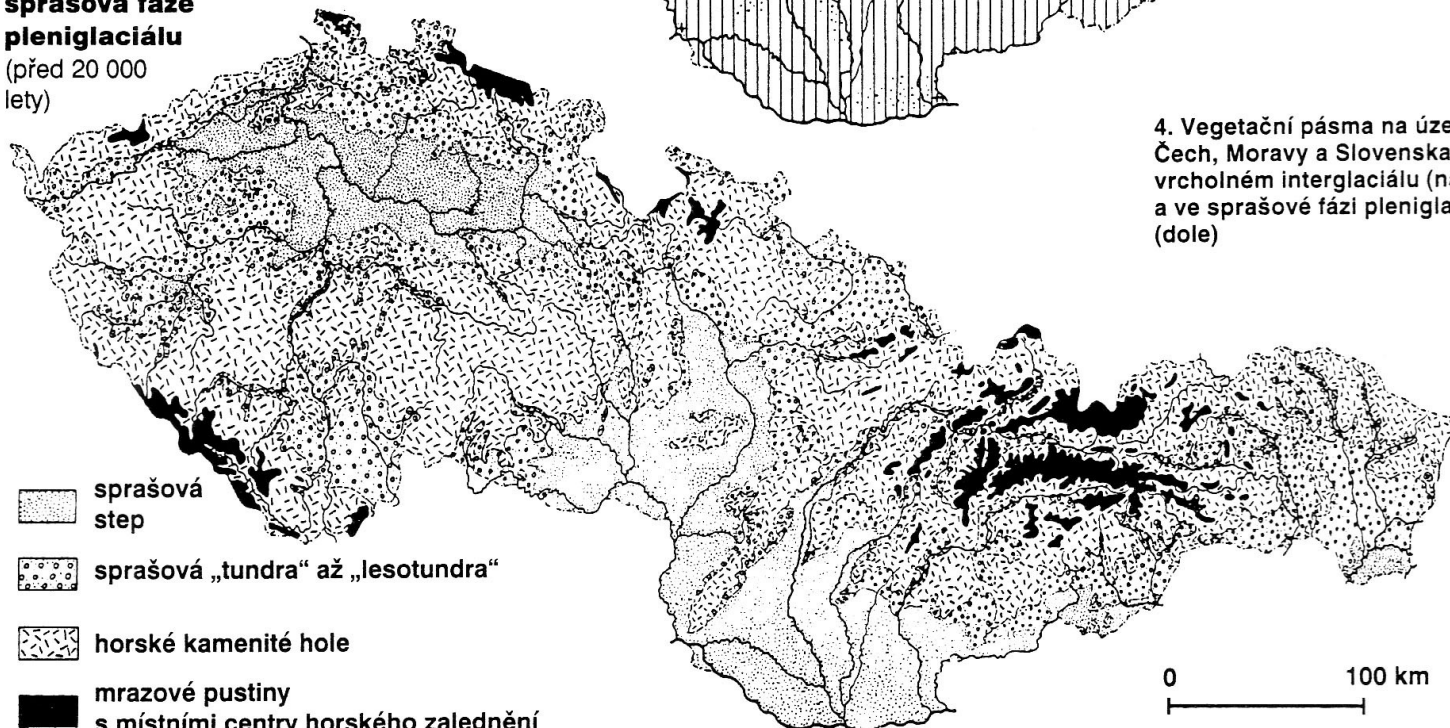






**vrcholný  
interglaciál**  
(před 120 000  
lety)



-  teplé smíšené listnaté lesy
-  les s drobnými stepními ostrůvky
-  okrsky skalních stepí
-  smíšené horské lesy
-  horské jehličnaté lesy
-  alpinské hole

**sprašová fáze  
pleniglaciálu**  
(před 20 000  
lety)

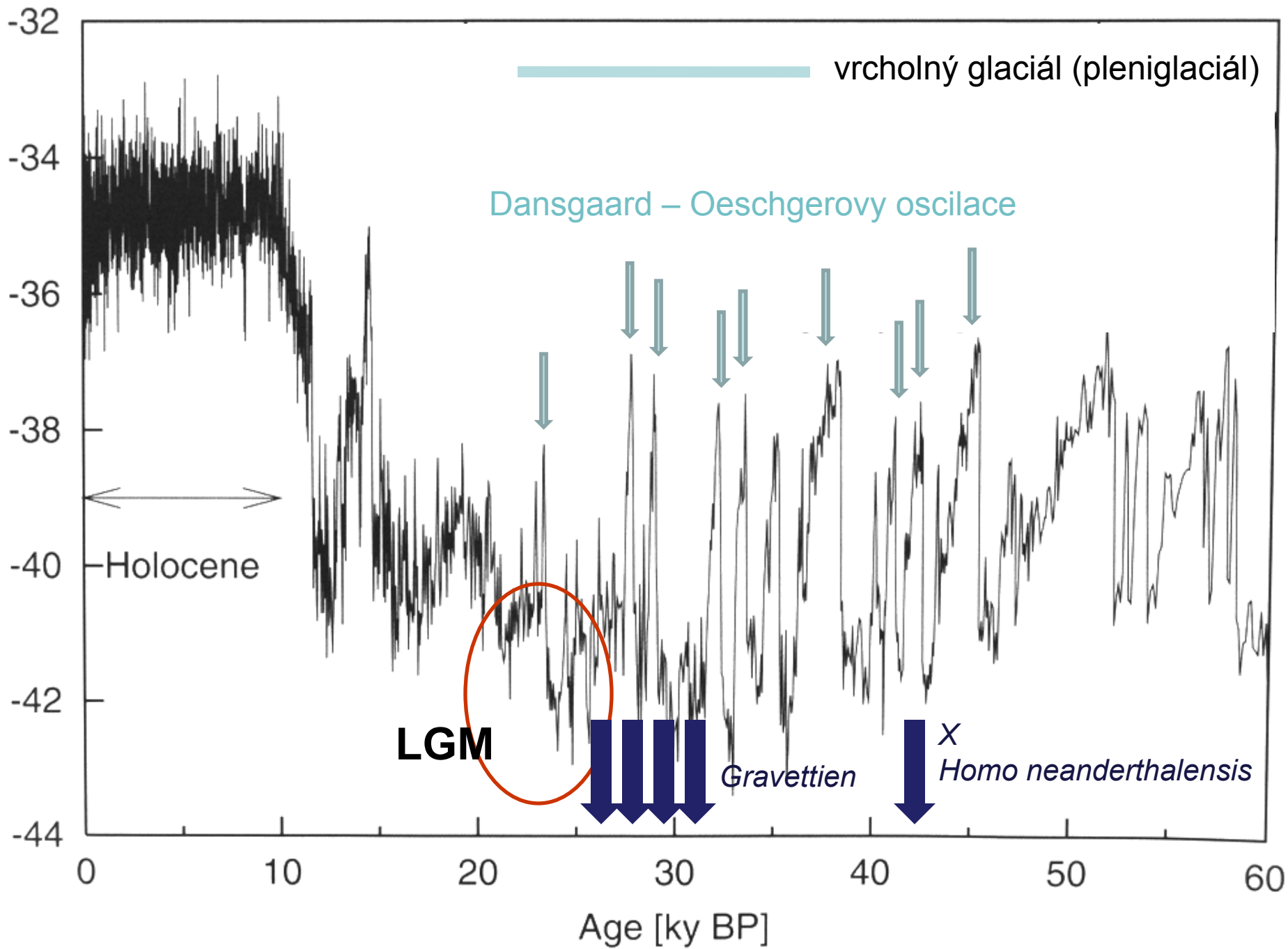


-  sprašová step
-  sprašová „tundra“ až „lesotundra“
-  horské kamenité hole
-  mrazové pustiny s místními centry horského zalednění

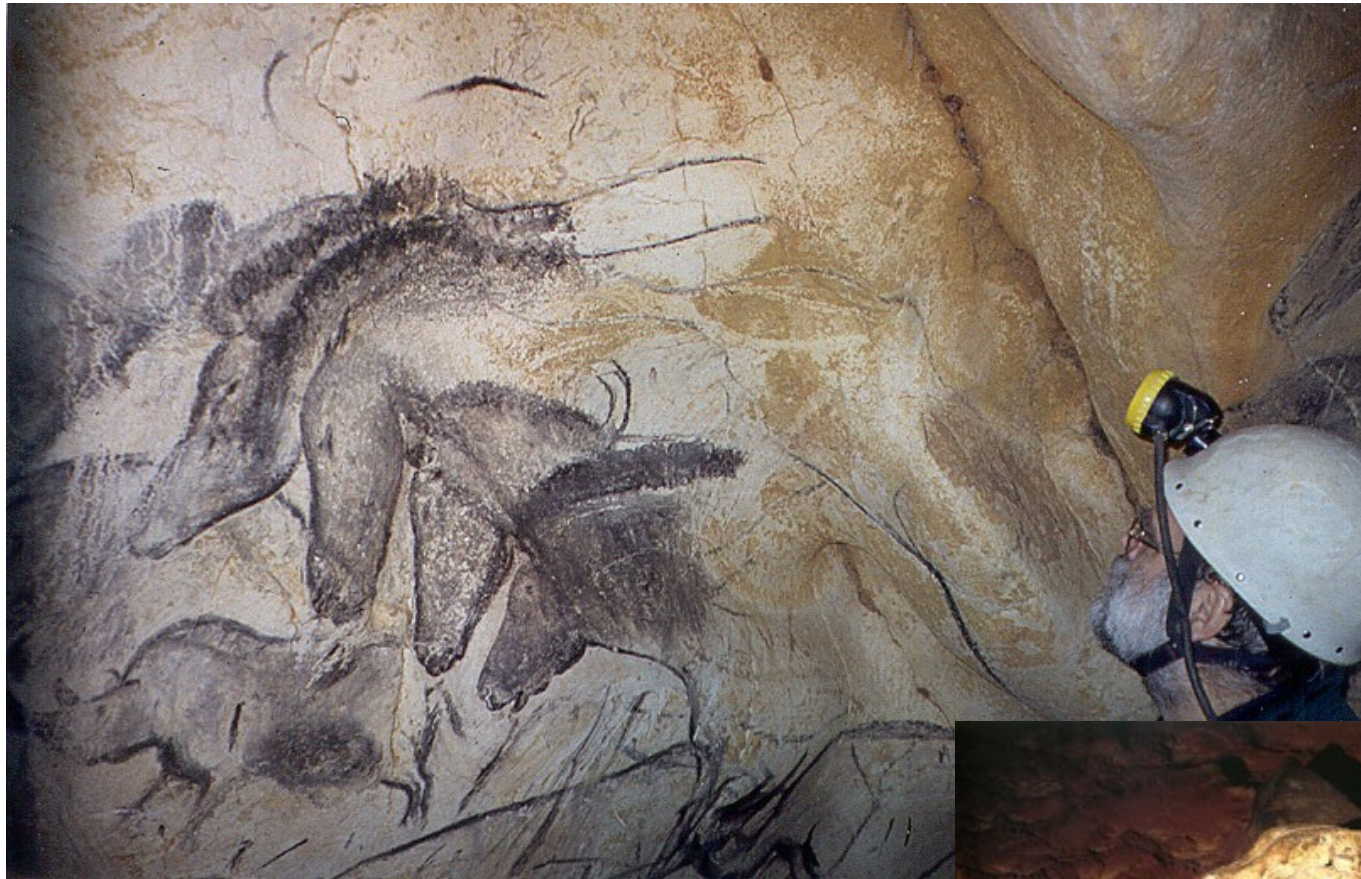
4. Vegetační pásma na území Čech, Moravy a Slovenska ve vrcholném interglaciálu (nahore) a ve sprašové fázi pleniglaciálu (dole)

0 100 km









**jeskyně Chauvet, 31 kA BP**

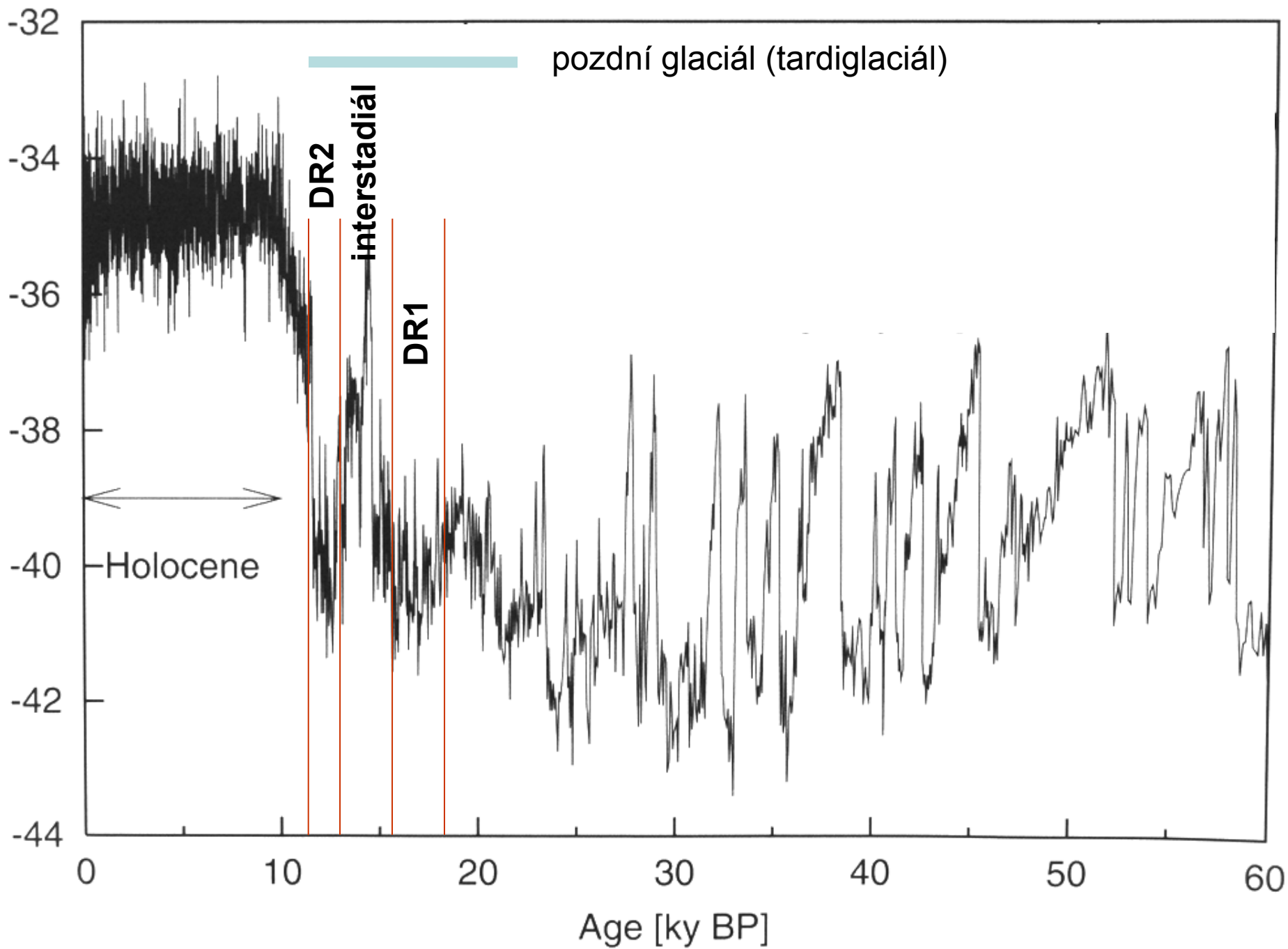




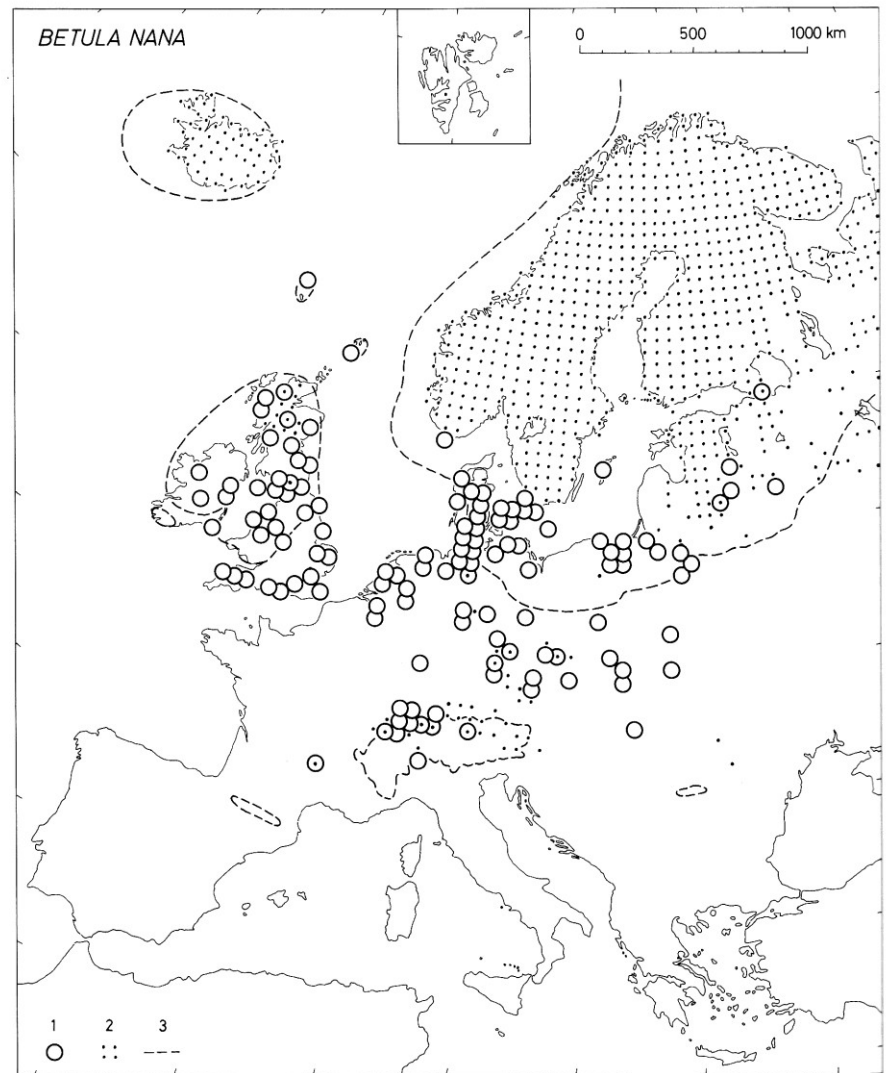
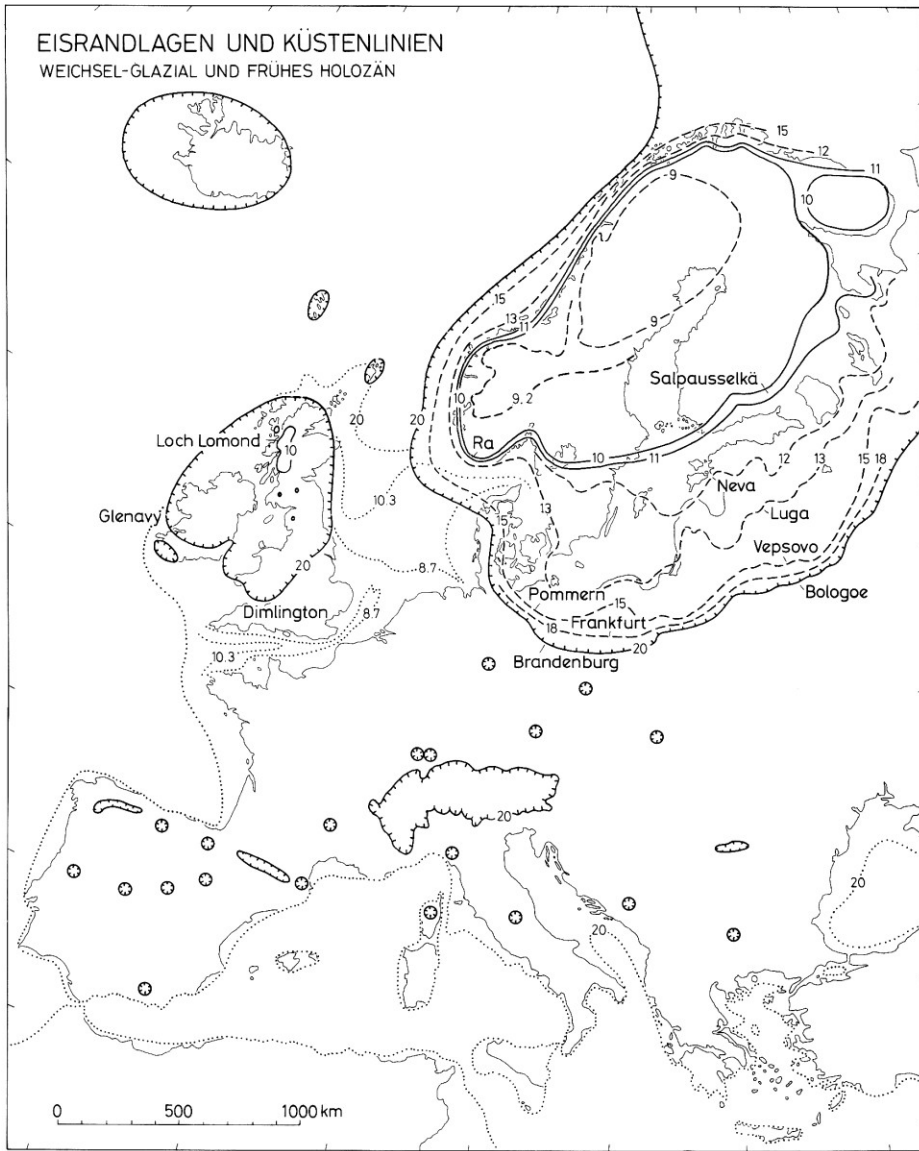
(b)



Figure 9.15 Ancient Art: (a) from Pont d'Arc in the French Ardeche, dated at 31 ka (b) faces traced from a 'sketchbook' on the walls of the La Marche cave in France.

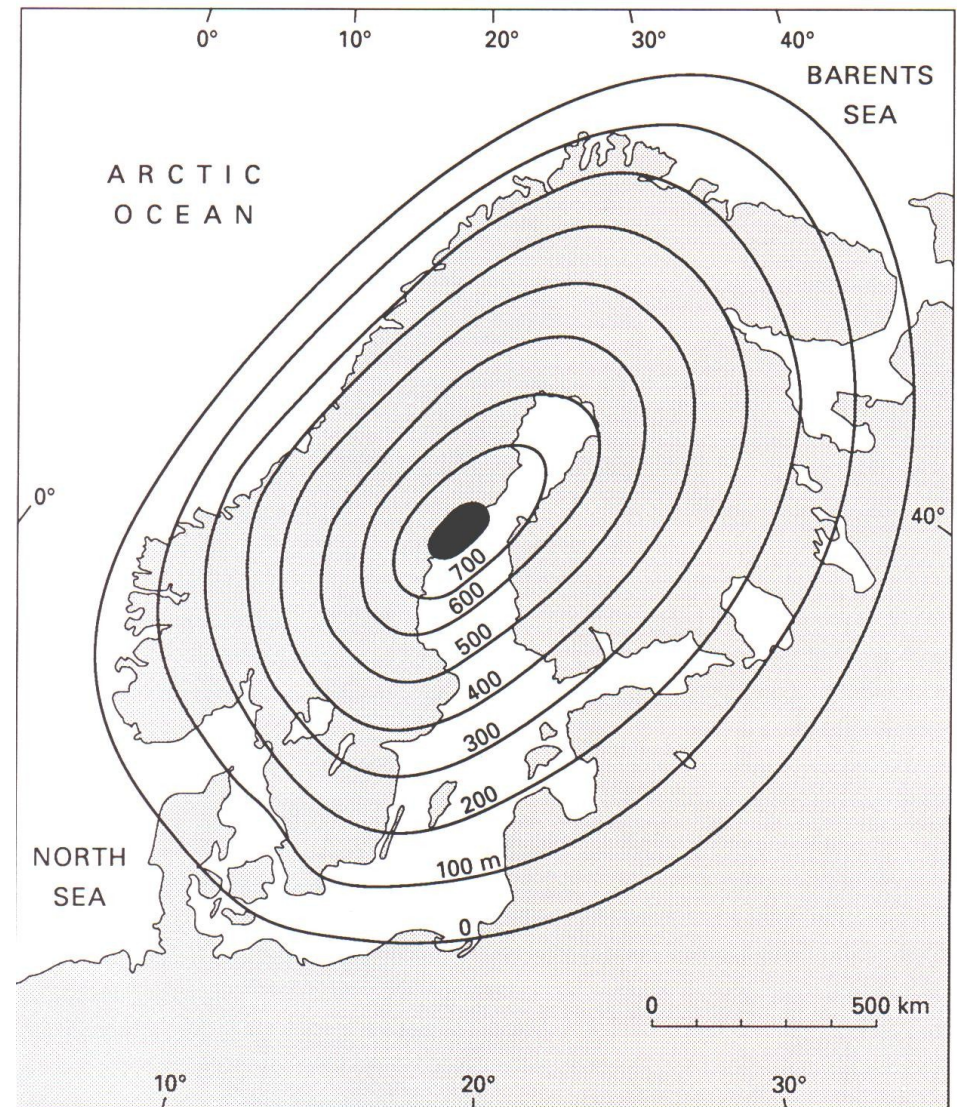
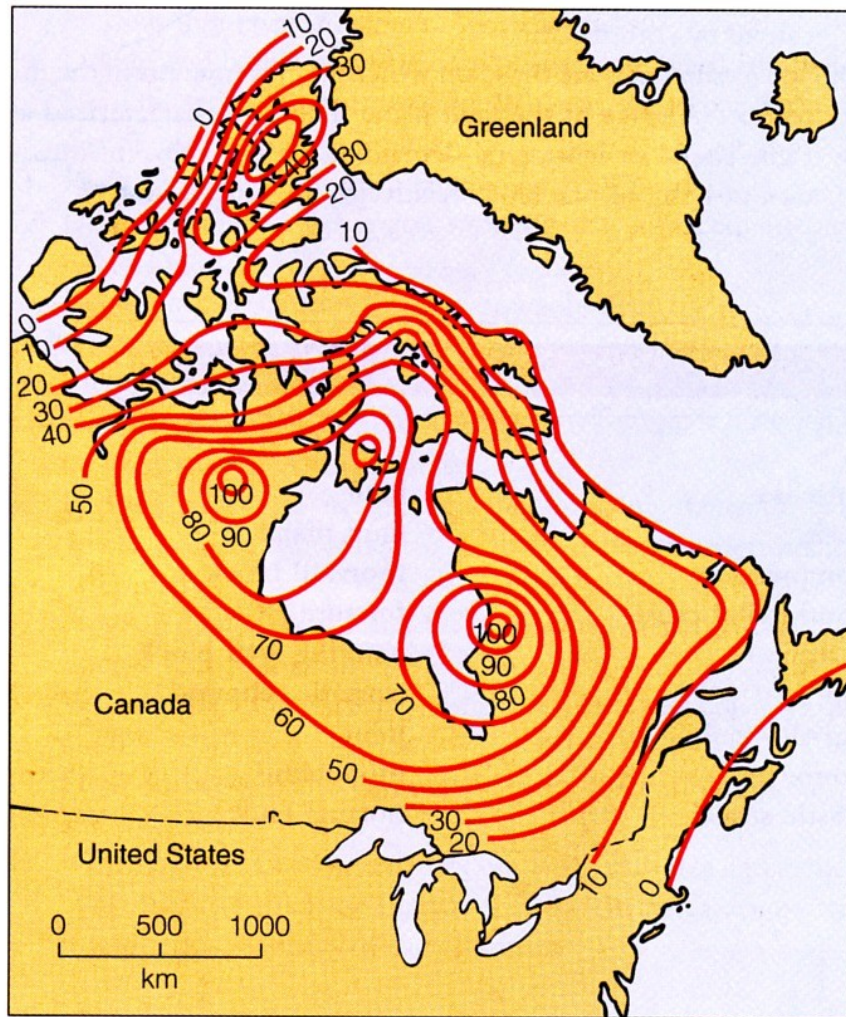






**Abb. 6.4-2. *Betula nana*. Spätquartäre Großrestfunde und heutiges Areal.** 1: Funde aus dem Pleni- und Spätglazial, sowie aus dem frühen Holozän. 2: Heutiges Areal (vgl. Abb. 6.4-1). 3: Maximalausdehnung der Weichsel-Verzeisung. Unter Verwendung einer Karte von TRALAU (1963b), ergänzt.

# Holocenní glaciizostatický výzdvih



■ FIGURE 10.29 Isostatic rebound in eastern Canada in meters during the last 6,000 years.



## Vnitřní Asie jako reliktní území



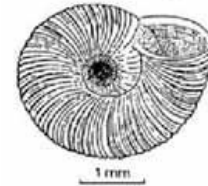
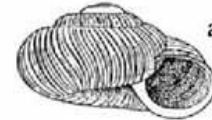
- Důvody:
- velká diverzita biotopů (kombinují se gradienty výšky a kontinentality)
  - klimatická konzervativnost (chybí výrazně vlhký střední holocén)
  - trvale přírodní charakter (nízká hustota osídlení)
  - přes velkou vzdálenost od Evropy bývaly areály mnoha druhů propojené



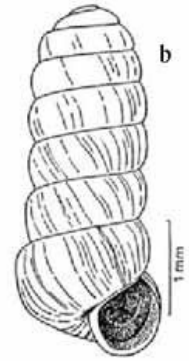
*Microtus gregalis*



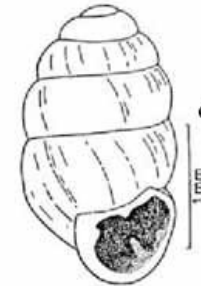
*Vallonia tenuilabris*



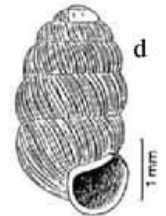
*Columella columella*



*Vertigo parcedentata*



*Pupilla loessica*



nežijí moc na stepi!

M. Chytrý, V. Řičánková,  
M. Horský  
a jejich týmy.

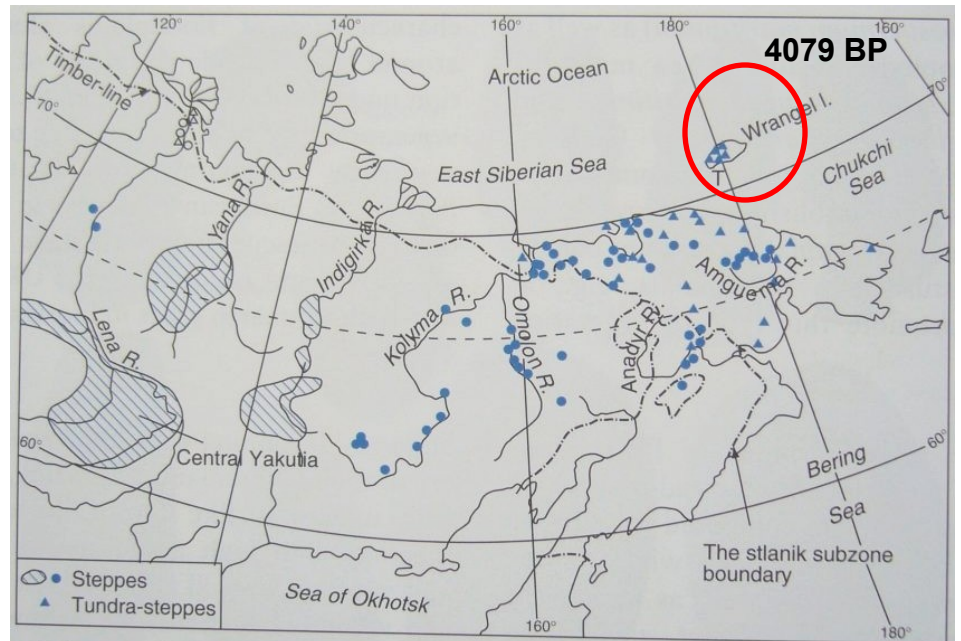
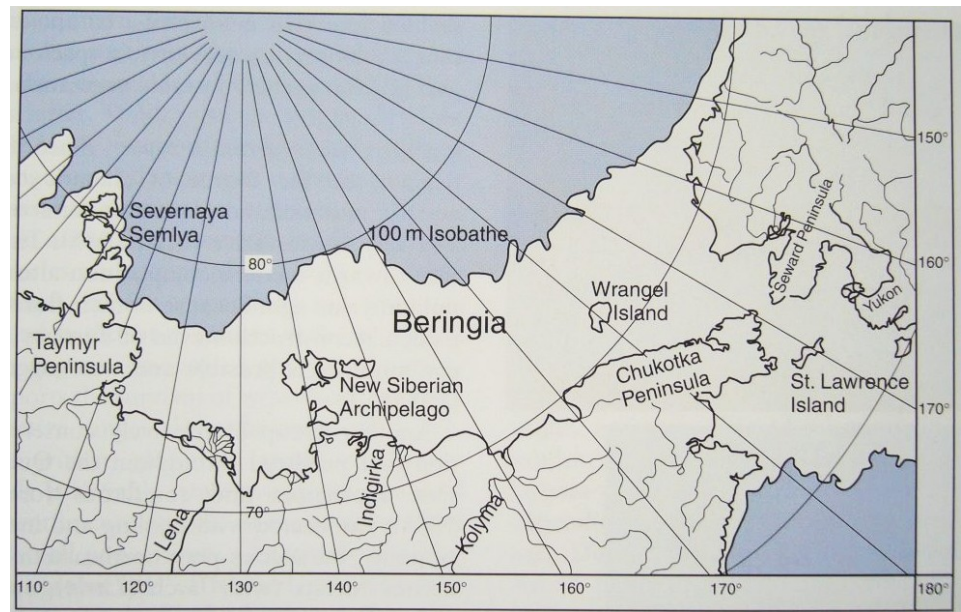




disjunktní areál stepí v SV Ázii –  
- zbytek původního rozšíření

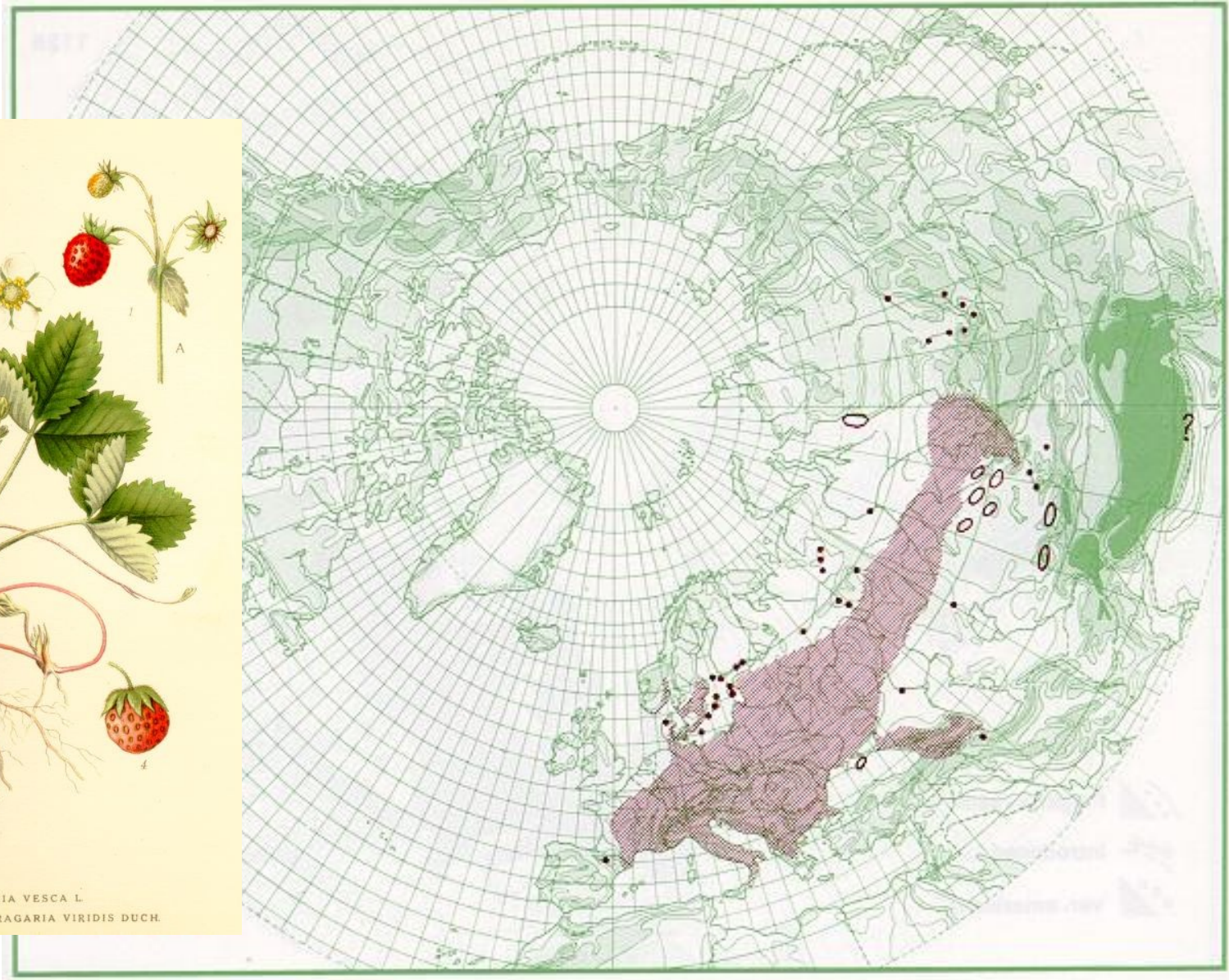


Weichselian steppe plant macrofossils preserved in permafrost deposits of Arctic Siberia.





# *Fragaria viridis*



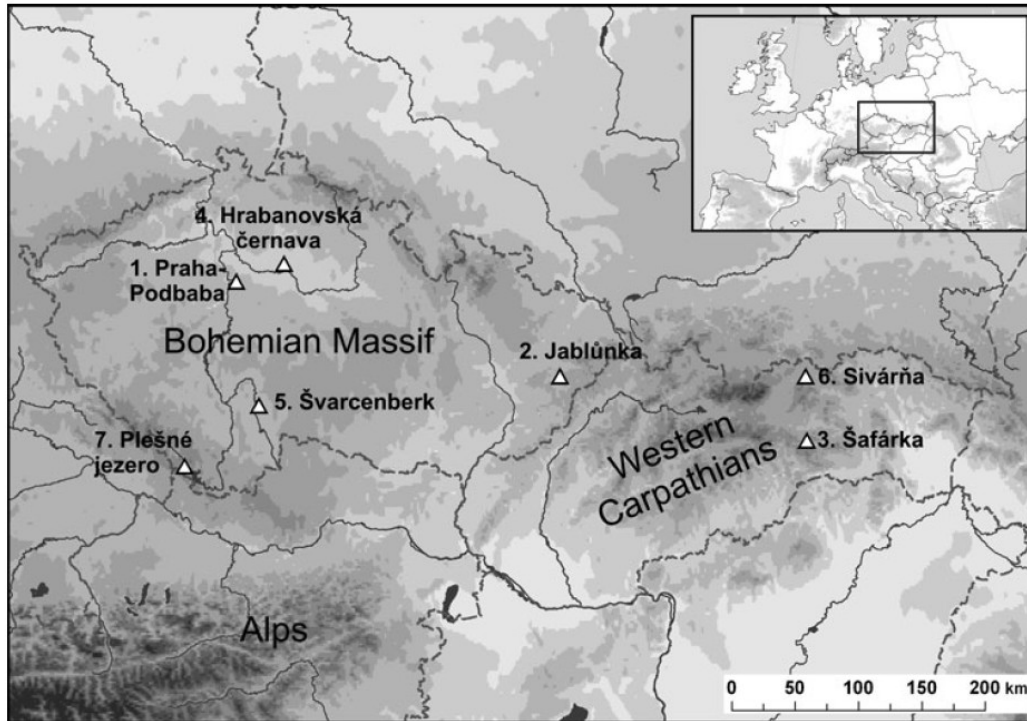
*Adonis vernalis*, *Anemone sylvestris*, *Astragalus danicus*, *Phleum phleoides*, *Phlomis tuberosa*, *Scabiosa ochroleuca*, *Scorzonera purpurea*, *Stipa pennata*



# Analogická situace ve střední Evropě

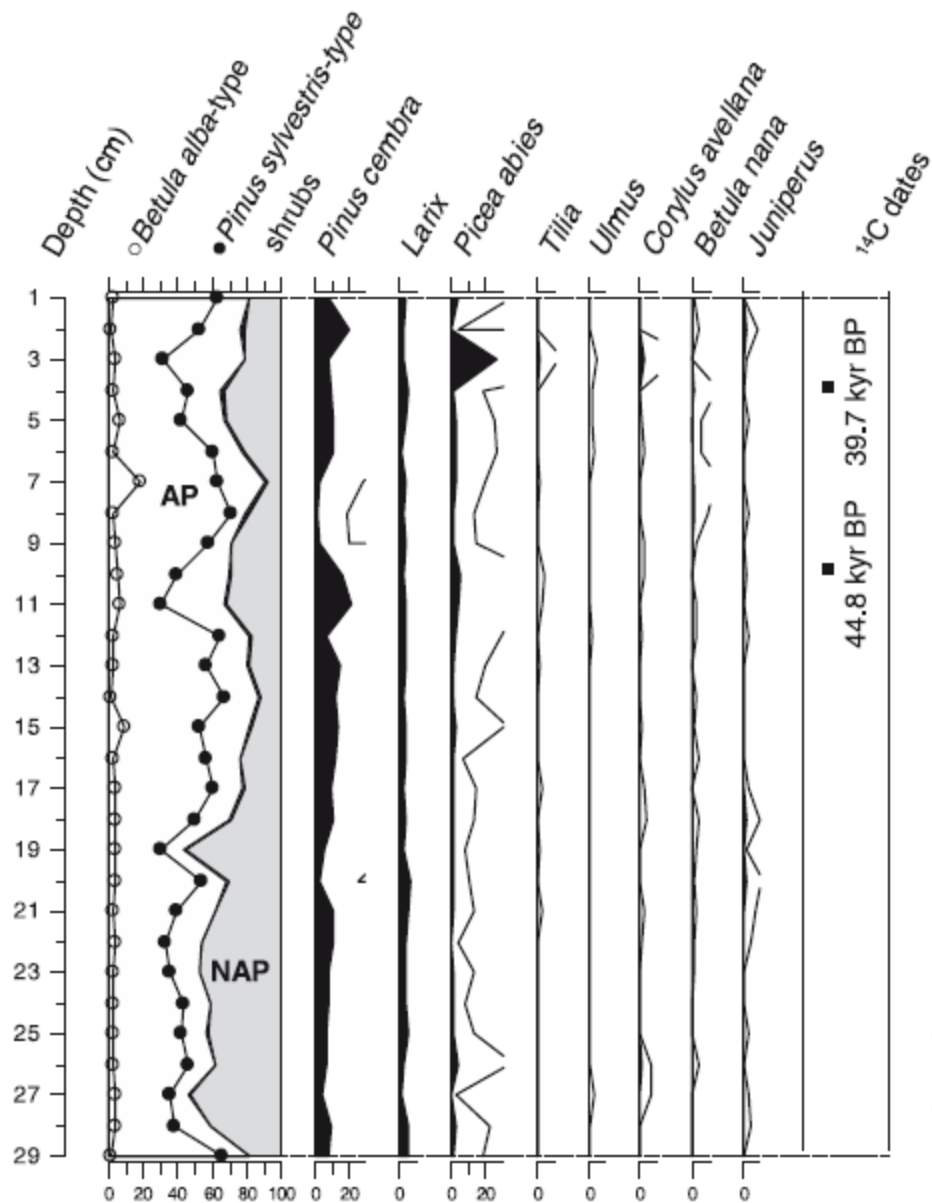
(Kuneš *et al.*, JBi, 2008

Jankovská *et Pokorný*, Preslia, 2008)

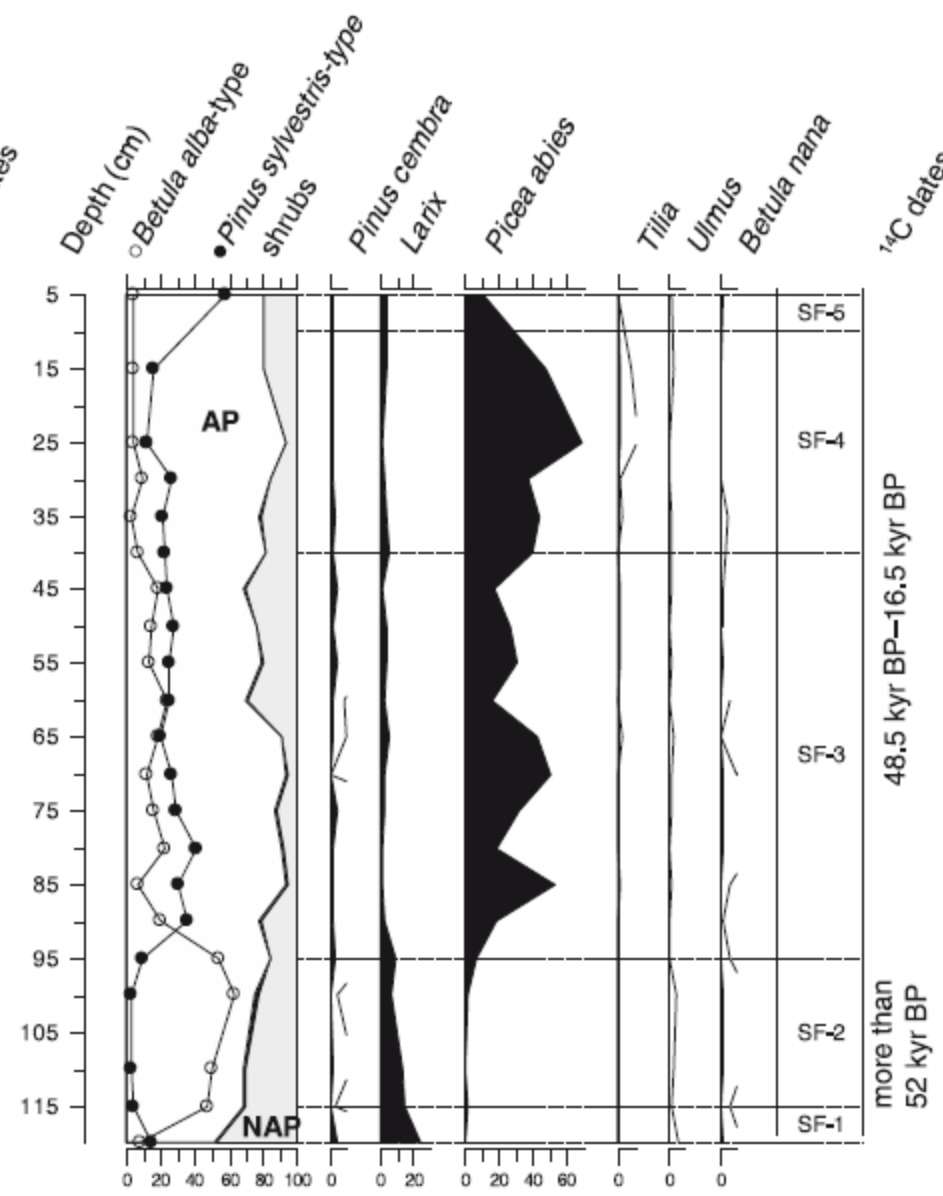


**Table 1** Full-glacial pollen spectrum from Praha-Podbaba locality (selected pollen taxa).

Pollen taxon	Total count	Percentage
Arboreal pollen (AP)		
<i>Abies</i>	2	0.3
<i>Alnus glutinosa</i> -type	5	0.7
<i>Betula alba</i> -type	21	2.8
<i>Corylus avellana</i>	1	0.1
<i>Larix</i>	6	0.8
<i>Picea</i>	23	3.1
<i>Pinus cembra</i> -type	8	1.1
<i>Pinus sylvestris</i> -type	365	49.5
<i>Betula nana</i> -type	1	0.1
<i>Juniperus</i>	3	0.4
Non-arboreal pollen (NAP)		
<i>Anthemis</i> -type	3	0.4
<i>Artemisia</i>	14	1.9
Compositae subfam. Cichorioideae	7	0.9
<i>Calluna vulgaris</i>	2	0.3
Cruciferae	3	0.4
<i>Filipendula</i>	8	1.1
Gramineae	181	24.5
Chenopodiaceae	2	0.3
<i>Phyteuma</i> -type	4	0.5
<i>Potentilla</i> -type	5	0.7
Rubiaceae	30	4.1

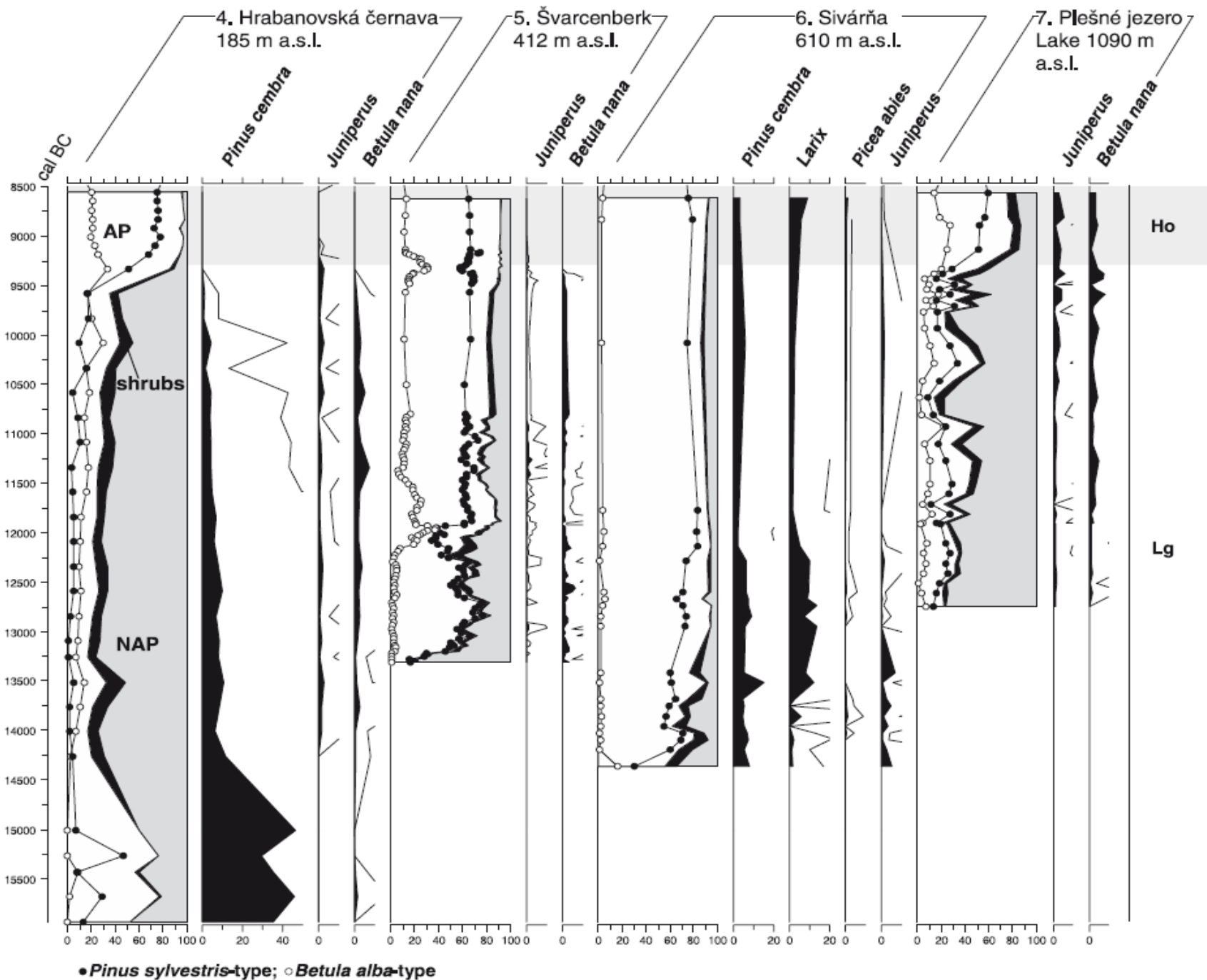


**2. Jablůnka (350 m a.s.l.)**



**3. Šafárka (600 m a.s.l.)**







Altai, Bol'shoi Akturu, 2200 m a. s. l. (Foto M.Chytrý)

Druhově bohatá  
step

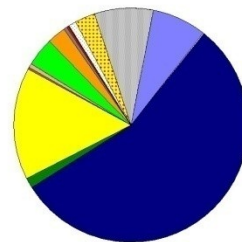
Tundra s *Betula rotundifolia* (*B. nana*)

„Stepotundra“ je možná pouhý palynologický konstrukt.

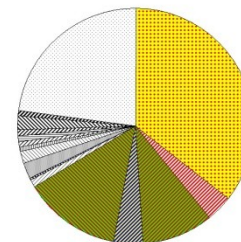


# Hlavní vegetační formace a jejich současná pylová spektra

## Tajga s *Pinus sibirica*



Pinus	10.6%
Pinus undif.	0.1%
Pinus sibirica	55.4%
Abies sibirica	1.4%
Betula	15.5%
Larix	0.3%
Picea obovata	0.6%
Alnus viridis	3.9%
Betula nana	2.6%
Rhododendron-type	0.4%
Salix	0.2%
Spiraea	0.1%
other AP	1.1%
Artemisia	2.8%
other NAP	8.1%



Artemisia	35.6%
Cyperaceae	3.6%
Graminae	9.8%
Chenopodiaceae	4.0%
fern spores	13.4%
Pteridium aquilinum	1.0%
Rubiaceae	0.3%
Thalictrum	2.2%
Urtica	1.7%
Cannabis sativa	0.6%
Cruciferae	0.7%
Cerealia undif.	0.8%
Aconitum-type	0.8%
Umbeliferae	2.0%
Ranunculaceae	0.7%
other NAP	23.0%

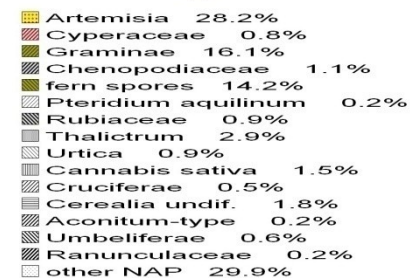
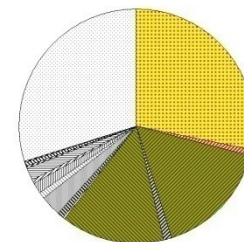
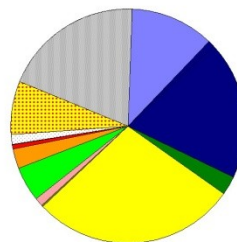
*Pinus sibirica*

*Rhododendron dahuricum*, *Vaccinium* spp.,  
*Bergenia crassifolia*

chudé bylinné patro



# Vlhká tajga s *Abies sibirica*

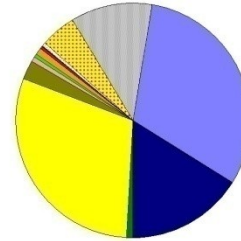


*Abies sibirica*

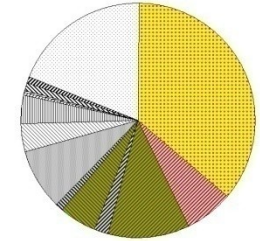
druhově bohaté keřové a bylinné patro



# Hemiboreální les



Pinus	33.8%
Pinus undif.	0.3%
Pinus sibirica	15.9%
Abies sibirica	0.8%
Betula	29.9%
Larix	2.6%
Picea obovata	0.7%
Alnus viridis	0.5%
Betula nana	1.0%
Rhododendron-type	0.1%
Salix	0.3%
Spiraea	0.2%
other AP	0.5%
Artemisia	4.9%
other NAP	11.3%



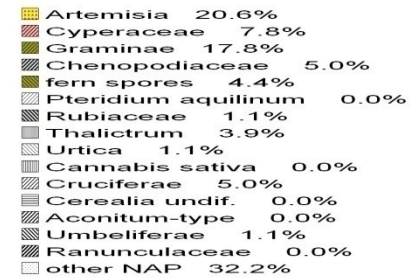
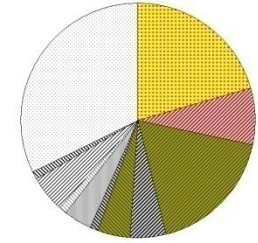
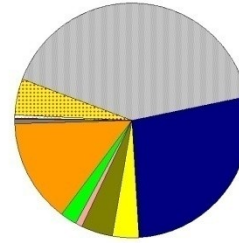
Artemisia	36.2%
Cyperaceae	6.7%
Graminae	11.2%
Chenopodiaceae	1.9%
fern spores	5.2%
Pteridium aquilinum	0.0%
Rubiaceae	1.1%
Thalictrum	8.4%
Urtica	3.9%
Cannabis sativa	3.9%
Cruciferae	0.4%
Cerealia undif.	0.2%
Aconitum-type	0.0%
Umbelliferae	1.1%
Ranunculaceae	0.9%
other NAP	19.2%

dominují *Betula pendula*, *Pinus sylvestris*, *Larix sibirica*

bohaté bylinné patro s mnoha heliofyty a stepními elementy (obdobá našich teplomilných i kyselých doubrav)



## Horské trávníky



## Alpínská keříčková vegetace

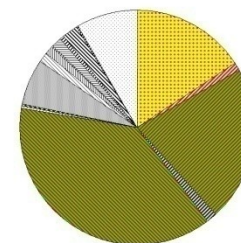
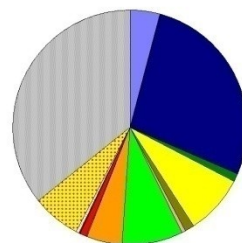


keříčky, ostřice, mechy, lišejníky

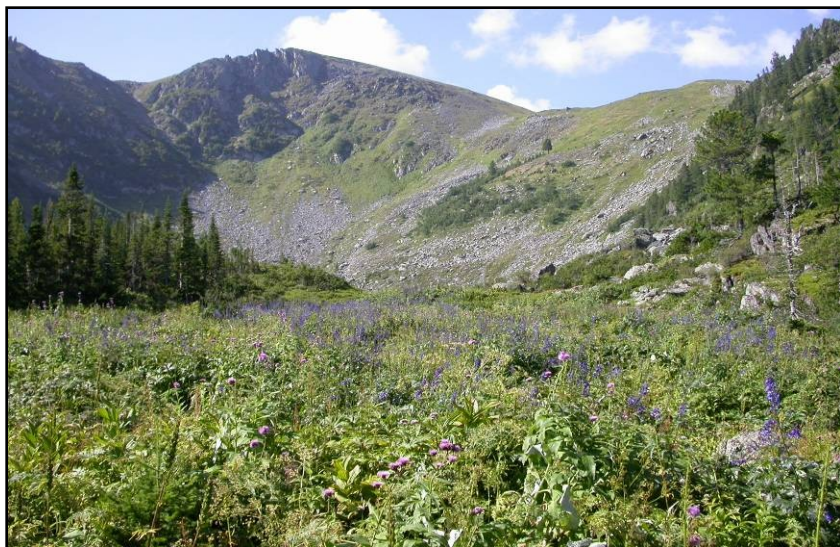
Individuálně *Larix*, *Pinus sibirica* podél hranice lesa



## Sněhová výležiska

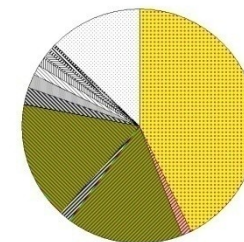
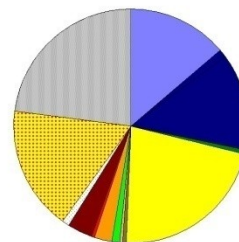


## Vysokobylinná vegetace



druhově bohatá bylinná vegetace

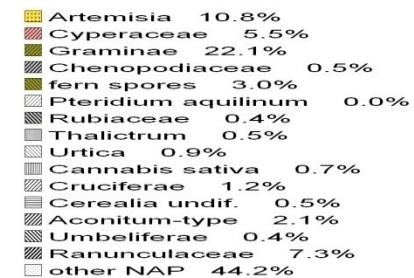
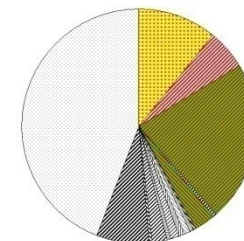
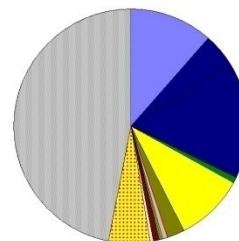
# Luční step



Převážně severní část pohoří:  
mozaika stepi a lesa s *Betula pendula*

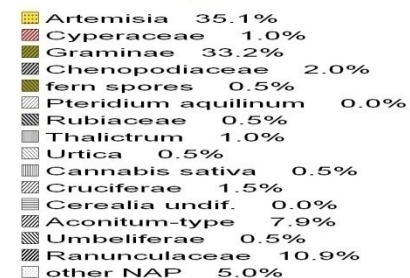
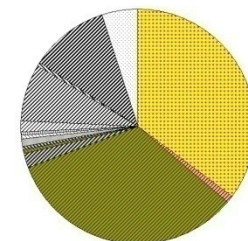
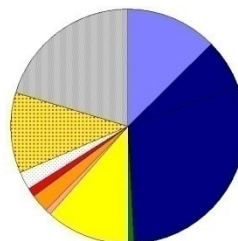


# Skalková step



převážně trávy a nízké byliny  
mongolského rozšíření

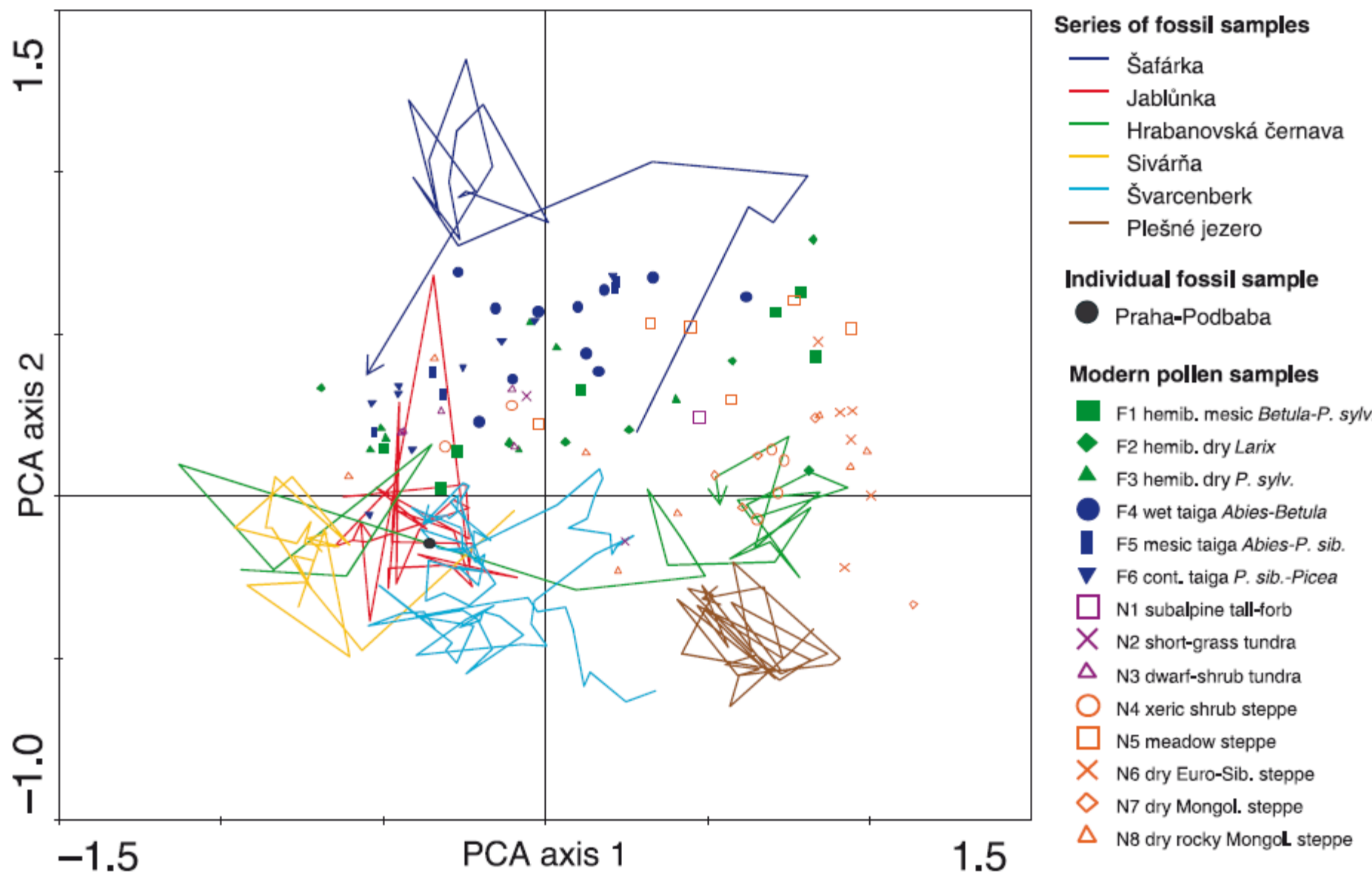
# Kontinentální step

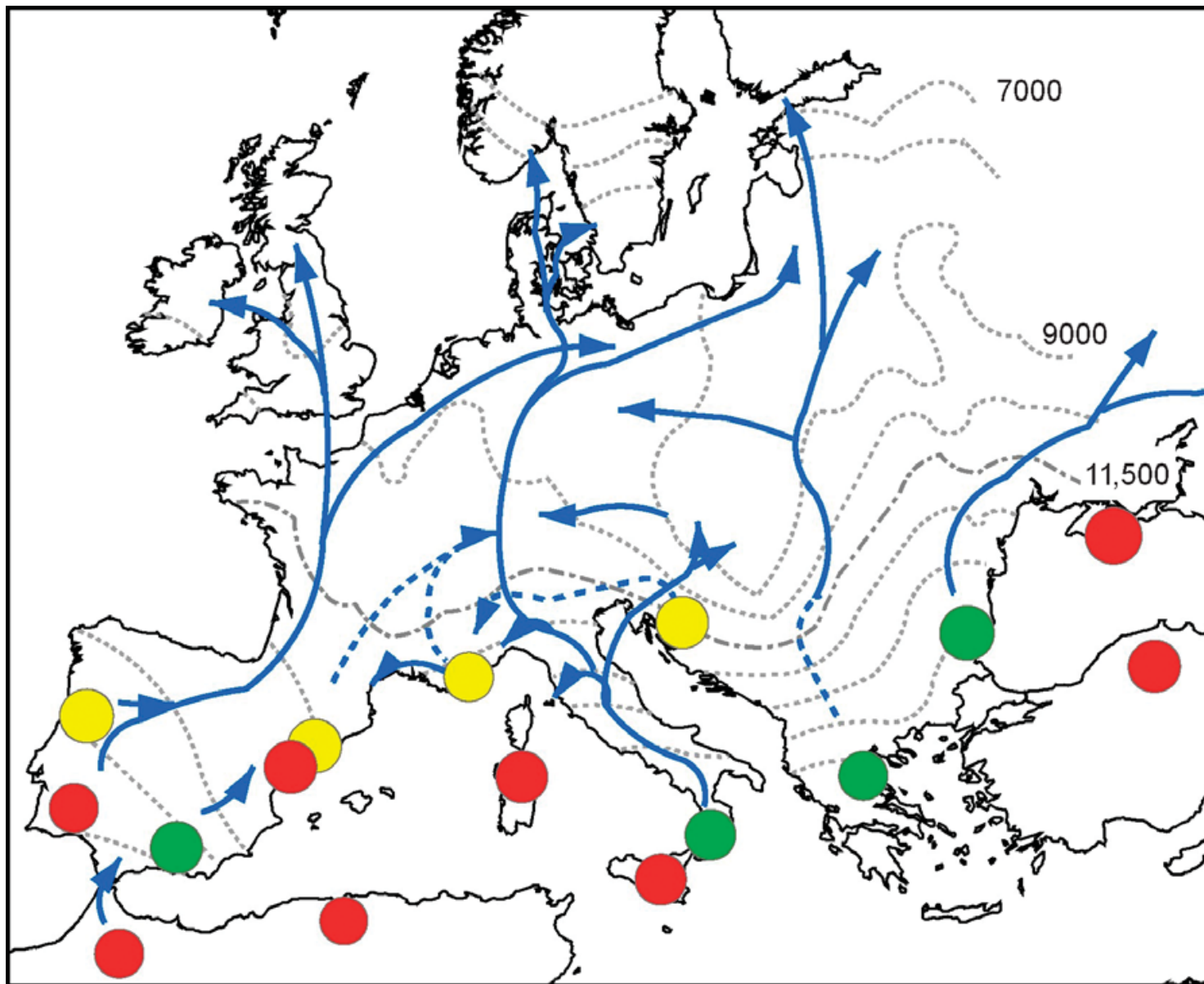


v kotlinách na jihu

podobná skalnaté stepi s druhy  
mongolského rozšíření (*Cleistogenes*)

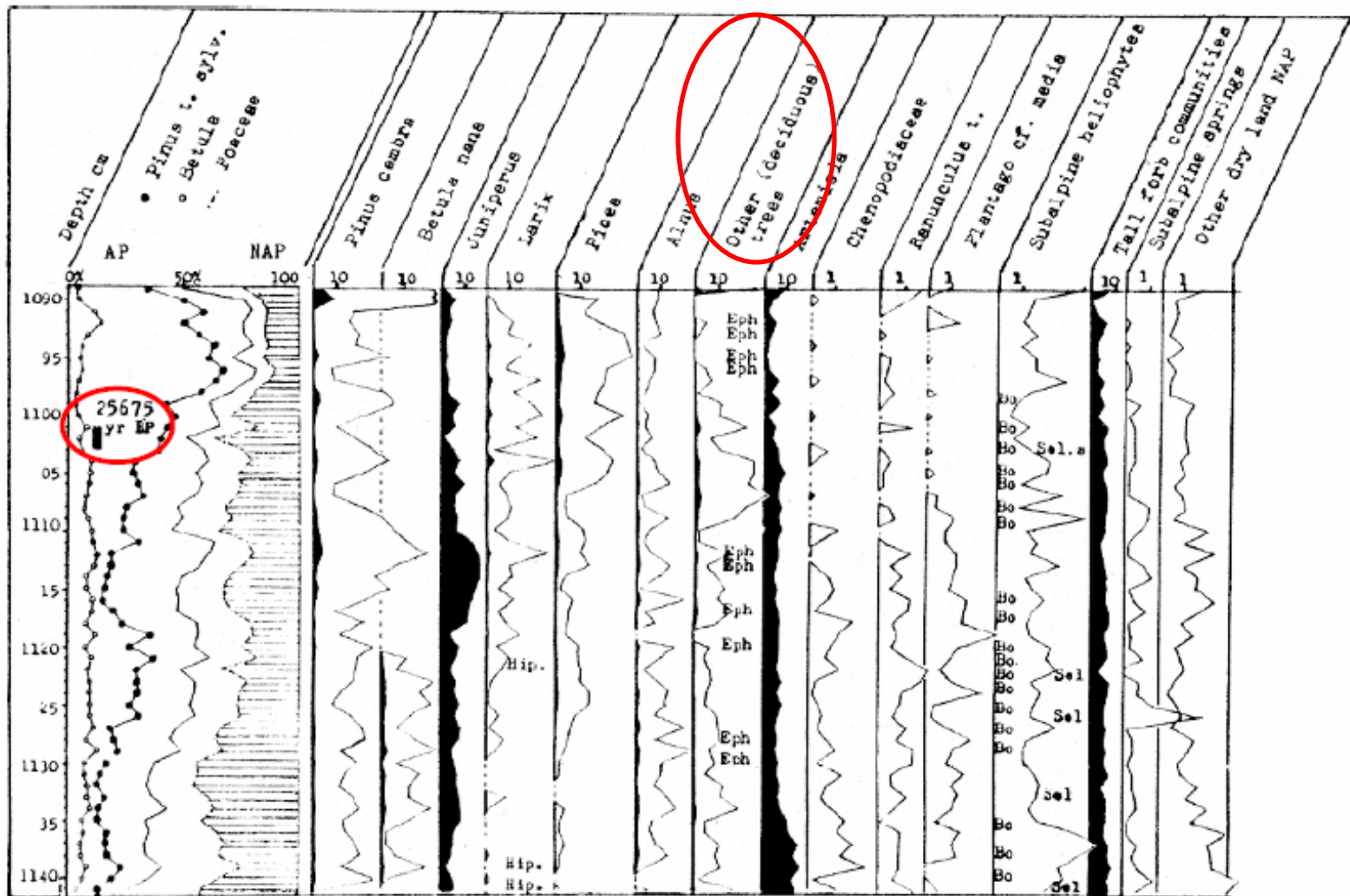






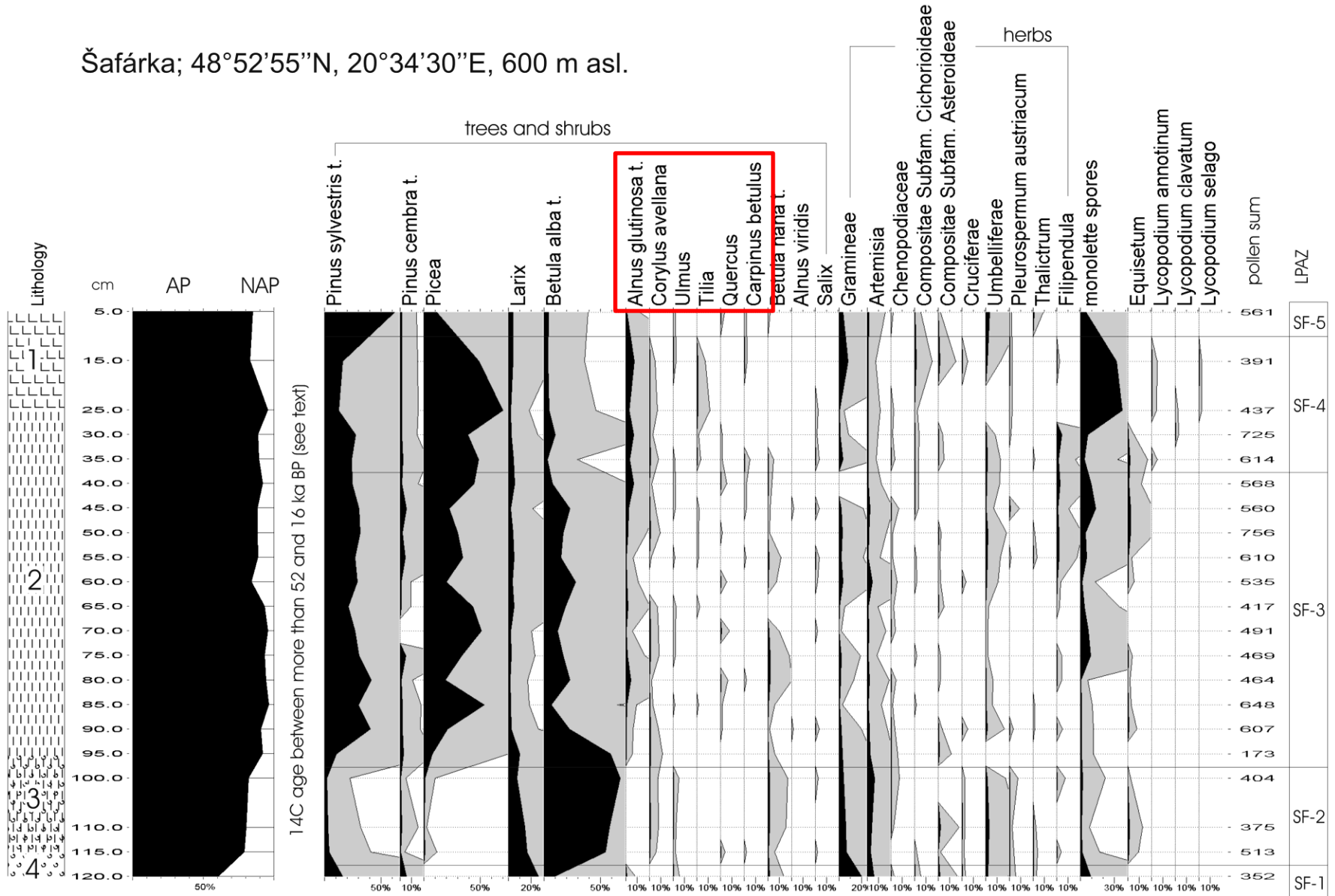
Šíření dubu: tradiční koncept rekolonizace střední a severní Evropy dřevinami





Bulhary  
Rybníčková & Rybníček 1992

Šafárka; 48°52'55"N, 20°34'30"E, 600 m asl.

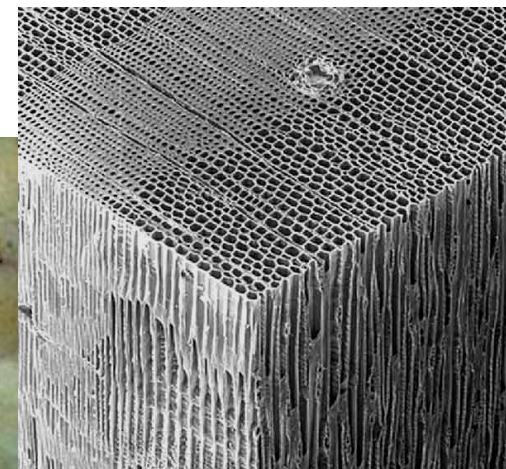


Analysed by V. Jankovská

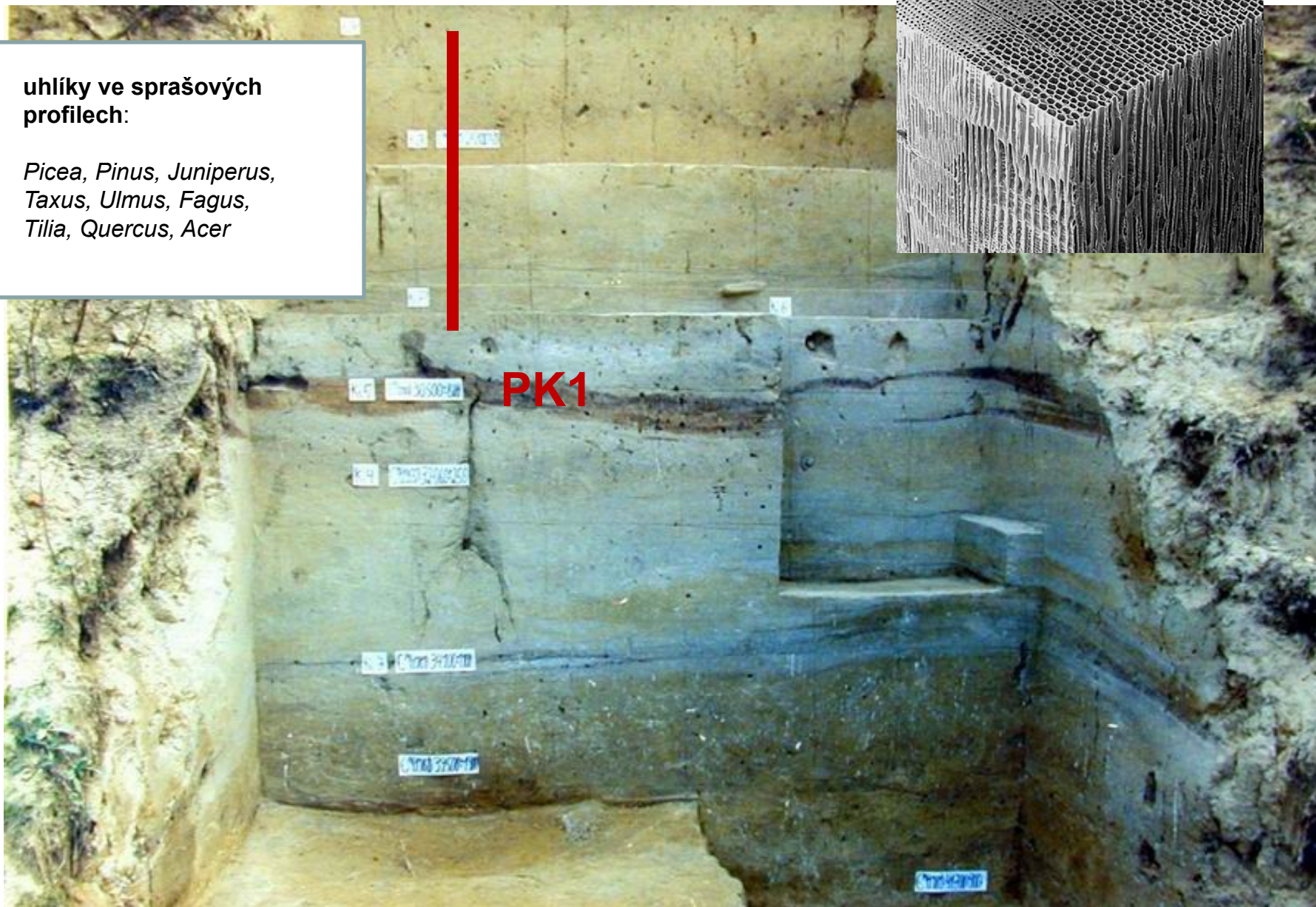


**uhlíky ve sprašových  
profilech:**

*Picea, Pinus, Juniperus,  
Taxus, Ulmus, Fagus,  
Tilia, Quercus, Acer*



**PK1**



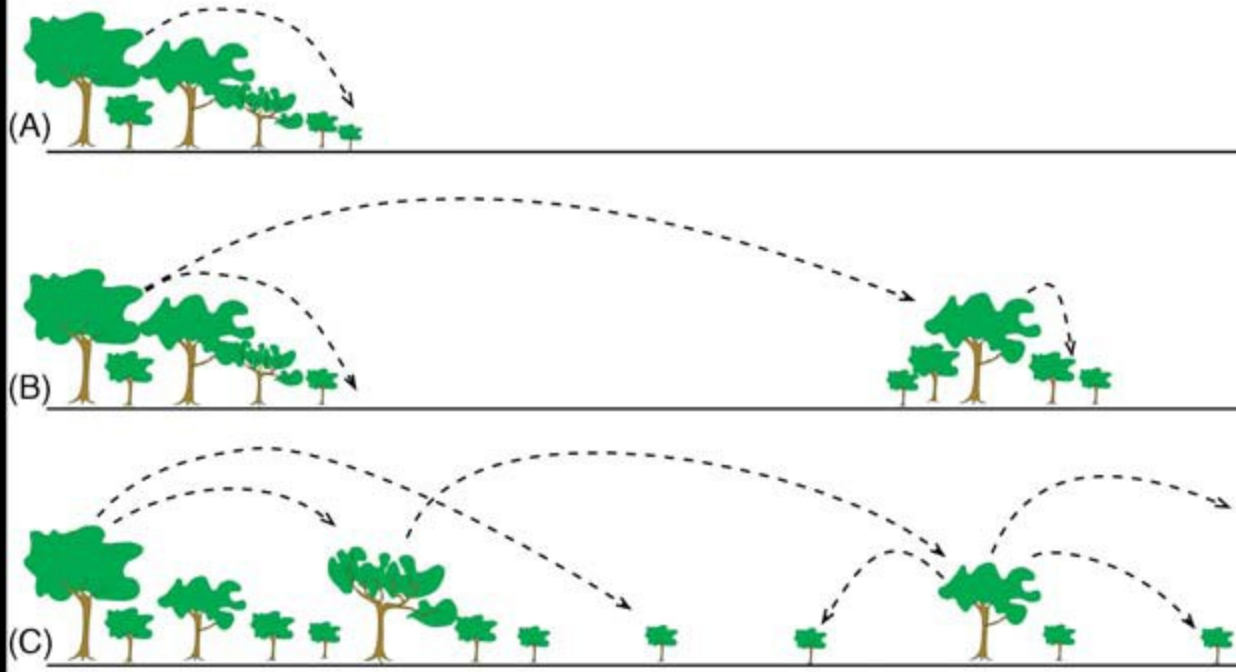
**Tabelle 6.2-2. Mutmaßliche Weichsel-glaziale Refugialgebiete wichtiger europäischer Gehölzsippen (Pollen Taxa). O: Vorkommen sehr wahrscheinlich. +: Vorkommen unsicher. A: Artenzahl des Pollen Taxons. R: Zahl der Refugialgebiete des Taxons. 1: Westliche Britische Inseln (Festland infolge glazialer Meeresspiegelsenkung). 2: Westrand von Frankreich einschließlich der Bretagne. 3: Biskaya (Festland infolge glazialer Meeresspiegelsenkung). 4: Nordrussland. 5: Nördliches Zentralrussland. 6: Südliches Zentralrussland. 7: Ukraine und Schwarzes Meer. 8: Westlicher und mittlerer Alpenraum. 9: Ostalpen und Karpaten. 10: Südliches Polen. 11: Nordwestliche Iberische Halbinsel. 12: Östliche und südliche Iberische Halbinsel. 13: Südfrankreich. 14: Korsika. 15: Italien. 16: Südliches Griechenland. 17: Balkan. Nach HUNTLEY & BIRKS (1983) und BIRKS & LINE (1993), leicht verändert.**

		West			Nordost/ Ost			Alpen/ Karpaten				Südwest/Süd/ Südost							
	A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	R
Nadelbäume																			
<i>Pinus Diploxylon</i>	10	O	.	.	.	.	.	.	O	O	O	O	O	O	.	.	.	O	8
<i>Pinus Haploxylon</i>	3	.	.	.	.	.	.	.	O	O	.	.	.	.	.	.	.	+	2
<i>Picea</i>	2	.	.	.	.	O	.	.	.	O	.	.	.	.	.	.	.	O	3
<i>Larix</i>	2	.	.	.	.	.	.	.	O	O	O	.	.	.	.	.	.	.	3
<i>Abies</i>	6	.	.	.	.	.	.	.	.	+	.	.	.	.	.	O	.	O	3
Sommergrüne Laubbäume																			
<i>Quercus sommergrün</i>	22	.	.	O	.	.	.	.	O	.	.	O	O	O	O	O	O	O	8
<i>Acer</i>	13	.	.	.	.	.	O	+	O	O	.	.	O	O	O	O	.	O	8
<i>Ulmus</i>	5	.	.	O	.	+	O	+	O	O	.	.	.	O	.	.	.	O	6
<i>Alnus</i>	4	.	O	.	O	.	.	O	.	O	.	O	.	.	O	.	.	.	6
<i>Tilia</i>	4	.	.	.	.	.	O	.	O	O	.	.	.	+	.	O	.	O	5
<i>Fraxinus excelsior Typ</i>	3	.	.	.	.	.	.	.	O	O	.	O	.	.	.	.	.	O	4
<i>Carpinus betulus</i>	1	.	.	.	.	.	.	.	.	O	.	.	.	.	.	O	.	O	3
<i>Castanea</i>	1	.	.	.	.	.	.	.	.	.	.	.	.	O	.	O	O	.	3
<i>Corylus Typ</i>	4	.	.	O	.	.	+	.	.	.	.	.	.	.	.	O	.	+	2
<i>Fagus</i>	2	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	O	O	2
<i>Ostrya Typ</i>	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	+	O	2
<i>Fraxinus ornus</i>	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	1
<i>Juglans</i>	1	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	+	?
Immergrüne Laubgehölze																			
<i>Quercus immergrün</i>	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	1
<i>Olea</i>	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	1
<i>Phillyrea</i>	2	.	.	.	.	.	.	.	.	.	.	.	.	.	O	.	.	O	2
<i>Pistacia</i>	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	?
Zahl der Pollen Taxa		1	1	3	1	1	3	1	810	2	4	5	4	3	9	512			

## Prokázaná refugia

1. Z Brit. ostrovy
2. Bretaň a přil.
3. Biskaj
4. S Rusko
5. S centr. Rusko
6. J centr. Rusko
7. Ukrajina a Černé moře
8. Z a Stř. Alpy
9. V Alpy a Karpaty
10. J Polsko
11. SZ Iberie
12. V a J Iberie
13. J Francie
14. Korsika
15. Itálie
16. J Řecko
17. Balkán





Frontální šíření

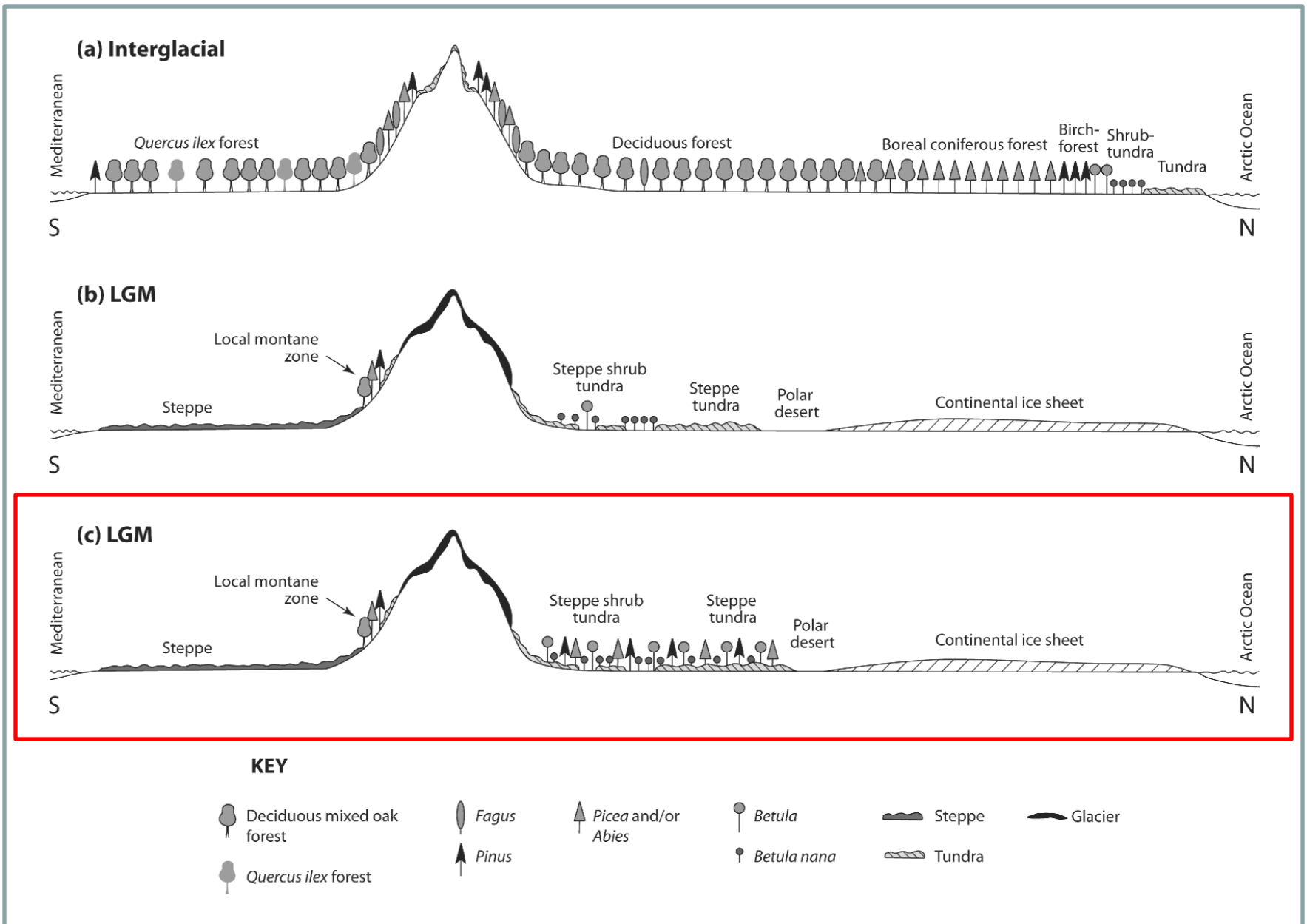
Šíření z výsadkových  
populací  
(zakladatelský efekt)

Nezávislé šíření  
z více refugií

Alternativní modely šíření populací

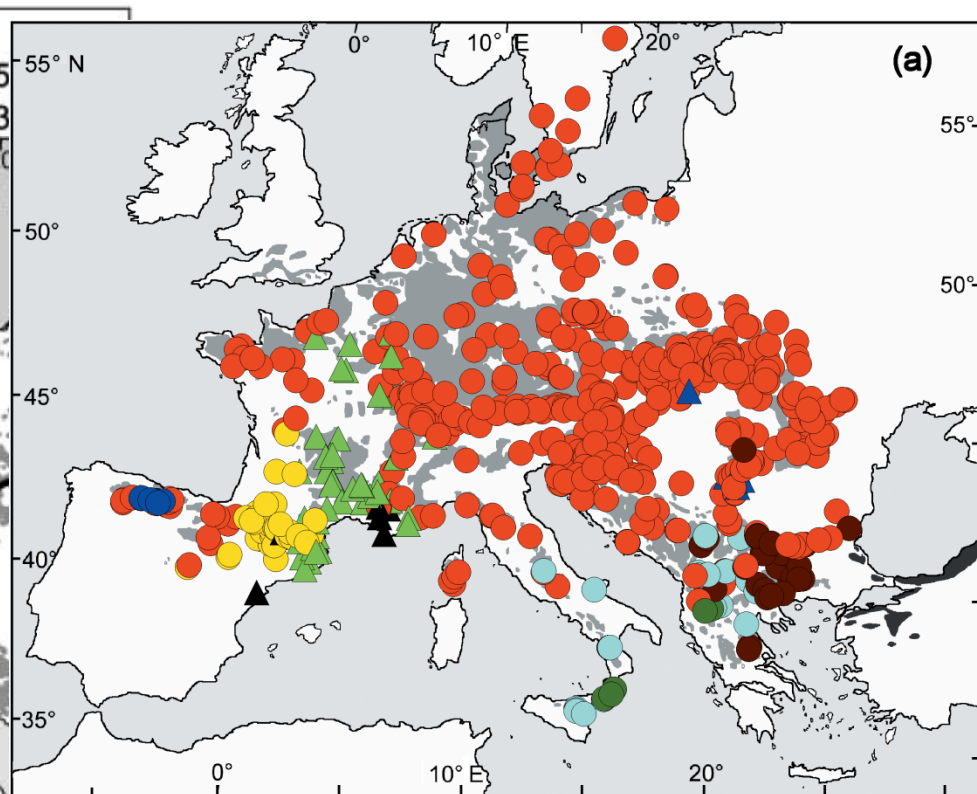
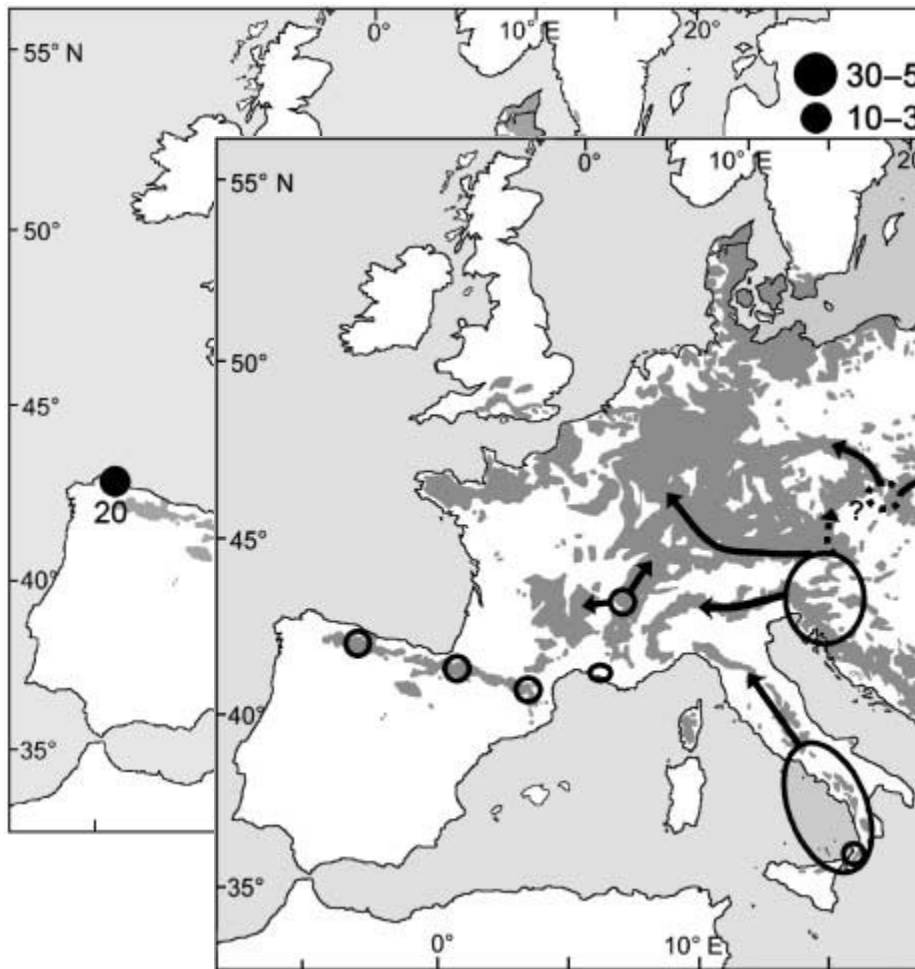
Všechny způsoby jsou možné zároveň

Ve střední Evropě dnes vychází jako plausibilní model 3

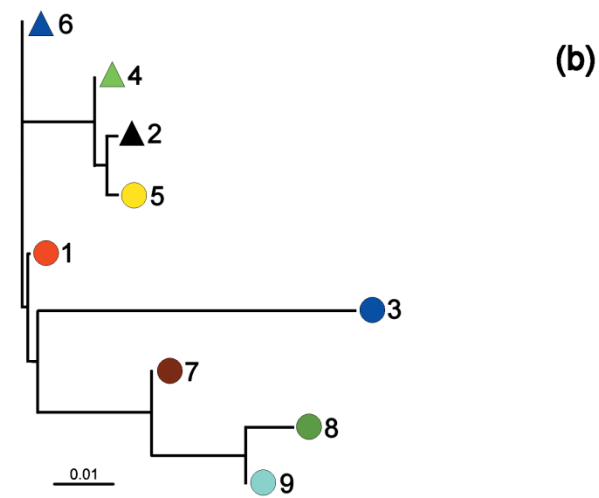


Alternativní hypotézy o refugiích, kryptická refugia





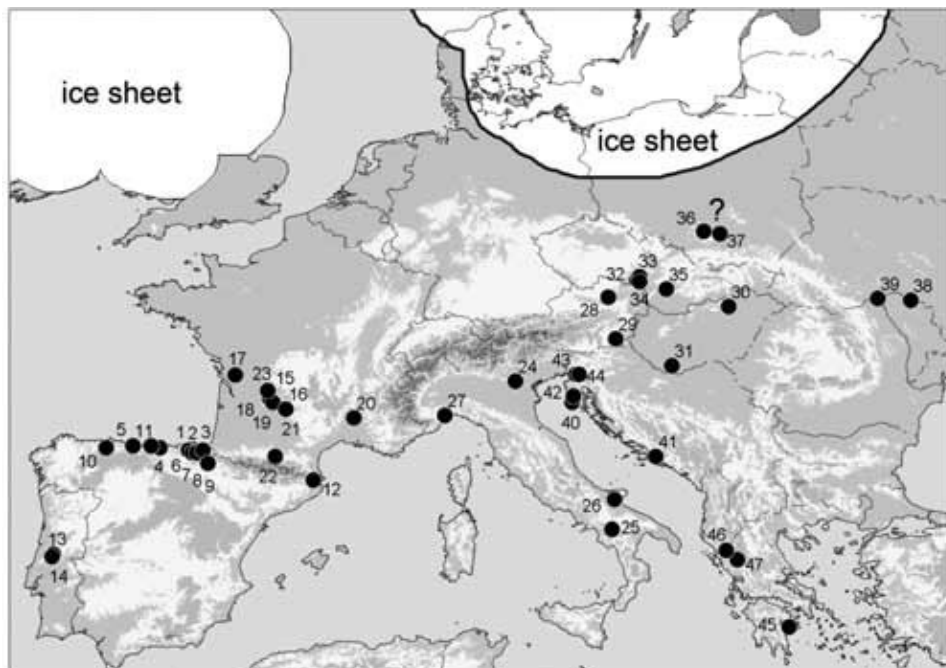
Fylogenetický model šíření *Fagus sylvatica*



- šneci tvrdí totéž: v Karpatech byly lesy;

- Slovenský kras: vedle glaciálních i mezofilní prvky jako skalnice *Faustina faustina*, vřetenatka *Laciniaria plicata* nebo vřetenovka *Cochlodina cerata*;

- Nízké Tatry: i v montánních polohách druhy jako vlahovka *Monachoides vicinus*, *Faustina faustina*, *Cochlodina cerata*.



Ložek 2007

Nadachowski 2006; medvěd hnědý na archeologických lokalitách z LGM







## Extinkce megafauny v pozdním pleistocénu.

„We live in a zoologically impoverished world, from which all the hugest, and fiercest, and strangest forms have recently disappeared...” (A. R. Wallace, 1876)

„Looking at the whole subject again, I am convinced that the rapidity of the extinction is due to man's agency, acting in co-operation with those general causes which at the culmination of each geological era has led to the extinction of the larger, the most specialised, or the most strangely modified forms. „ (A. R. Wallace, 1911)



(A)



(B)



(C)

**Figure 5** European megafaunal species that became extinct in the late Pleistocene or Holocene. (A) *Mamthus primigenius* from Lange (2002), p. 176; (B) *Coelodonta antiquatus* from Lange (2002), p. 136; (C) *Megaloceros giganteus* Art by Mauricio Anton (A, B) Reproduced from Lange IM (2002) *Ice Age Mammals of North America. A Guide to the Big, the Hairy, and the Bizarre*. Mountain Press Publishing Company; (C) image supplied courtesy of Mauricio Anton.







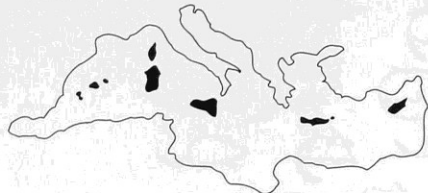
**Afroeurasia:** No major episodes of extinction during past 100,000 years, although some losses occurred.



**Meganesia:** Humans arrive 40,000–60,000 years B.P.; major extinction episode follows, but extends to circa 15,000 years B.P. (or later?).



**Americas:** Ecologically significant human populations arrive 12,500 years B.P.; major extinction episode terminates circa 10,500 years B.P., few extinctions thereafter.



**Mediterranea:** Humans arrive 10,000 years B.P.; major extinction episode follows and terminates circa 4,000 years B.P., few extinctions thereafter.



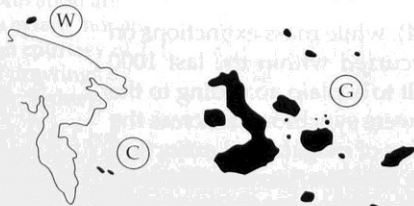
**Antillea:** Humans arrive 7000 years B.P.; major episode of extinction follows, but extends to circa A.D. 1600 (or later?).



**Madagascar:** Humans arrive 2000 years B.P.; major episode of extinction follows and terminates circa A.D. 1500, few extinctions thereafter.

**Mascarenes (Ms):** Humans arrive A.D. 1600; major episode of extinction follows and terminates circa A.D. 1900.

**New Zealand:** Humans arrive 800–1000 years B.P.; major episode of extinction follows and terminates circa A.D. 1500.



**Commander Islands (C):** Humans arrive A.D. 1741; Steller's sea cow extinct by A.D. 1768.

**Wrangel Island (W):** Humans arrive ?; mammoths survive to 4000 years B.P.

**Galápagos Islands (G):** Humans arrive A.D. 1535; modern-era extinctions only.

Největší extinkce v Austrálii a Americe (70 – 80%)

Slabší v Africe a Eurázii (14 – 20%)

## Hypotézy:

-Vybití (Overkill Hypothesis; Martin 1967)

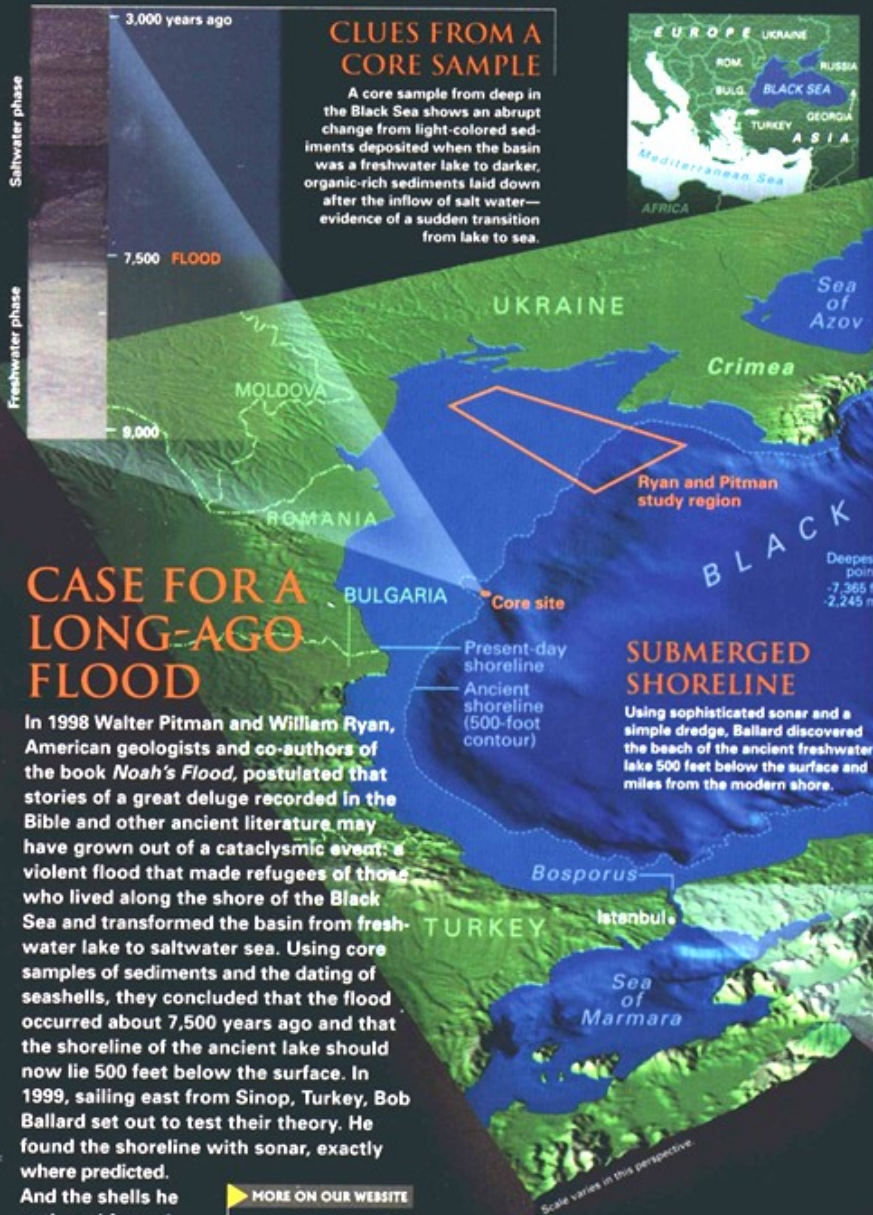
- Environmentální stres

- ☐ (Tehdejší ekosystémy musely být velmi produktivní.
- ☐ Velká role herbivorů s fermentačním trávením.
- ☐ V zimě snadno dostupná zmrzlá rostlinná biomasa.)

- Globální epidemie







## CASE FOR A LONG-AGO FLOOD

In 1998 Walter Pitman and William Ryan, American geologists and co-authors of the book *Noah's Flood*, postulated that stories of a great deluge recorded in the Bible and other ancient literature may have grown out of a cataclysmic event: a violent flood that made refugees of those who lived along the shore of the Black Sea and transformed the basin from freshwater lake to saltwater sea. Using core samples of sediments and the dating of seashells, they concluded that the flood occurred about 7,500 years ago and that the shoreline of the ancient lake should now lie 500 feet below the surface. In 1999, sailing east from Sinop, Turkey, Bob Ballard set out to test their theory. He found the shoreline with sonar, exactly where predicted. And the shells he gathered from the submerged beach perfectly matched Pitman and Ryan's findings.

**MORE ON OUR WEBSITE**  
See another 3-D computer model of the Black Sea, drawn from a different perspective, at [nationalgeographic.com/ngm/0105](http://nationalgeographic.com/ngm/0105).

### CLUES FROM A CORE SAMPLE

A core sample from deep in the Black Sea shows an abrupt change from light-colored sediments deposited when the basin was a freshwater lake to darker, organic-rich sediments laid down after the inflow of salt water—evidence of a sudden transition from lake to sea.

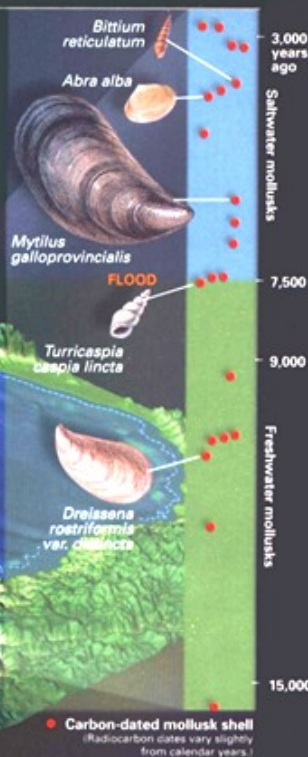


### SUBMERGED SHORELINE

Using sophisticated sonar and a simple dredge, Ballard discovered the beach of the ancient freshwater lake 500 feet below the surface and miles from the modern shore.

### SHELLS RECORD A SEA CHANGE

Carbon-dated mollusk shells from the submerged shoreline divide into two groups: older freshwater species and younger saltwater species. The split supports Ryan and Pitman's theory that seawater flooded the basin about 7,500 years ago.



### BIRTH OF THE BLACK SEA

When the last ice age waned some 12,000 years ago, world oceans rose as glaciers melted. In the scenario suggested by Ryan and Pitman, the swollen Sea of Marmara breached the Bosphorus Valley (right), and salt water poured into the Black Sea Basin, then a freshwater lake. The new sea settled into two layers: a brackish upper layer and a deeper, salty layer bereft of oxygen and life.



CORE SAMPLE IMAGE BY CANDACE MAJOR, LAMONT-DOHERTY EARTH OBSERVATORY OF COLUMBIA UNIVERSITY; GILLES LEICHLAIS, FRENCH; FRANCE, IRAN, HUNGARY, ETH. SWITZERLAND. SHELL ART BY NEJAL JAKSEVIC, FLOOD ART BY RICHARD SULLIVANT. 3-D COMPUTER MODELS BY PETER W. BLOSS, NATIONAL GEOGRAPHICAL DATA CENTER, NOAA. NATIONAL GEOGRAPHIC MAPS.