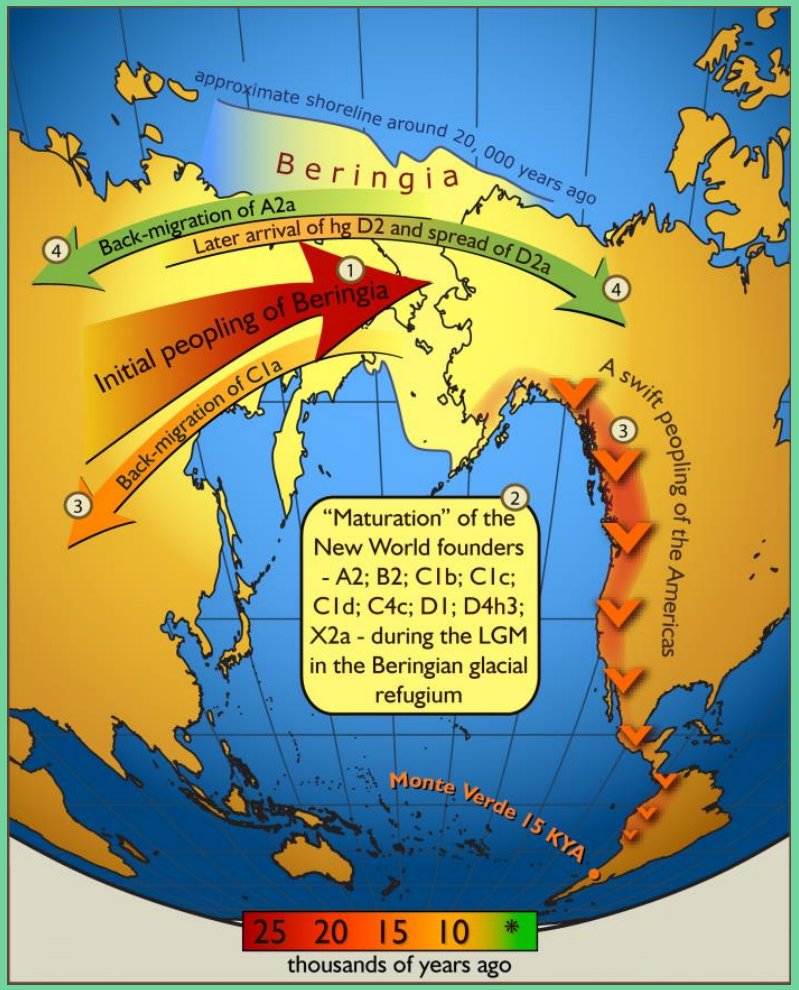
Out of Beringia

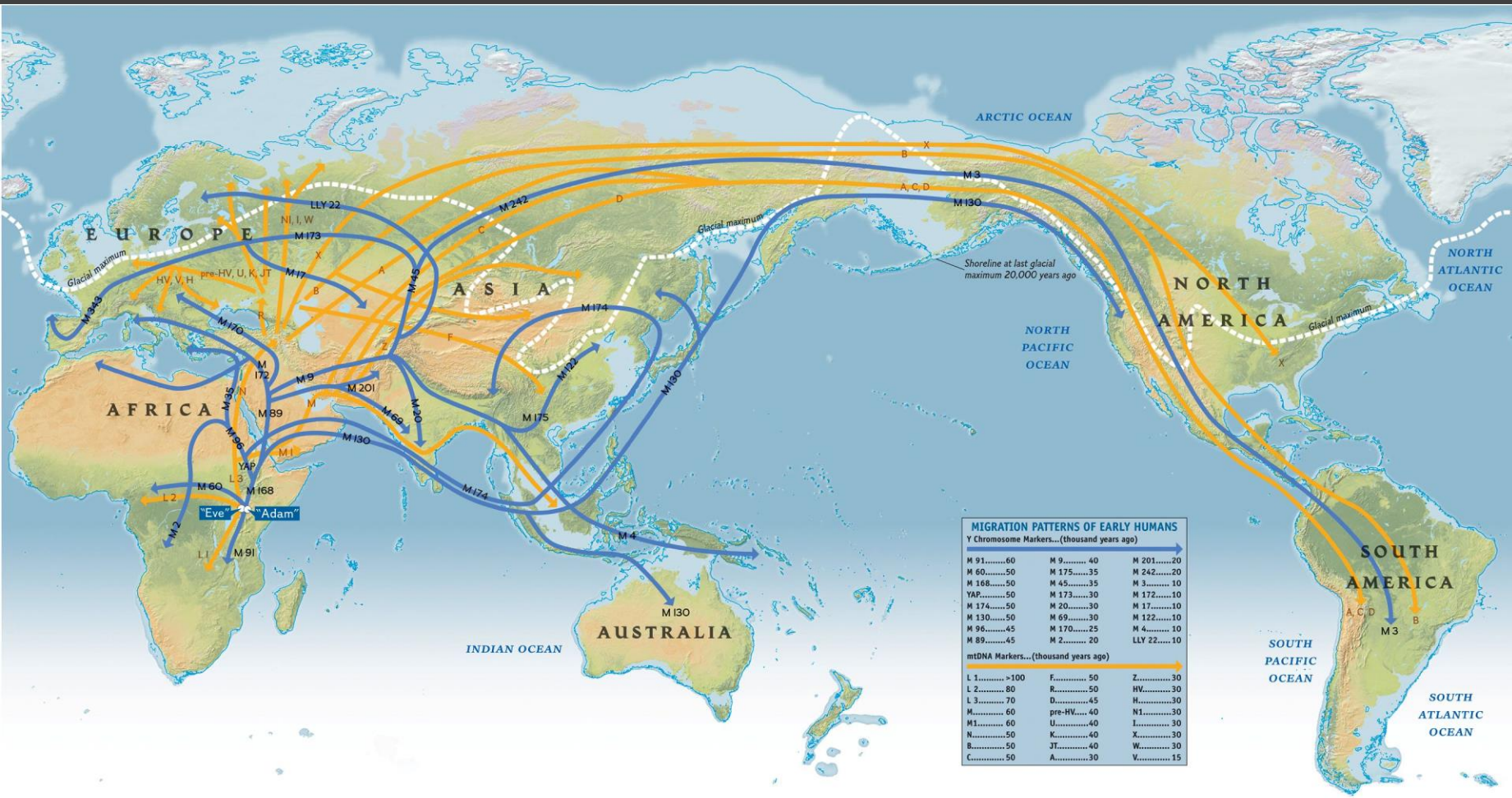
Genetics, Paleo-ecology, and Archaeology

John F. Hoffecker

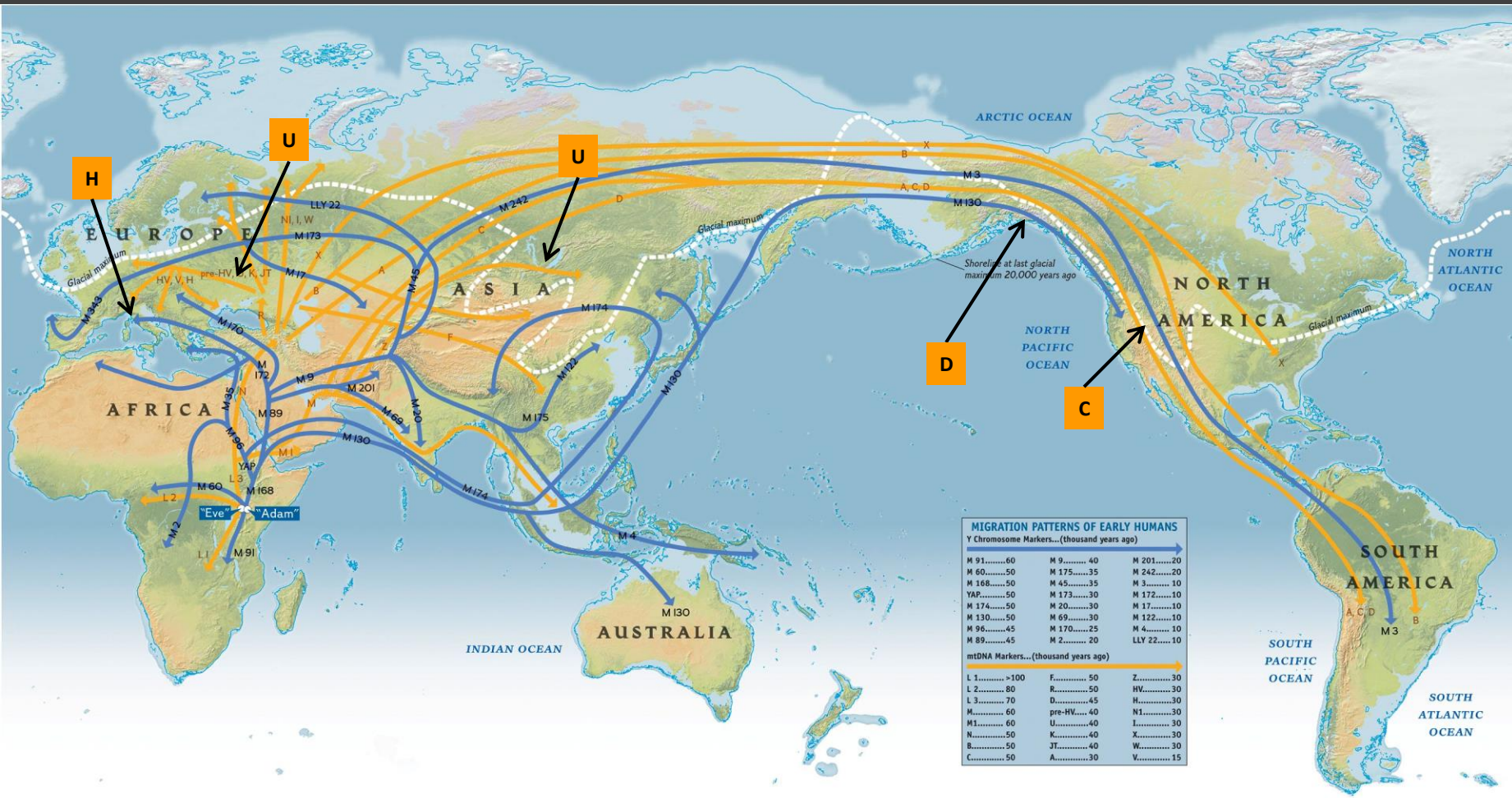


INSTAAR Monday Noon Seminar

7 October 2013



from Spencer Wells (2009)



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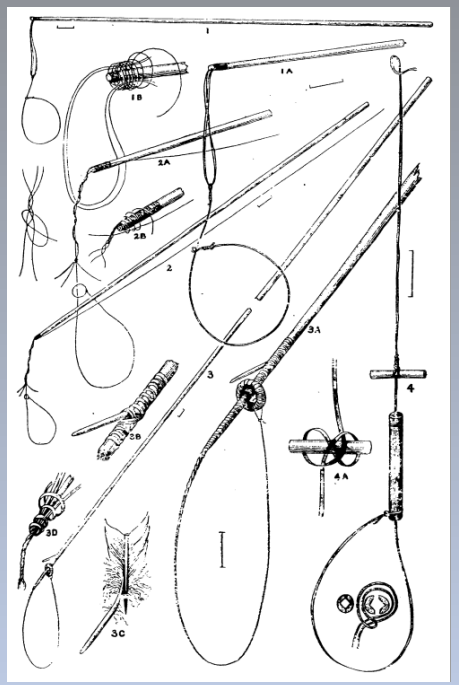
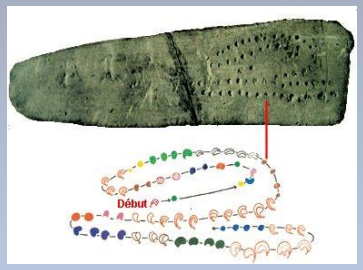
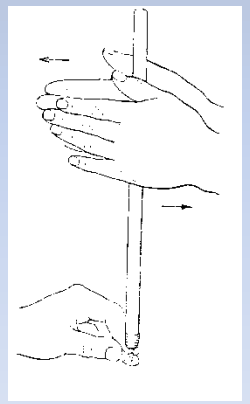
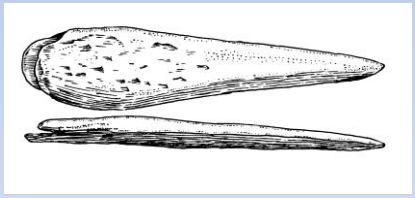


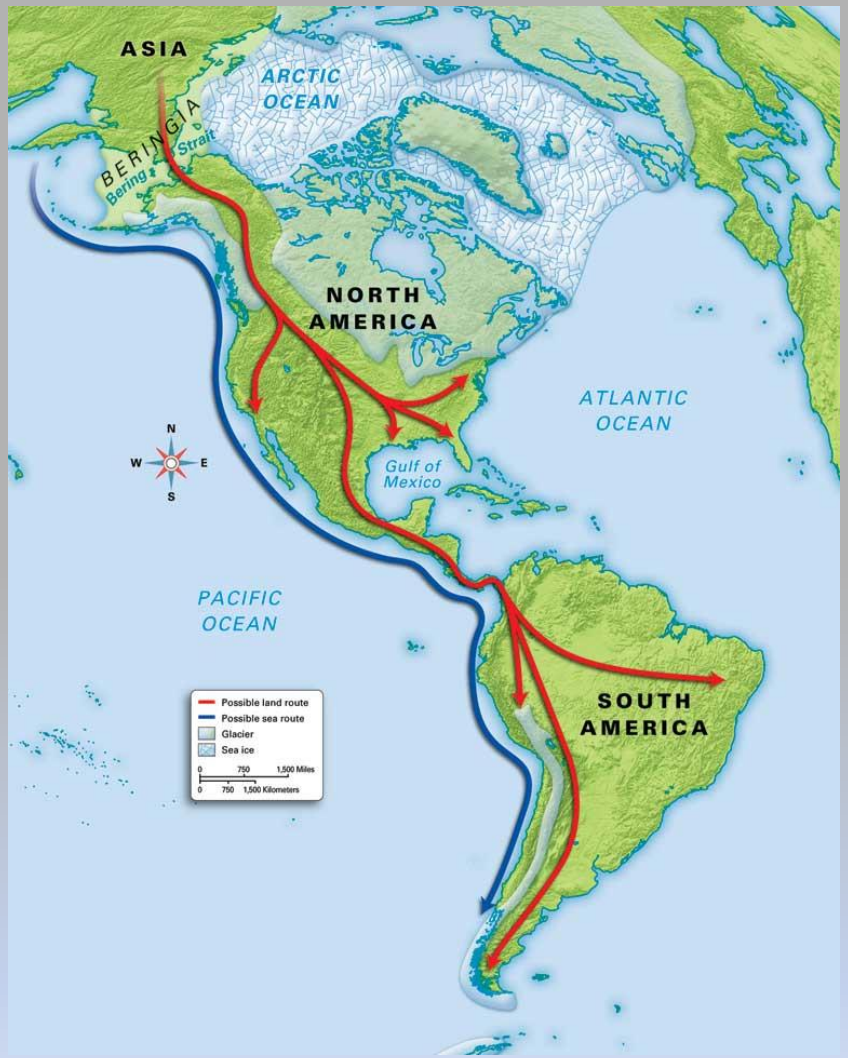






archaeological data are source for identifying technological innovations

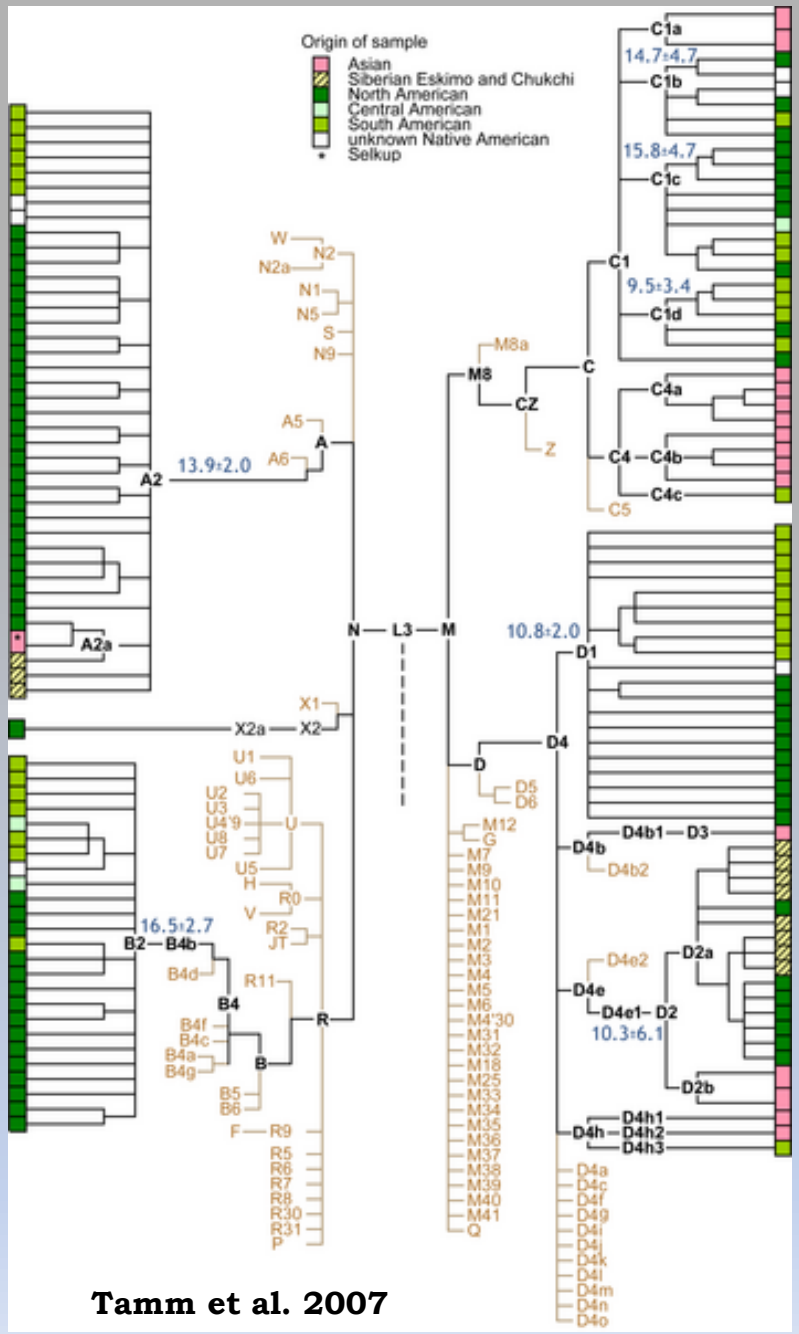
global dispersal of *Homo sapiens* and the New World:



a) **Western hemisphere occupied much later than Eurasia & Australia (<15 ka)**

b) **Why? Coalesced ice-sheets in northern North America created barrier before 16–14 ka (were Beringian environments another factor?)**

c) **Dispersal throughout North & South America very rapid as indicated by genetics & archaeology**



Tamm et al. 2007

Native American population

mtDNA haplogroups

A

B

C

D

X

NRY haplogroups

C-M130

P-M45

Q-M3

early mtDNA estimates of the time of divergence of Native Americans from Asian parent population were older than expected . . .

Torroni et al. 1992, 1994	**35,000–20,000 years**
Forster et al. 1996	**30,000–20,000 years**
Bonatto & Salzano 1997	**43,000–30,000 years**

. . . especially when matched with archaeological evidence from Beringia and North & South America and the timing of ice-sheet expansion and coalescence in North America

. . . most of the . . . colonization models regard Beringia just as a ‘corridor’ or a ‘bridge’ for a migration to America, centering the origin of the different migration(s) somewhere in Asia. Our results support a different model that, on the contrary, puts Beringia in a central role, where the population that originated the Native Americans settled and diversified before the further colonization of the rest of the American continent. It could be called an “out of Beringia” model . . .

Bonatto and Salzano 1997: 1870

Tamm et al. 2007

- **"Beringian Standstill" model (aka "Beringian incubation" model)**
- **sample = 623 complete mtDNA sequences**
- **mtDNA mutation rate = 3.5×10^{-8} per year**
- **conclusion: "widespread derived founding haplotypes specific to the Americas . . . implies that migrants were isolated for an extended period before entering the Americas"**

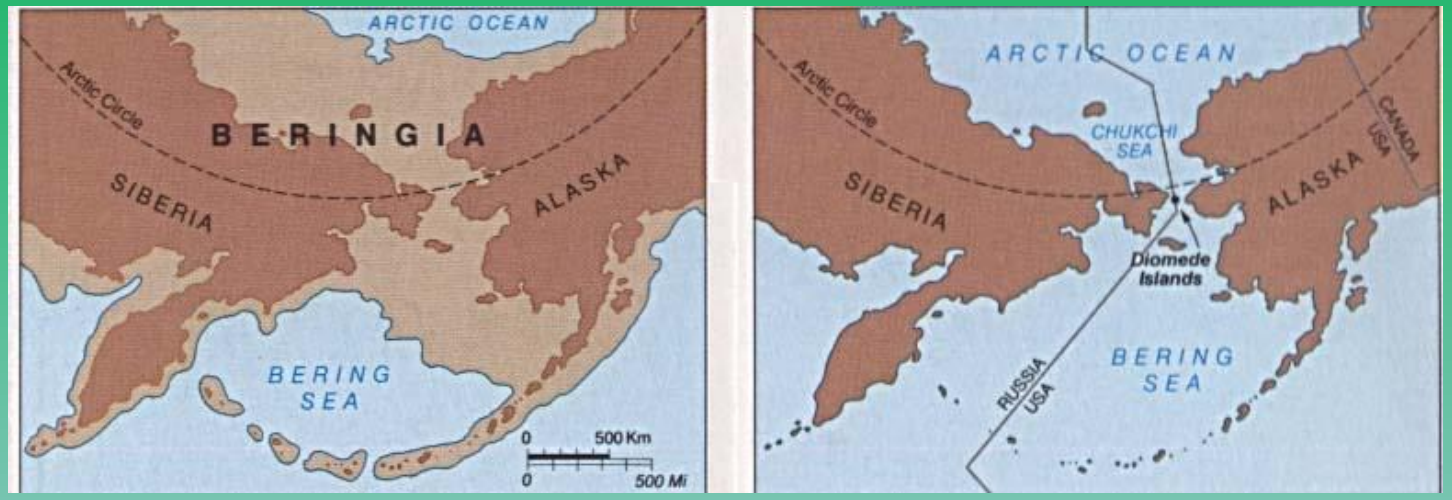
defining mutations for Native American mtDNA haplogroups

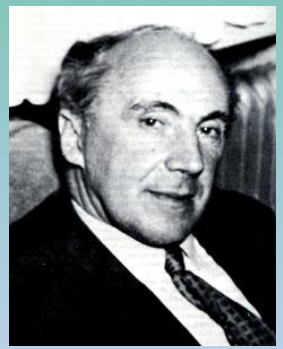
Hg	HVS I	HVS II	Coding region
A	16223-16290-16319	73-235-263	663, 1736, 4248, 4824, 8794
A2	**16111**-16223-16290-16319-16362	**64**-73-**146**-**153**-235-263	**8027, 12007**
A2a	**16111**-16223-16290-16319-16362	**64**-73-**146**-**153**-235-263	**3330**
B	16189	73-263	8281-8289del
B4bd	16189-16217	73-263	827, 15535
B4b	16189-16217	73-263	499, 4820, 13590
B2	16189-16217	73-263	**3547, 4977, 6473, 9950, 11177**
C	16223-16298-16327	73-249d-263	3552A, 9545, 11914, 13263, 14318
C1	16223-16298-**16325**-16327	73-249d-263-**290-291d**	-
C1b	16223-16298-16325-16327	73-249d-263-290-291d	**493**
C1c	16223-16298-16325-16327	73-249d-263-290-291d	**1888, 15930**
C1d	16223-16298-16325-16327	73-249d-263-290-291d	**7697**
C4	16223-16298-16327	73-249d-263	2232iA, 6026, 11969, 15204
C4c	16223-**16245**-16298-16327	73-263	**11440, 13368, 14433, 15148**
D	16223-16362	73-263	4883, 5178A
D4	16223-16362	73-263	3010, 8414, 14668
D1	16223-**16325**-16362	73-263	**2092**
D2	**16129**-16223-**16271**-16362	73-263	3316, **7493, 8703**, 9536, 11215
D2a	**16129**-16223-**16271**-16362	73-263	**11959**
D2b	**16129**-16223-**16271**-16362	73-263	**9181**
D4h3	16223-**16241**-**16301**-**16342**-16362	73-263	3336, **3396**, 3644, 5048, **6285, 8949, 9458, 13135**
D3	16223-**16319**-16362	73-263	**951**, 8020, 10181, 15440, 15951
X	16189-16223-16278	73-153-263	6221, 6371, 13966, 14470
X2a	16189-**16213**-16223-16278	73-153-195-**200**-263	1719, **8913, 12397, 14502**

The full substitutional motif is shown in control region, the sub-clades defining mutations are indicated in bold.
doi:10.1371/journal.pone.0000829.t001

Tamm et al. 2007

Tamm et al. 2007

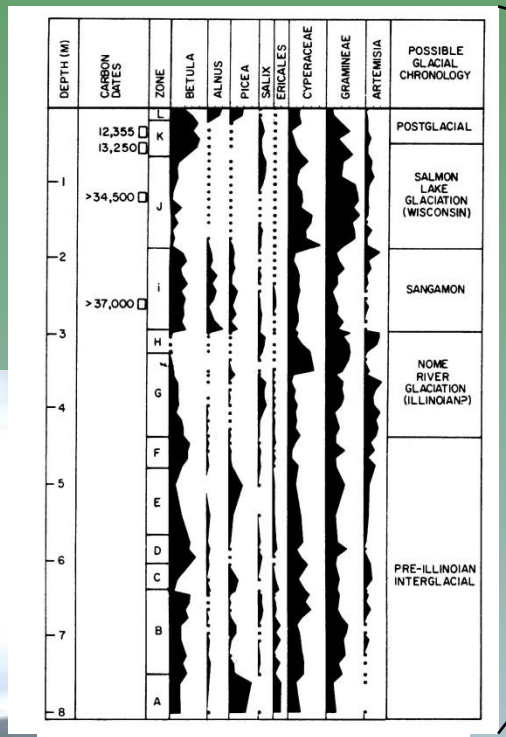


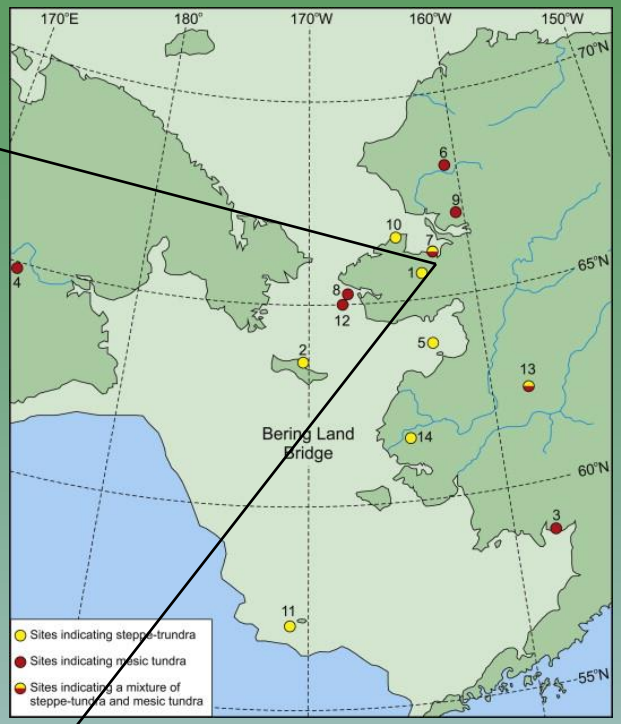


Eric Hultén (1894–1981)

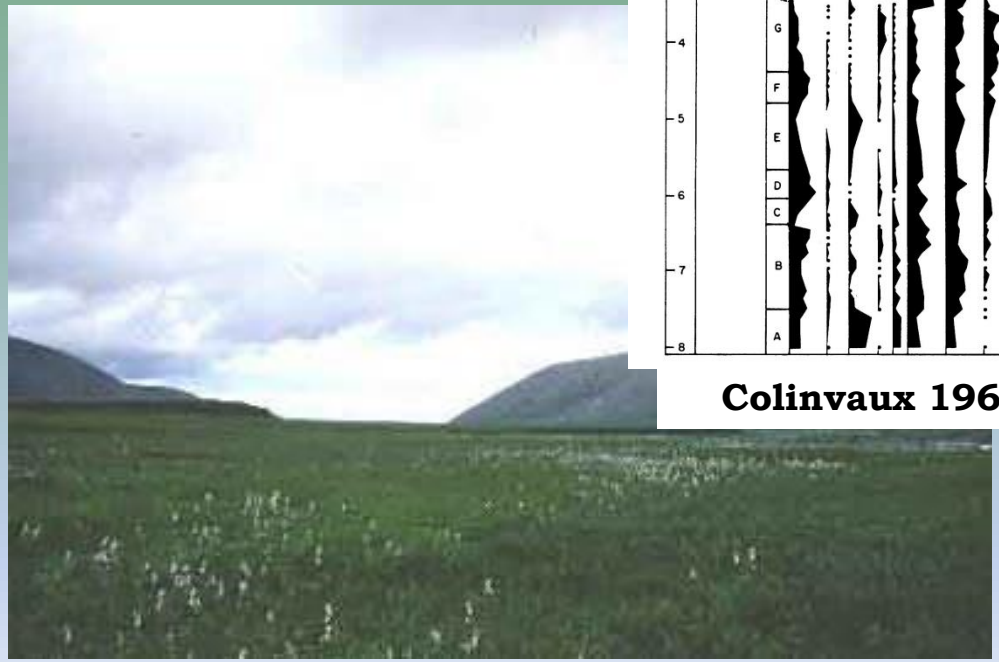
Hultén (1937) defined *Beringia* on the basis of modern plant distribution around the Bering Strait—suggested that the Bering Land Bridge was a plant refugium during glacial periods

“. . . herbaceous tundra like that of modern Barrow”





Colinvaux 1964



early pollen studies of the BLB and adjoining areas by Colinvaux indicated a “herbaceous tundra” during the LGM

. . . but Guthrie (1968) reconstructed a Beringian "steppe-tundra" for the LGM on the basis of large mammal assemblages—dominated by grazers—from central Alaska

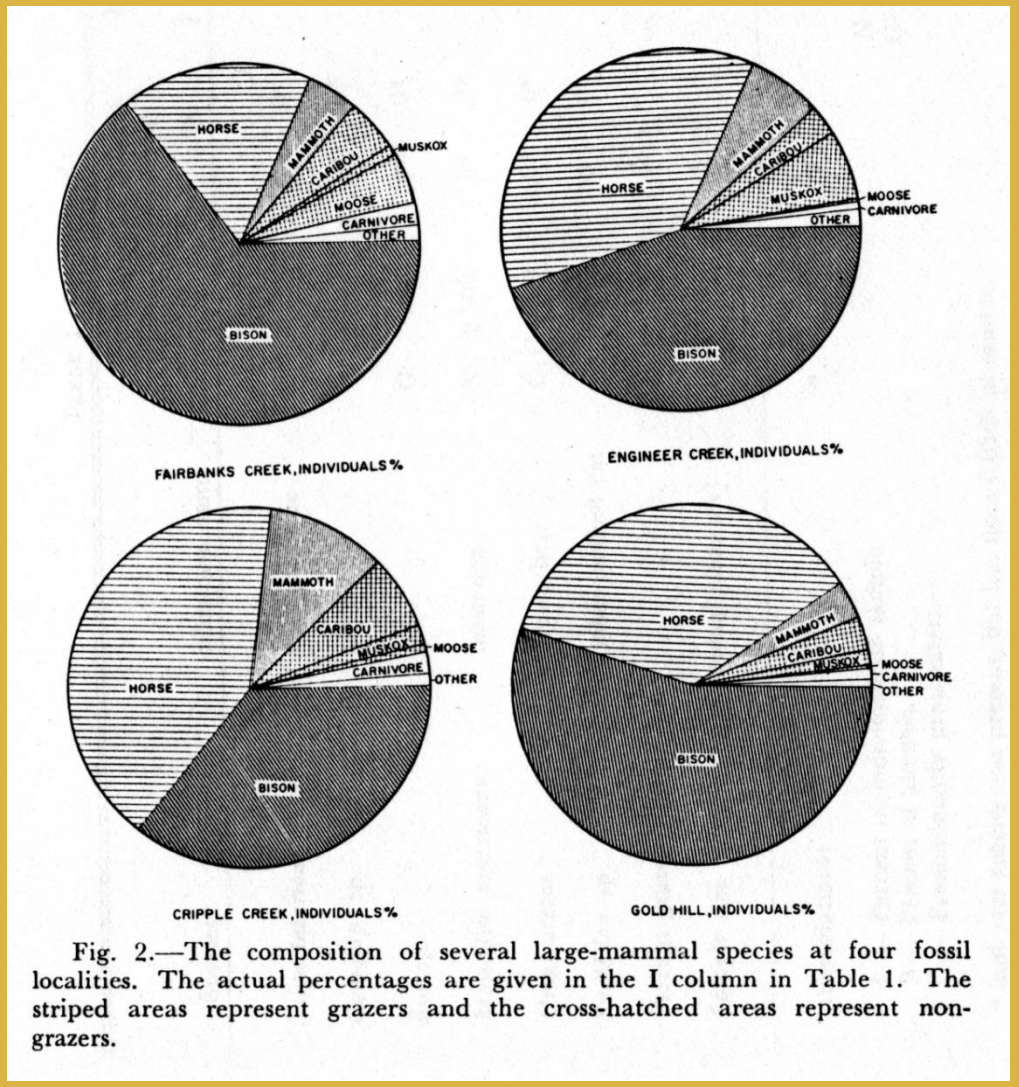
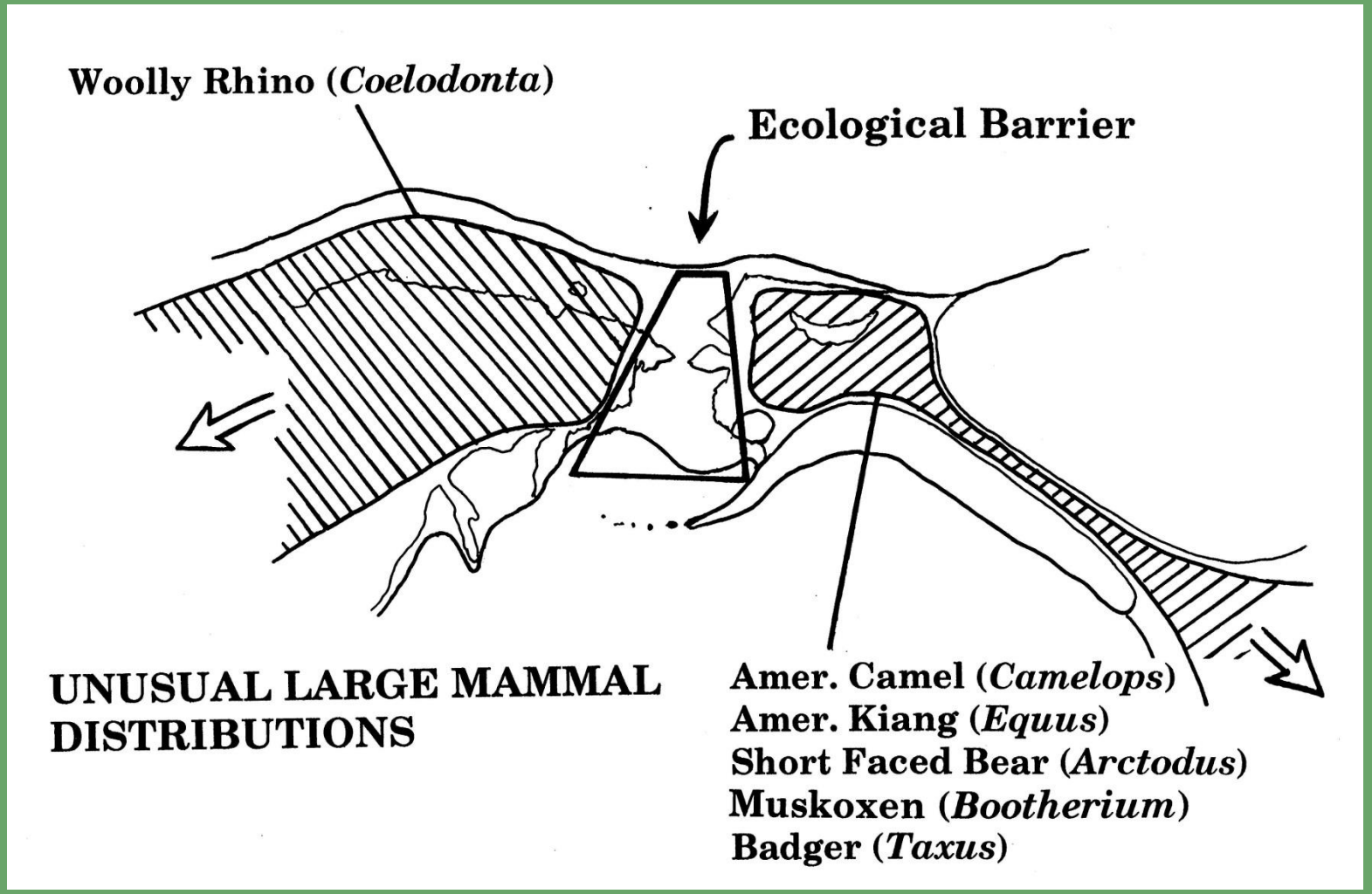
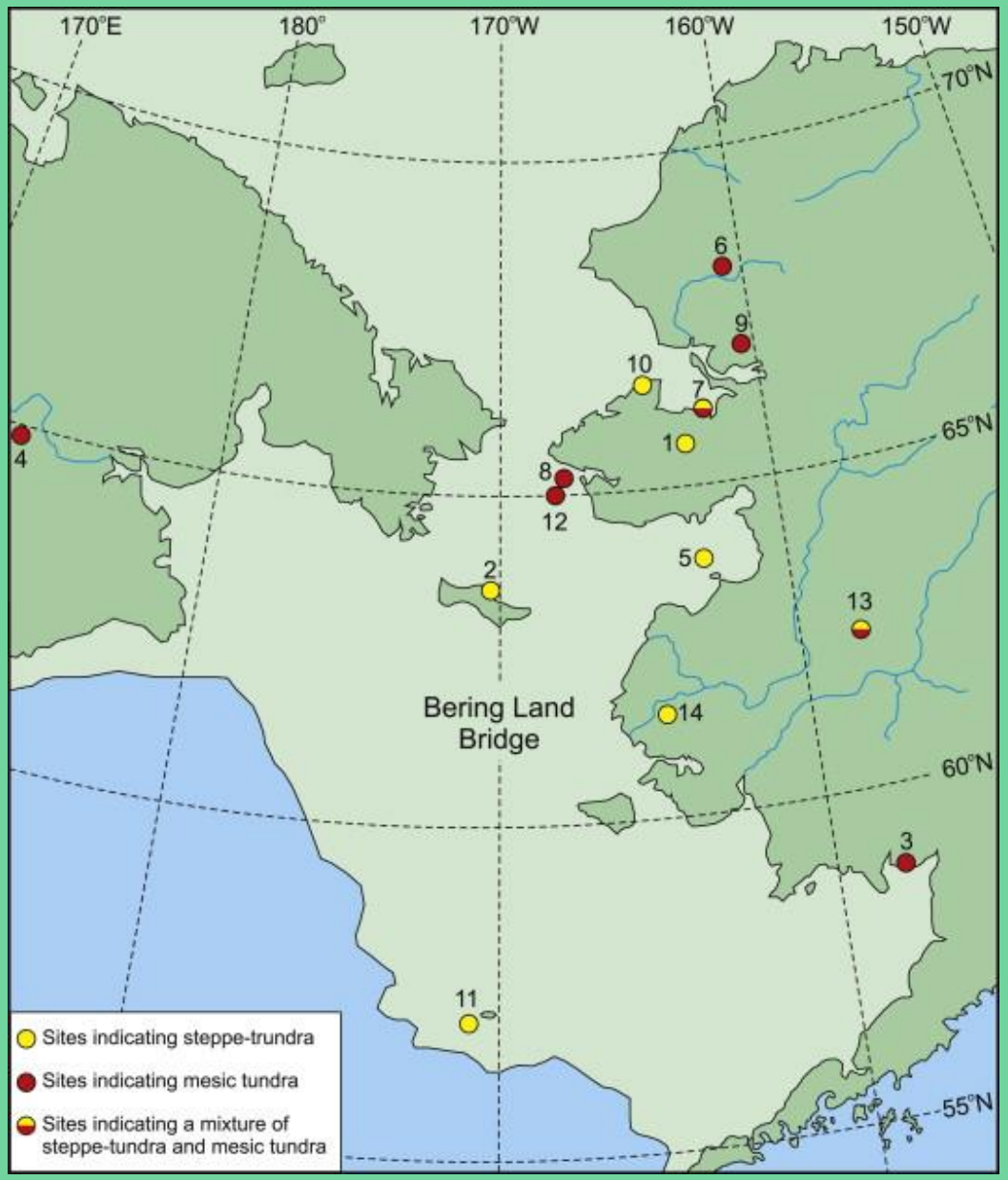


Fig. 2.—The composition of several large-mammal species at four fossil localities. The actual percentages are given in the I column in Table 1. The striped areas represent grazers and the cross-hatched areas represent non-grazers.

Guthrie (2001) later concluded that a mesic tundra zone in central Beringia during the LGM explained mammal distribution (e.g., prevented woolly rhino from colonizing Alaska)



Guthrie 2001: fig. 8



Elias and Crocker 2008: fig. 2

Elias and others found similar pattern of distribution for some beetles (e.g., steppe weevils of Western Beringia did not spread to steppic habitat in Alaska during LGM).

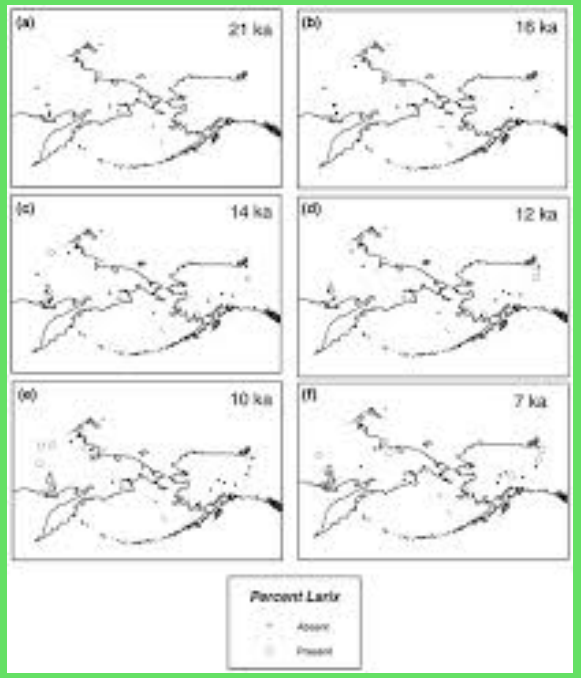
Elias et al. (1997) analyzed pollen, plant macro-fossils, and insects in sediment cores from the BLB dating to 24,700–19,835 cal BP, reporting that "all three lines of evidence indicate shrub tundra."

Brubaker et al. 2005

- **LGM trace pollen percentages across Beringia that are not consistent with long-distance transport from outside source (i.e., no south-to-north gradient)**

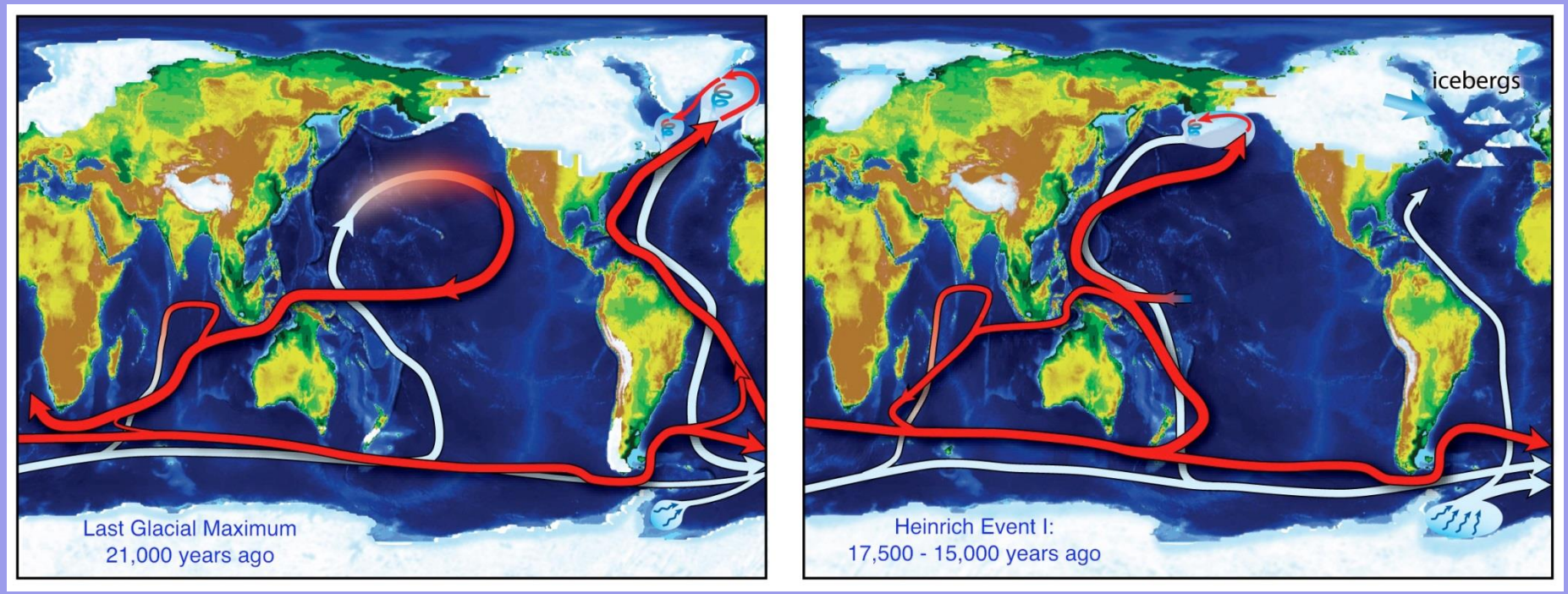
- **subregions show above-background percentages followed by rapid local increase after LGM**

- **taxa include: *Populus*, *Larix*, *Picea*, *Pinus*, *Betula*, *Alnus*/ *Duschekia***



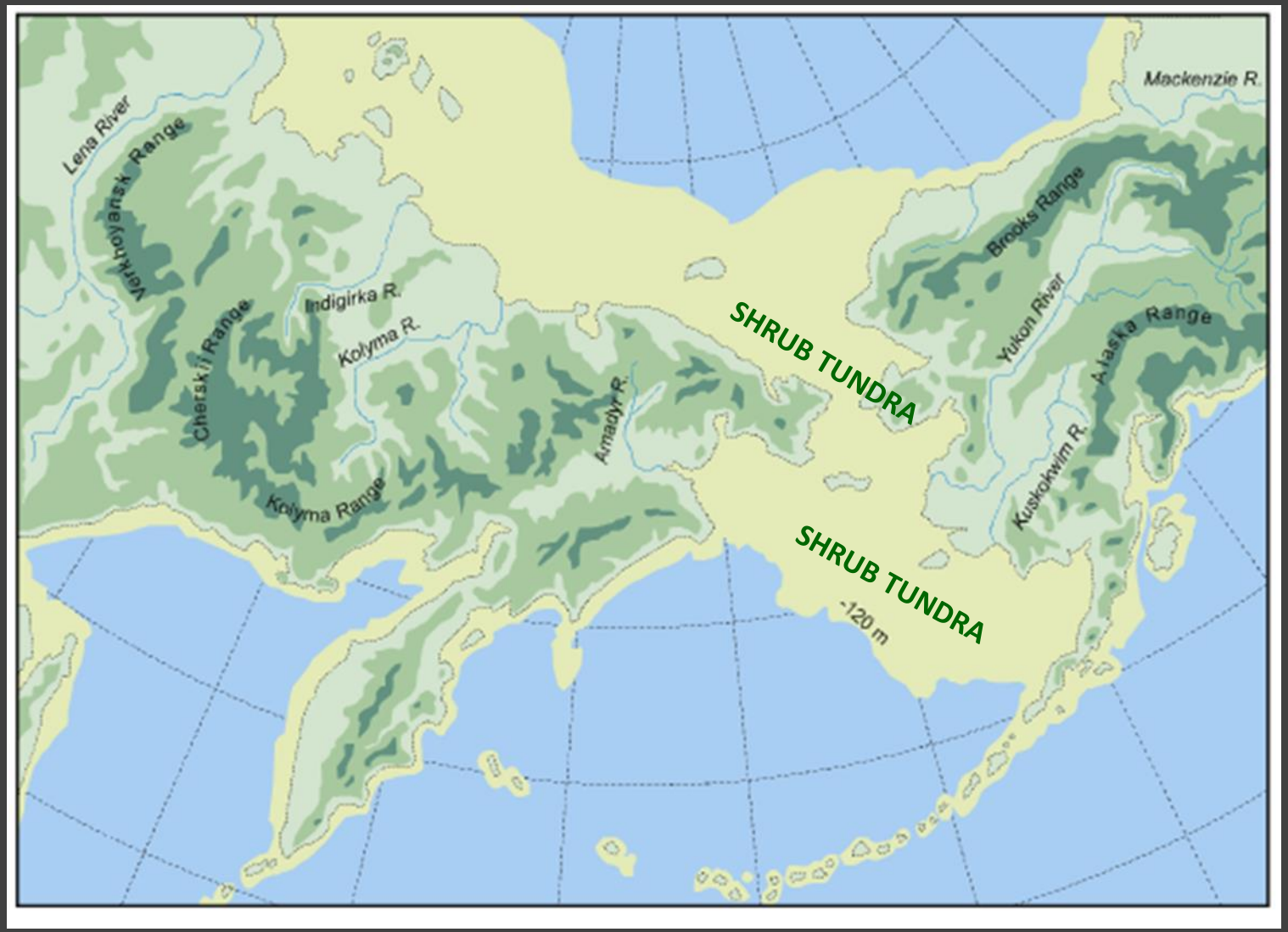
Brubaker et al. 2005: 839, fig. 5

Beringia occupies a unique position with respect to ocean circulation and unglaciated land above 50° North during the LGM



Okazaki et al. 2010

Shrub tundra refugium in central Beringia during the LGM?



Shrub tundra refugium in central Beringia during the LGM?

- **provided the *only substantive source of wood* (in the form of woody shrubs and some trees) above latitude 50° North during the LGM?**

- **acted as *isolating mechanism* for human population, as areas lacking adequate wood were abandoned during LGM?**

- **wood essential *fuel source* (as supplement to bone)?**

Théry-Parisot (2001) concluded that (fresh) bone is practical as a fuel only when supplemented by wood . . .

Combustible / Caractéristiques	Bois			Os	Lignite
	altéré	sec (18 % sur brut)	vert		
Facilité de la collecte	facile	facile à difficile	difficile	facile	facile
Disponibilité	dépend de la biomasse végétale disponible			dépend de la masse des résidus de l'alimentation carnée non destinés à d'autres usages	dépend de la présence de gisements de charbon fossile et de leur accessibilité
Allumage Flux incident critique	très facile < 280 °C	facile 280 °C	difficile à impossible 350 à 380 °C	difficile 350 à 380 °C	très difficile 500 °C
Contraintes de combustion	durée des flammes brève	pas de contraintes	• se consumme lentement • basses T° de combustion • durée réduite des ≠ phases	• nécessite toujours la présence d'un minimum de bois • s'éteint rapidement	• doit toujours être ajouté après le démarrage du feu • brûle sans flammes
Pouvoir calorifique (en Kcal/kg)	?	3 500	1 500	< 1 900	7 à 8 000
Durées des différentes phases de la combustion	« éclair »	modulables		• durée des combustions mixtes os/bois toujours supérieure à la durée des combustions simples (bois uniquement) • améliore sensiblement la durée des flammes	• augmente sensiblement la durée d'incandescence des braises
Types de combustions idéales	tous types de combustion en faisant varier morphologie, états phénologiques et physiologiques, essences			chaleur rayonnante et convectrice : éclairage, cuisson directe, séchage et chauffage d'un corps, chauffage d'un lieu clos	chaleur conductrice, cuisson indirecte, bilan de chaleur élevé, transformation des matières premières, entretien de braises

Fig. 38. Qualités combustibles et propriétés du bois, de l'os et du lignite.

(Théry-Parisot 2001: fig. 38)

3 hearths x 6 hours = 40 kg fresh bone

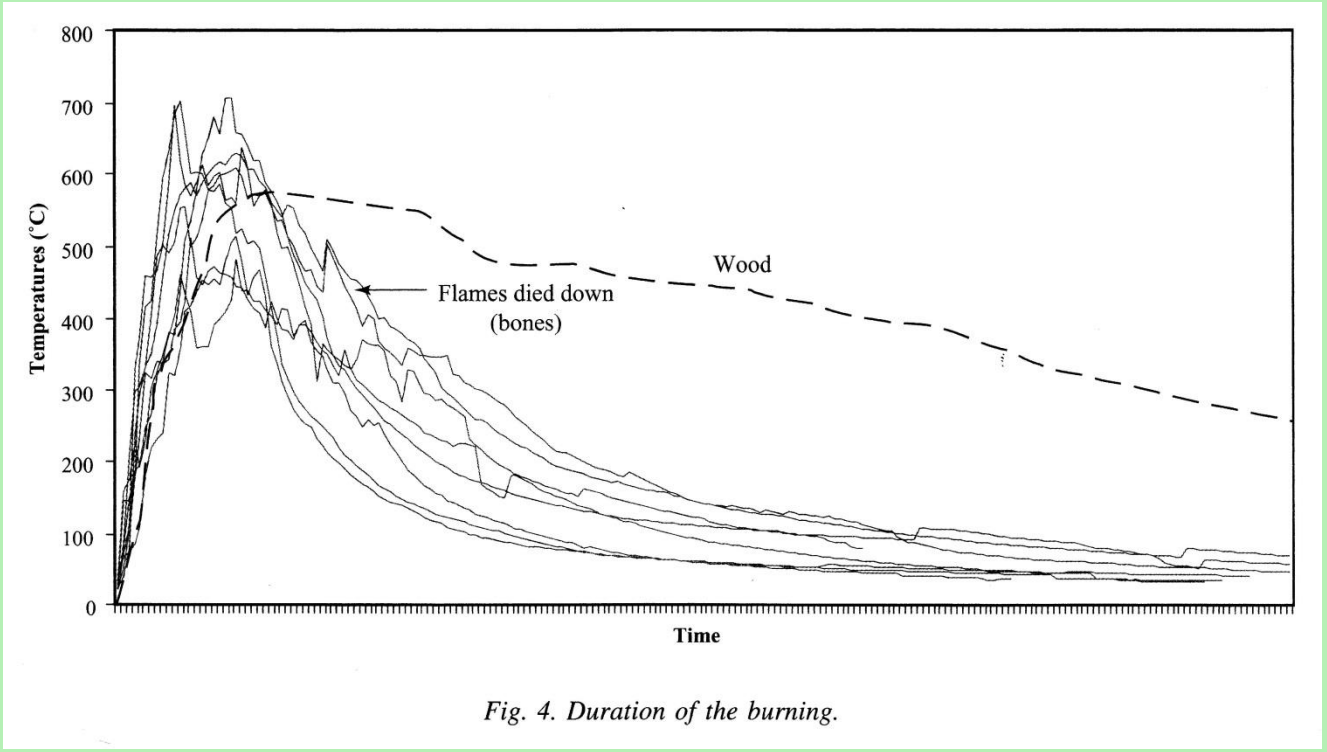
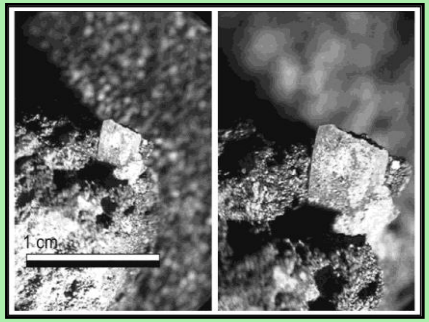


Fig. 4. Duration of the burning.

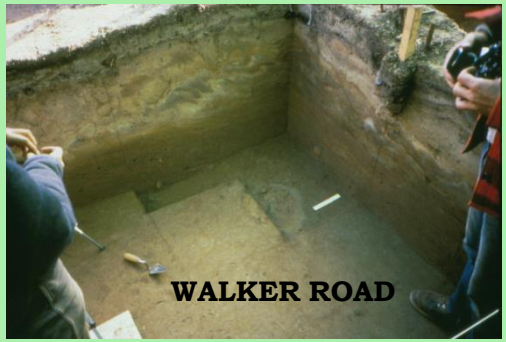
(Théry-Parisot et al. 2002: fig. 4)

Beringian archaeological sites contain large quantities of bone ash and some wood charcoal —usually willow

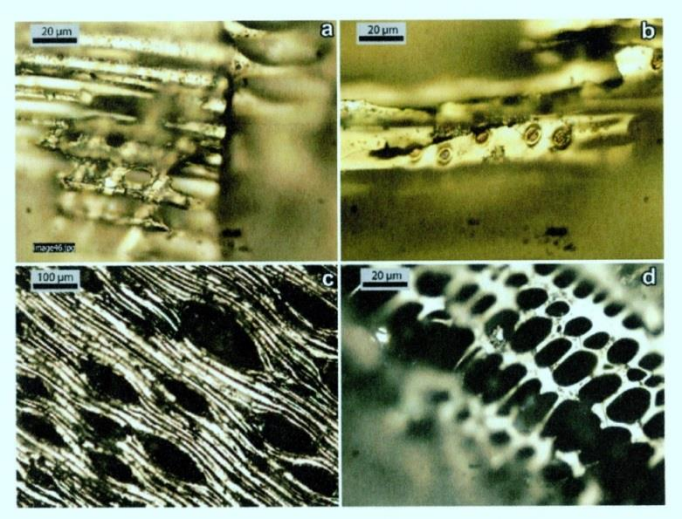
BERELEKH	***Salix* spp., *Larix* sp.**	**14 ka**
SWAN POINT	***Salix* spp.**	**13.5 ka**
	***Populus*/*Salix* group**	**13.5 ka**
TULUAQ HILL	***Salix* spp./*Populus***	**13.1 ka**
DRY CREEK	***Salix* sp.**	**13 ka**
MOOSE CREEK	***Salix* spp.**	**13 ka**
MESA	***Salix*, *Populus*, *Alnus***	**11.5 ka**



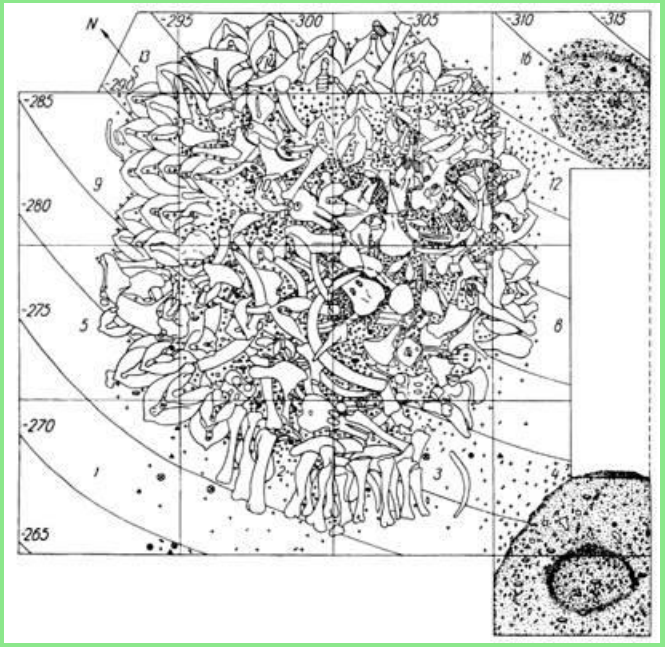
SWAN POINT


WALKER ROAD

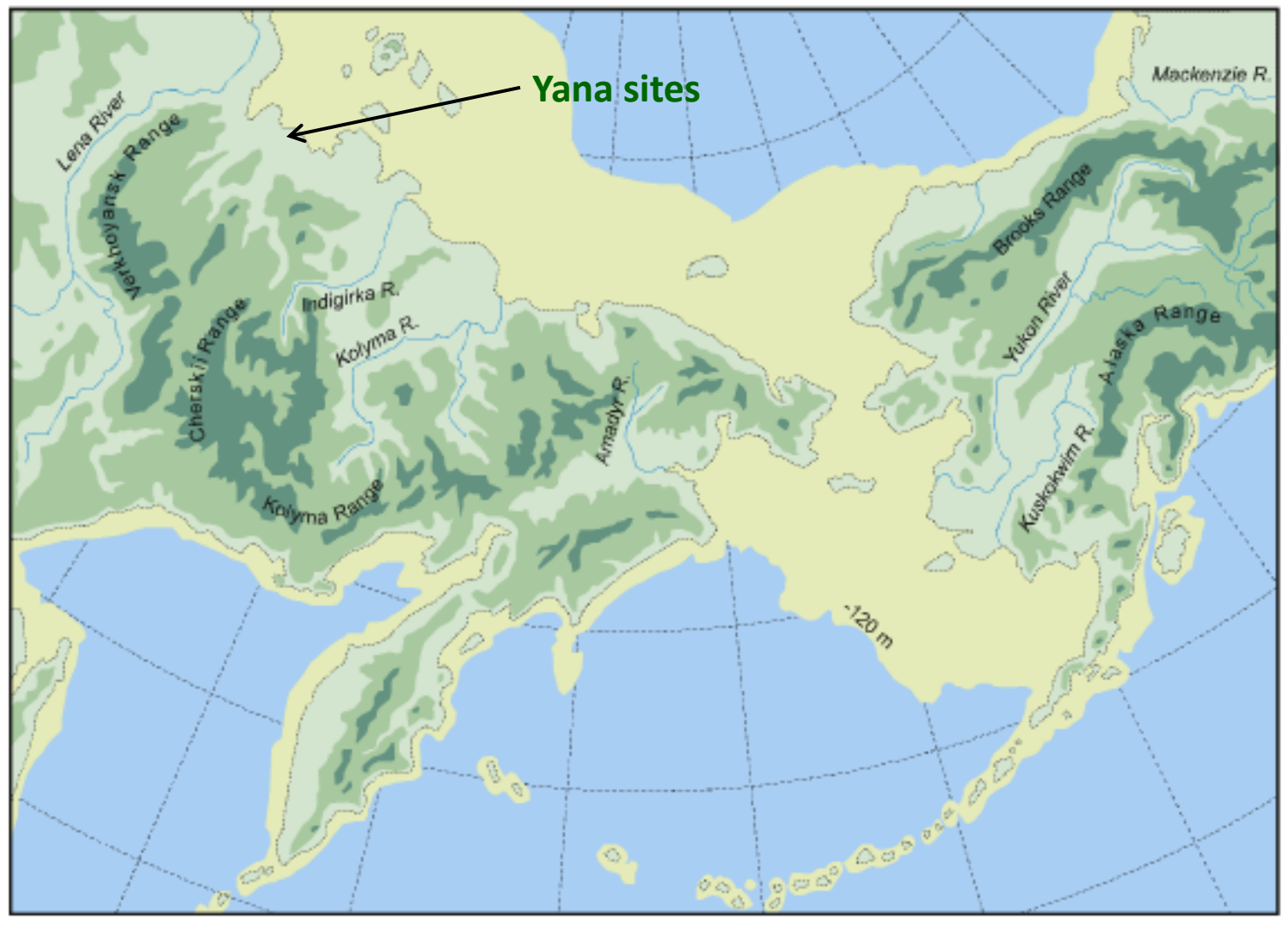
Occupants of northern Eurasia during the last glacial often used bone fuel, but also used wood as supplement, as recently shown in new analysis of Mezhirich (Ukraine) hearths (Marquer et al. 2012)



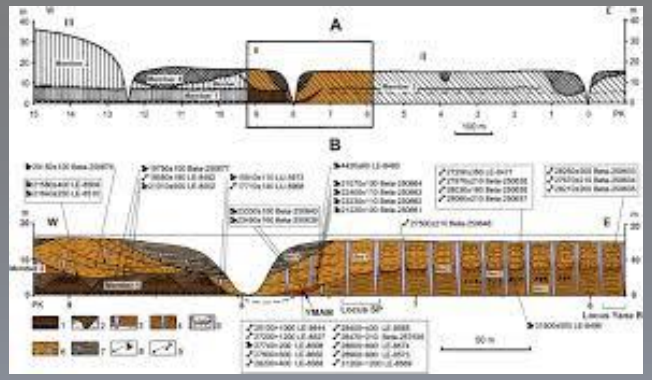
Marquer et al. 2012: 117, fig. 6



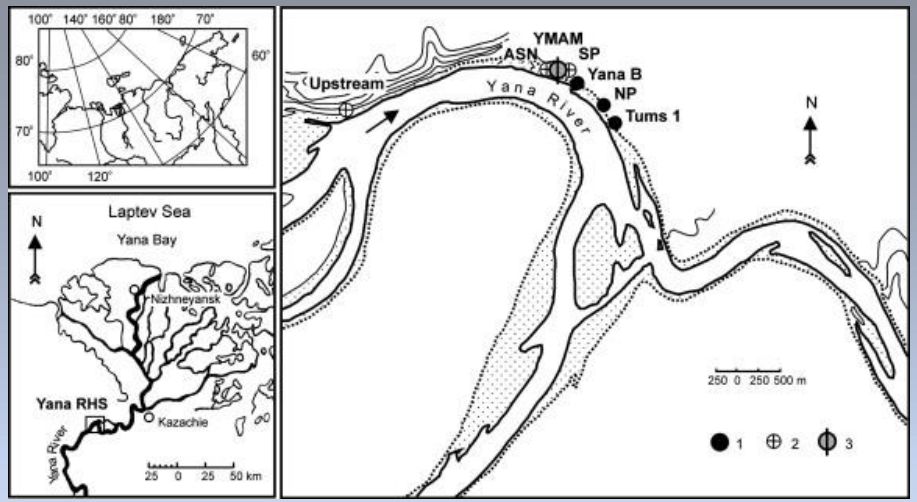
Pre-LGM settlement of Beringia

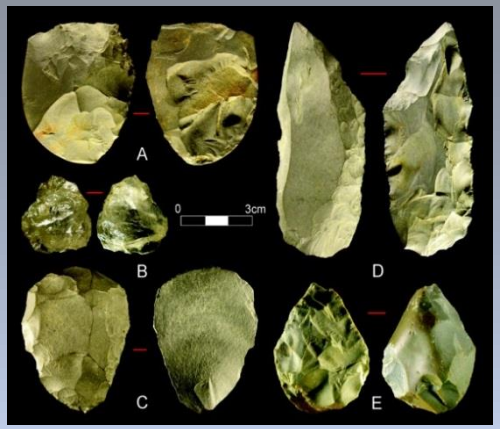


Pitulko et al. 2012



32–30 ka

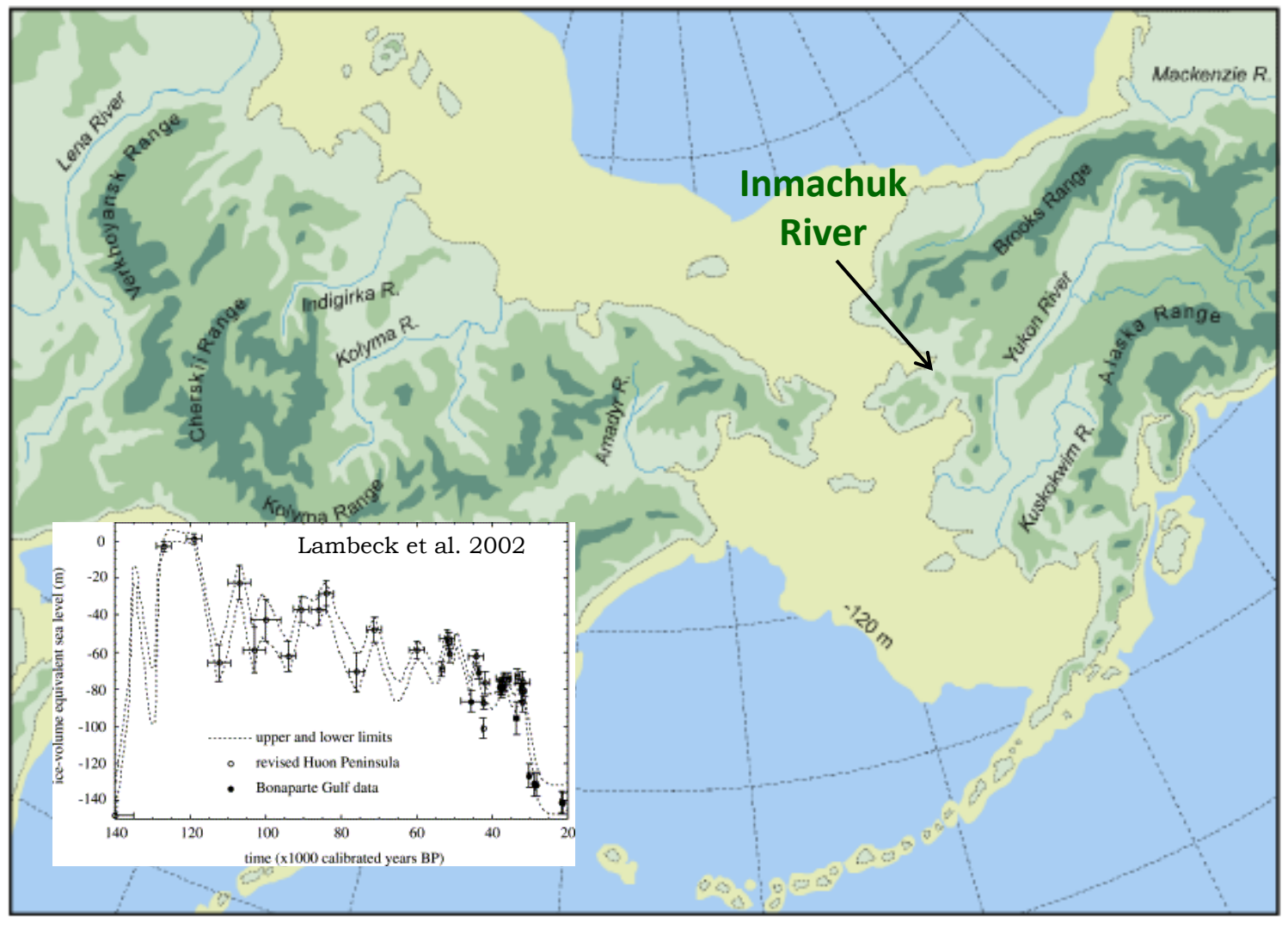




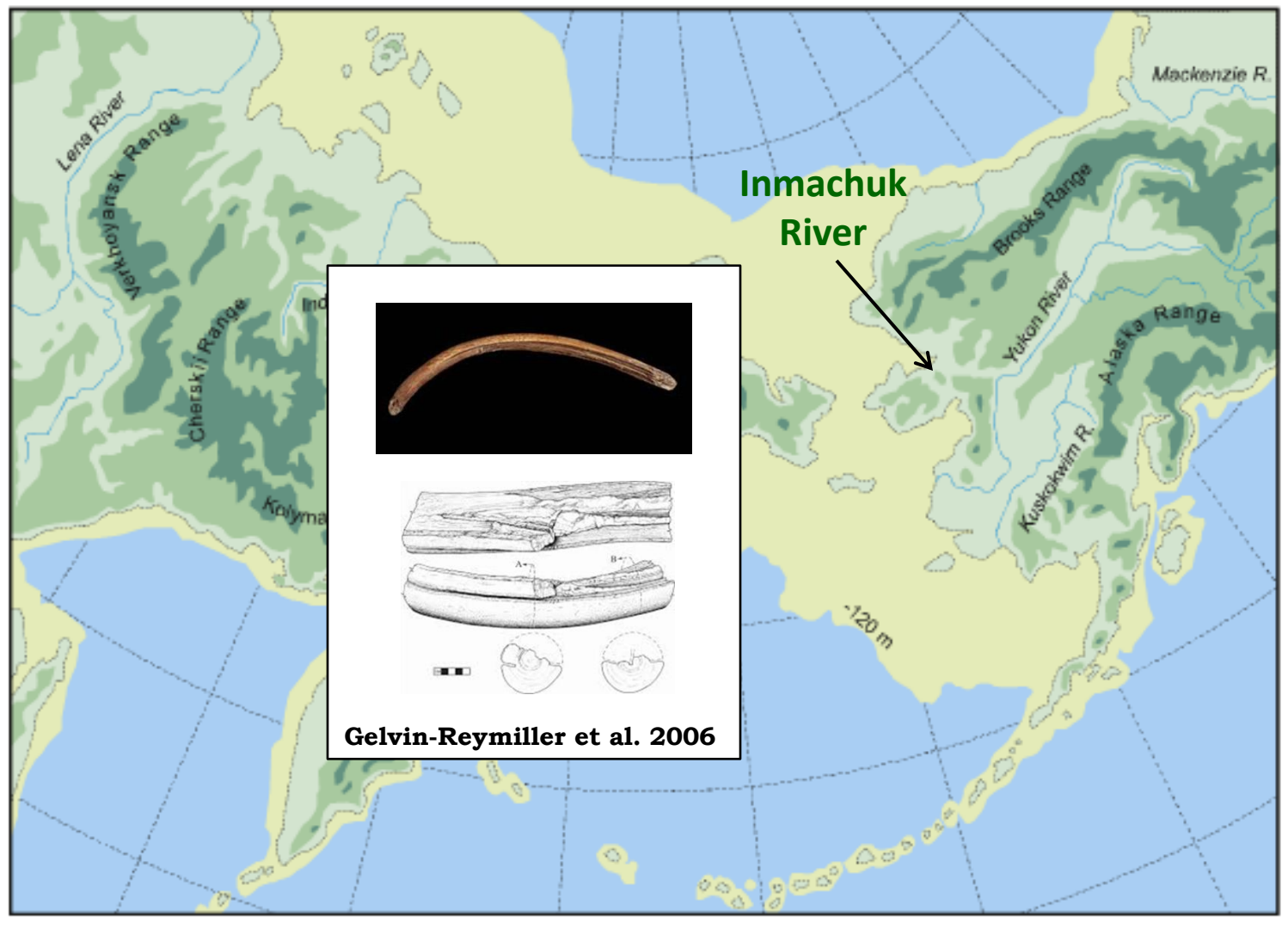
Pitulko et al. 2004

Yana sites dated to ~32,000–30,000 cal BP

Pre-LGM settlement of Beringia

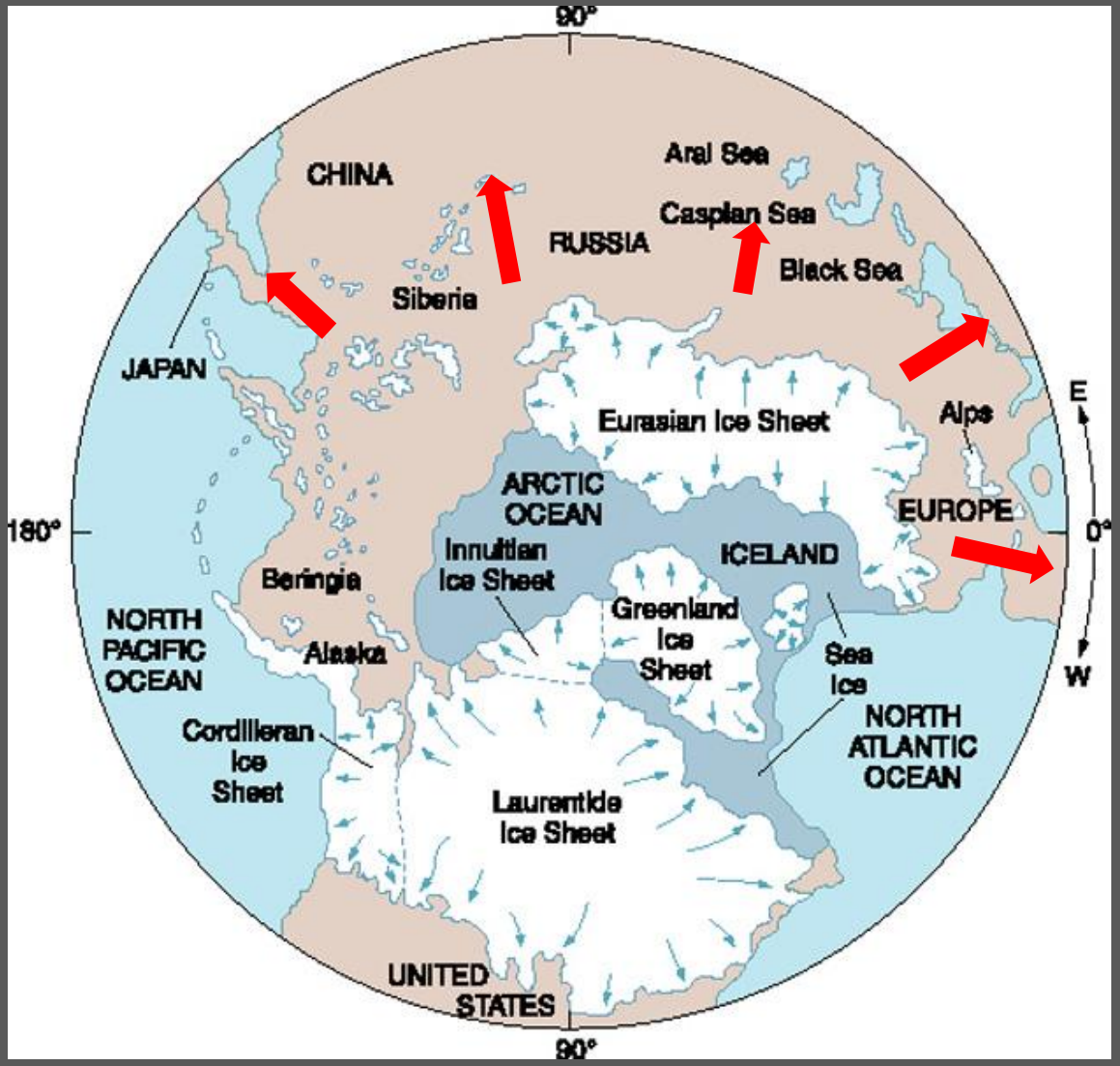


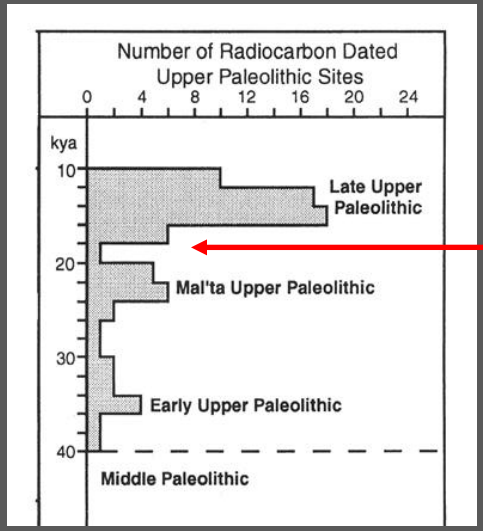
Pre-LGM settlement of Beringia



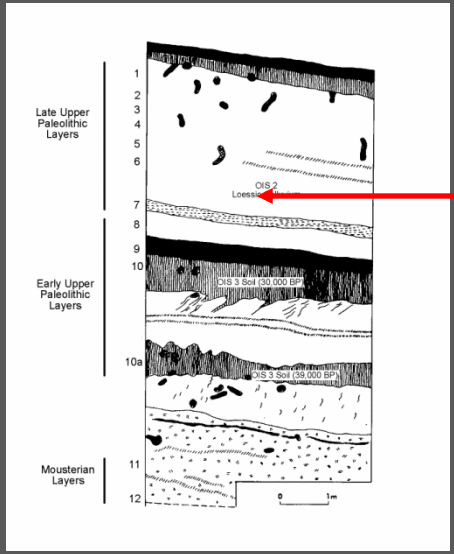
worked tusk dated to 40,100 ± 927 cal BP

abandonment of northern Eurasia during the LGM



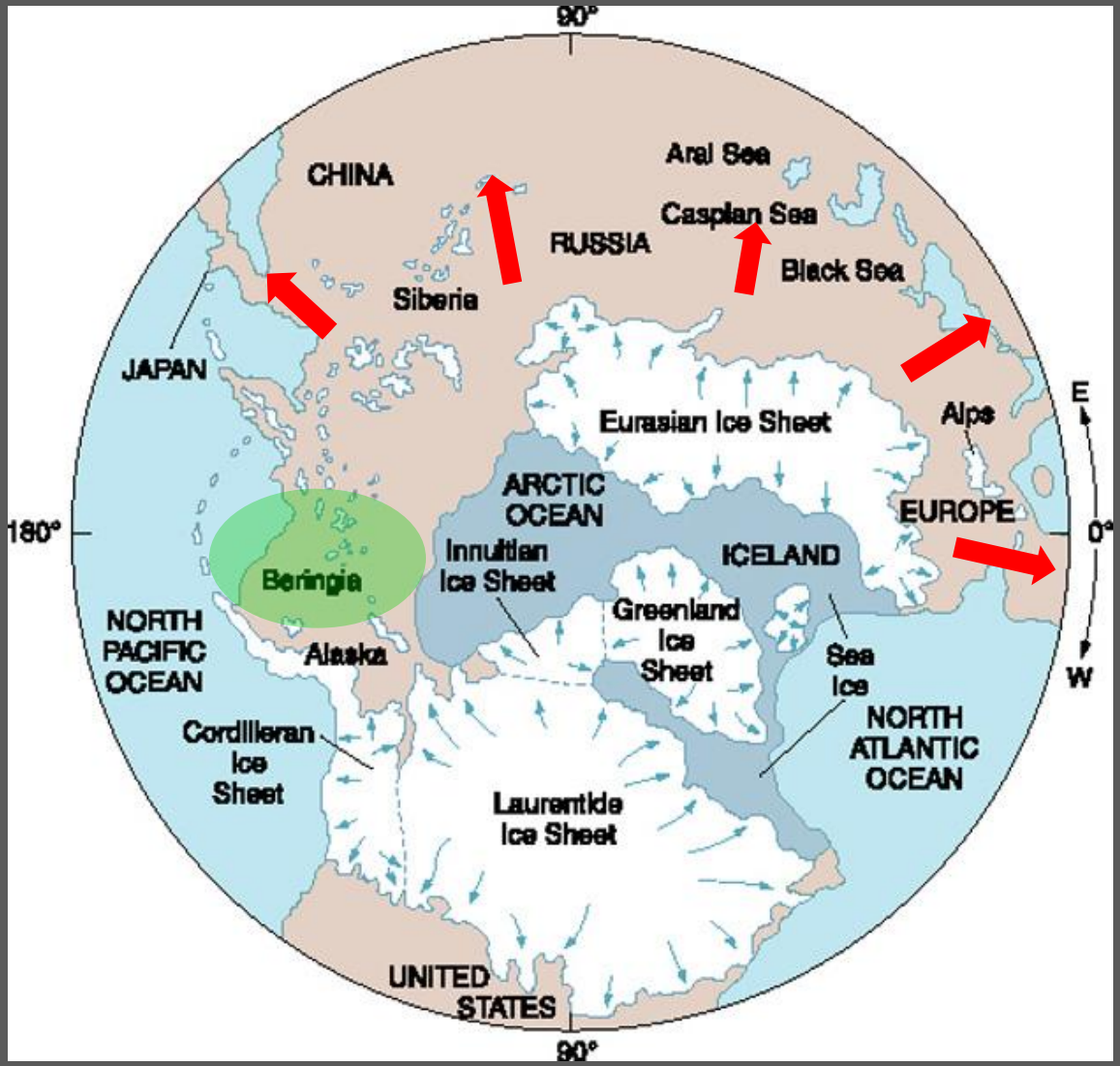


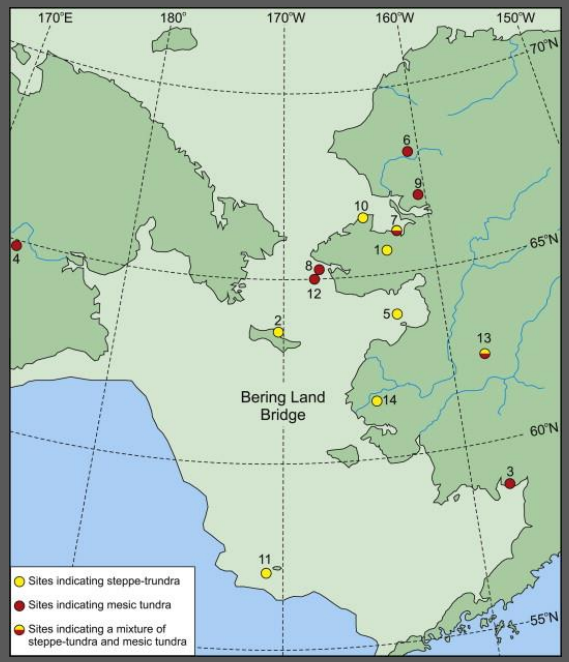
Goebel 1999: 201



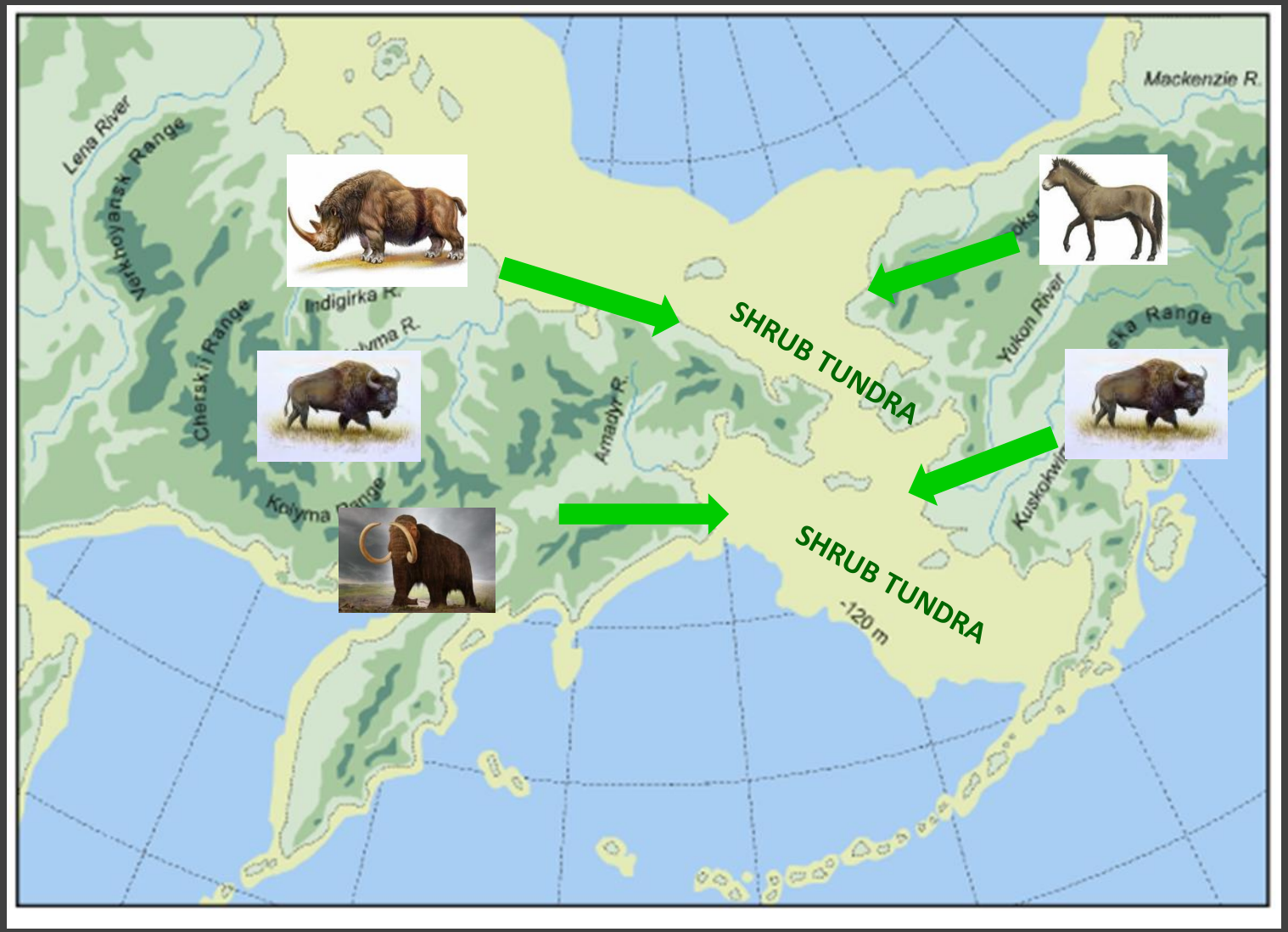
Molodova 5 (Ukraine)

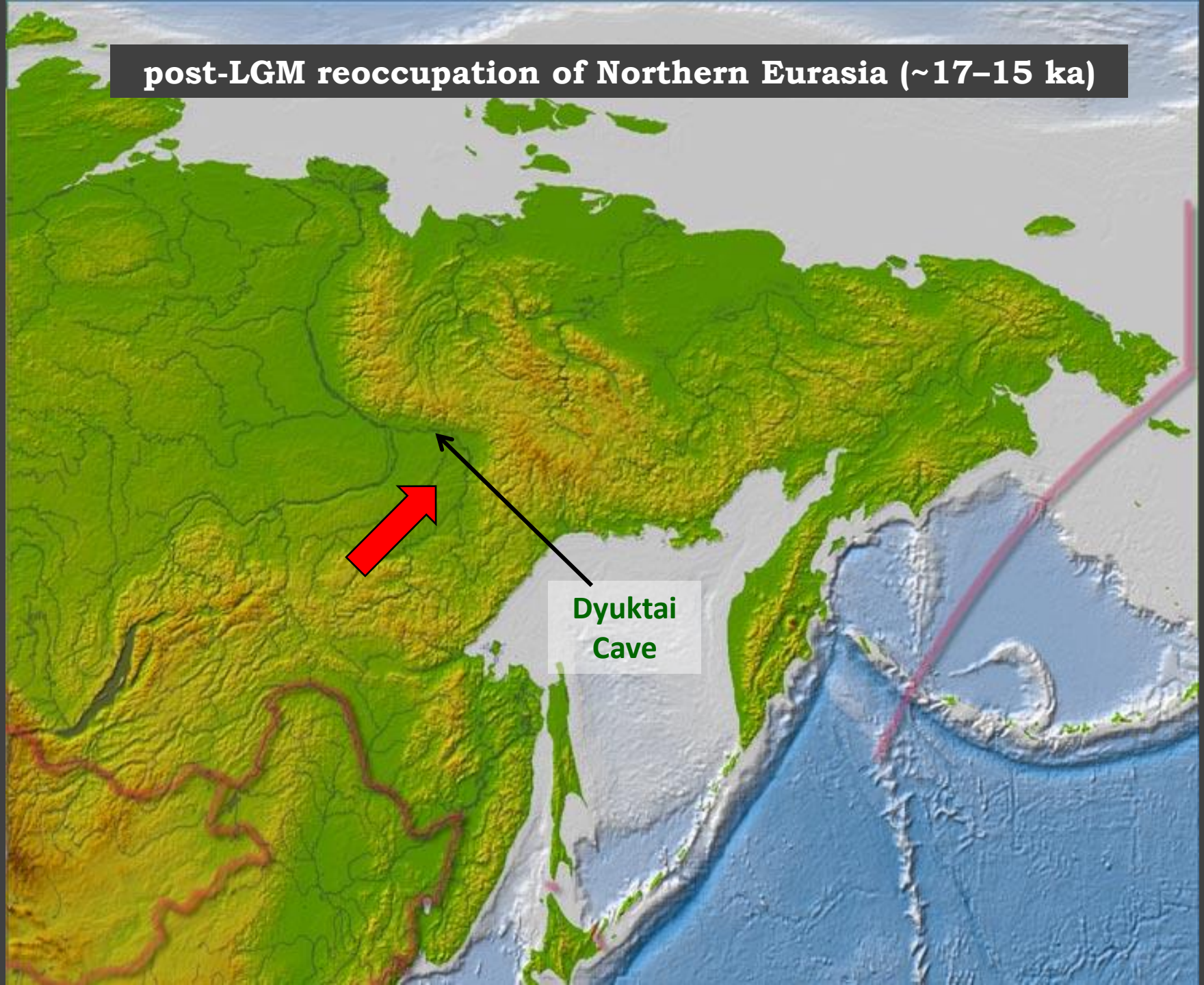
Beringian population isolated in shrub tundra refugium?





Exploitation of adjoining “steppe-tundra” zones?

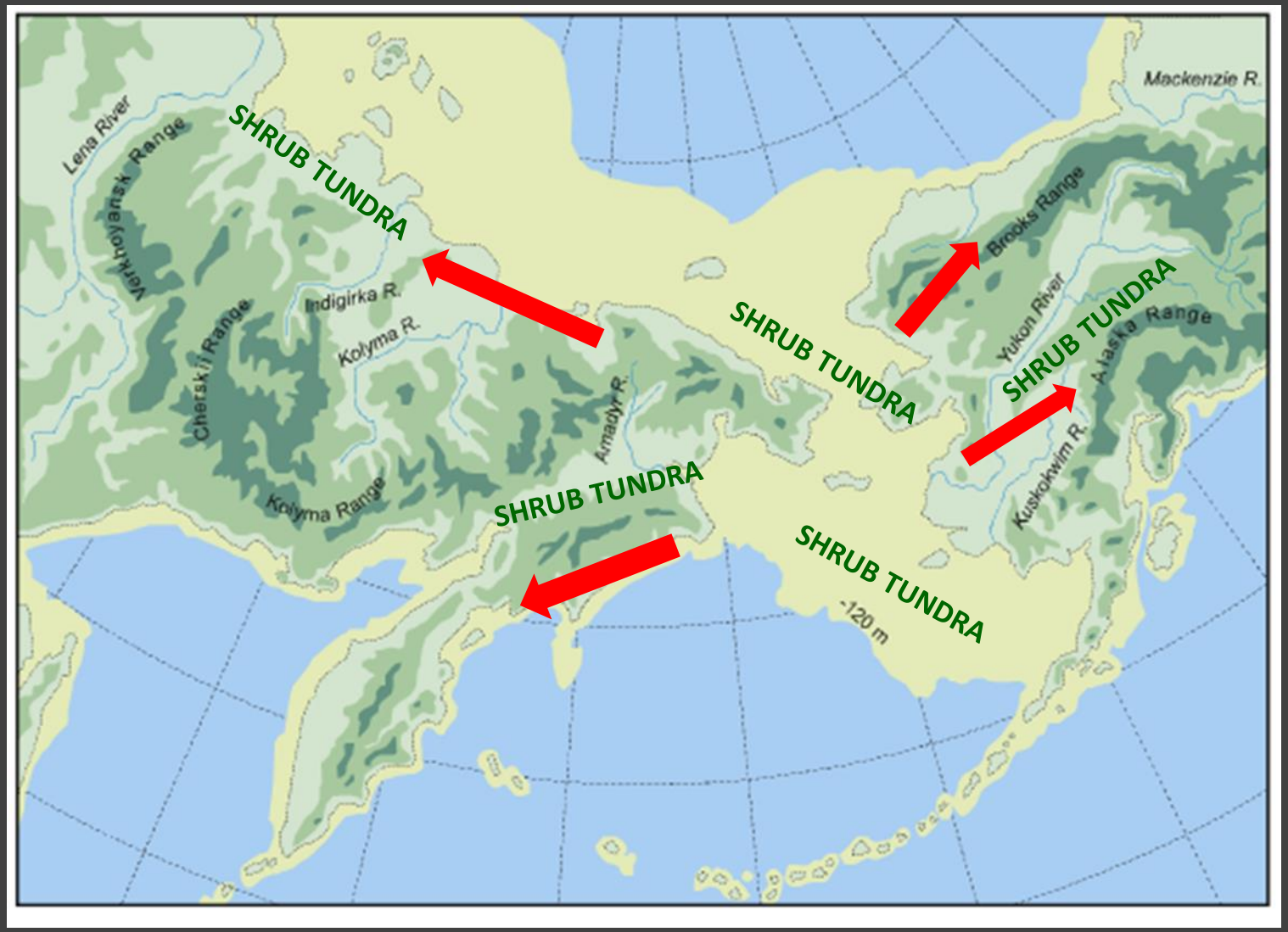


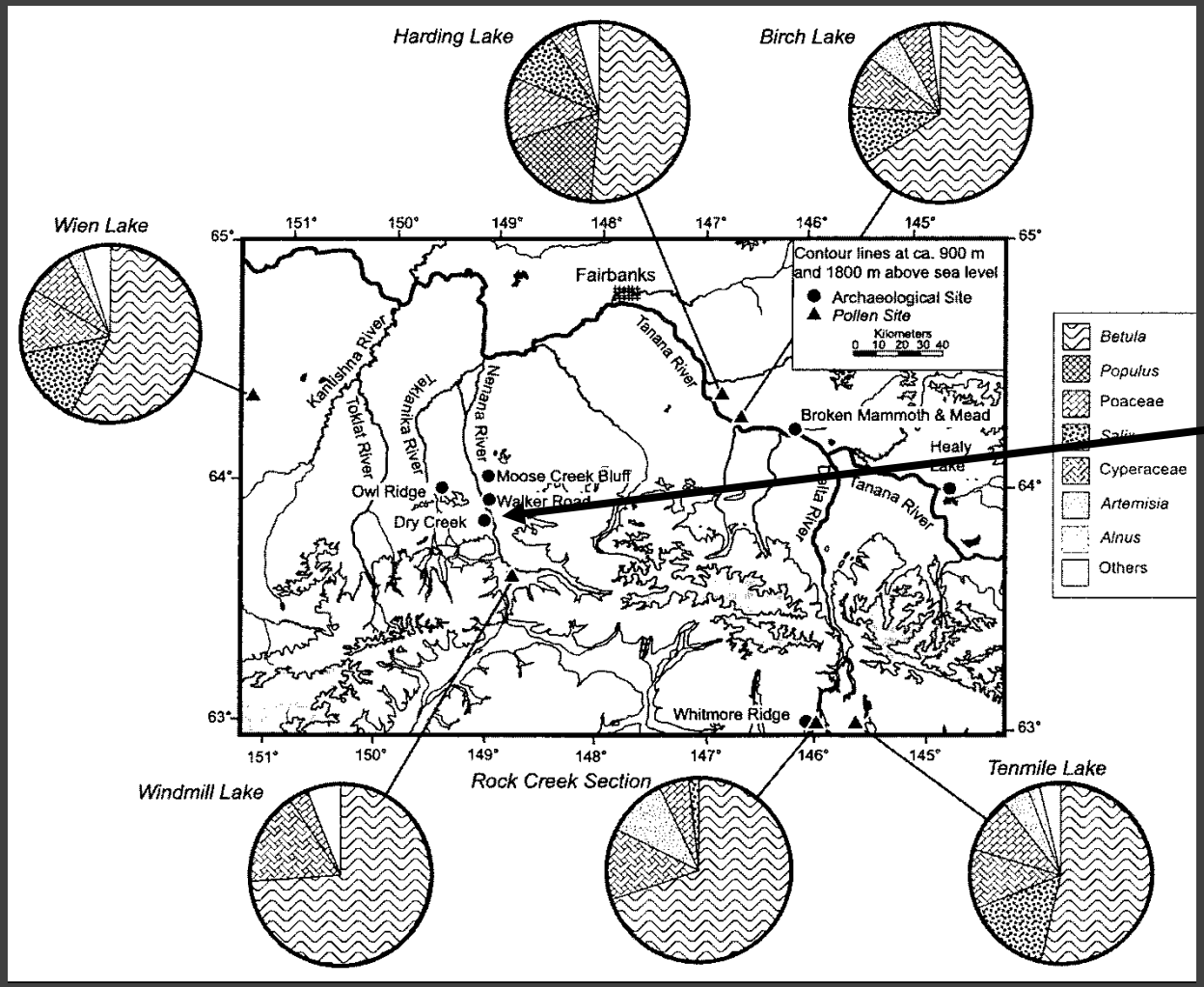

post-LGM reoccupation of Northern Eurasia (~17–15 ka)
Dyuktai
Cave

post-LGM reoccupation of Northern Eurasia (~17 – 15 ka)

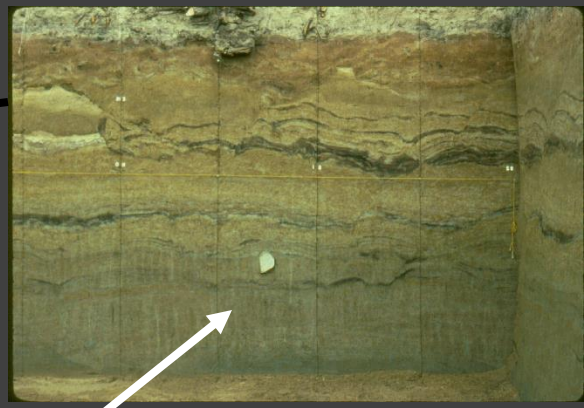
Dyuktai Cave

Lateglacial expansion out of central Beringia as shrub tundra spreads





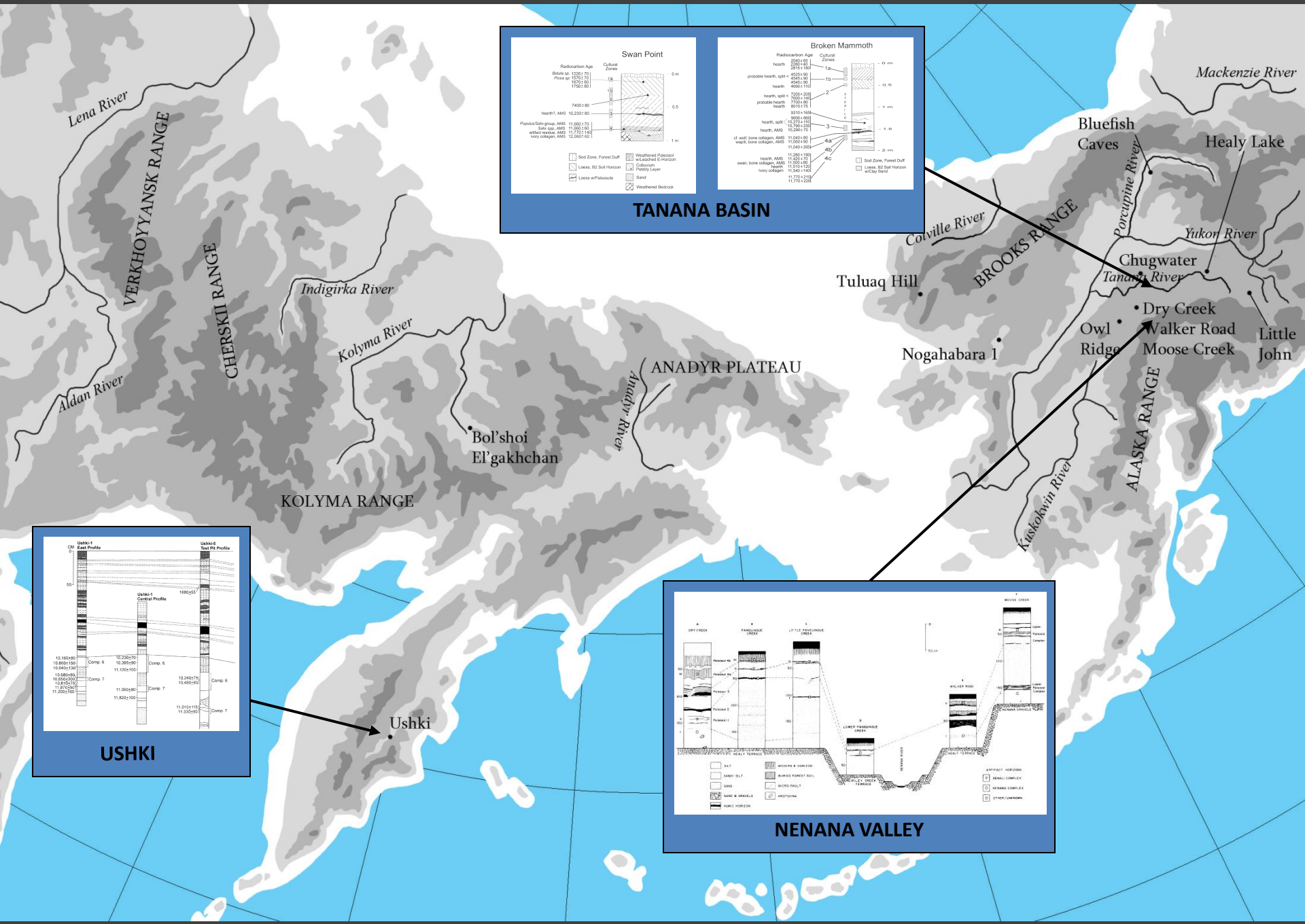
DRY CREEK (470 m asl)



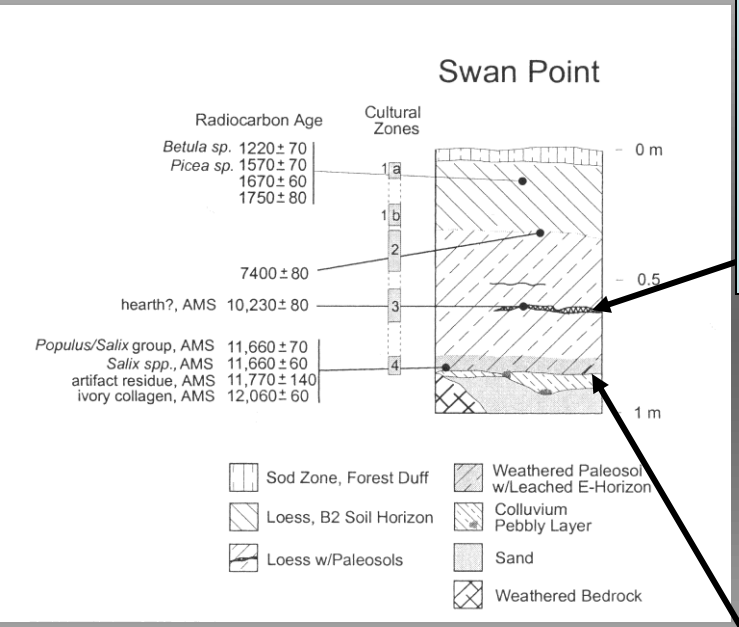
OCCUPIED AT 13 ka

North Alaska Range: shrub tundra at 13 ka

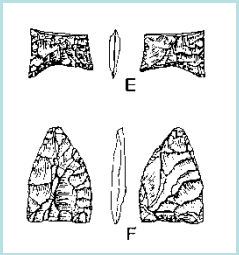
(Bigelow and Powers 2001: fig. 5)


Lena River
VERKHOYYANSK RANGE
CHERSKII RANGE
Aldan River
Indigirka River
Kolyma River
KOLYMA RANGE
ANADYR PLATEAU
Anadyr River
Bol'shoi
El'gakhchan
Ushki
Coville River
BROOKS RANGE
Tuluaq Hill
Nogahabara 1
Bluefish
Caves
Mackenzie River
Porcupine River
Healy Lake
Yukon River
Chugwater
Tanana River
Dry Creek
Owl
Ridge
Walker Road
Moose Creek
Little
John
ALASKA RANGE
Kuskokwim River
Swan Point
Broken Mammoth
TANANA BASIN
USHKI
NENANA VALLEY

ARCHAEOLOGICAL STRATIGRAPHY OF THE TANANA BASIN: 14-11 cal ka



(Holmes 2001)

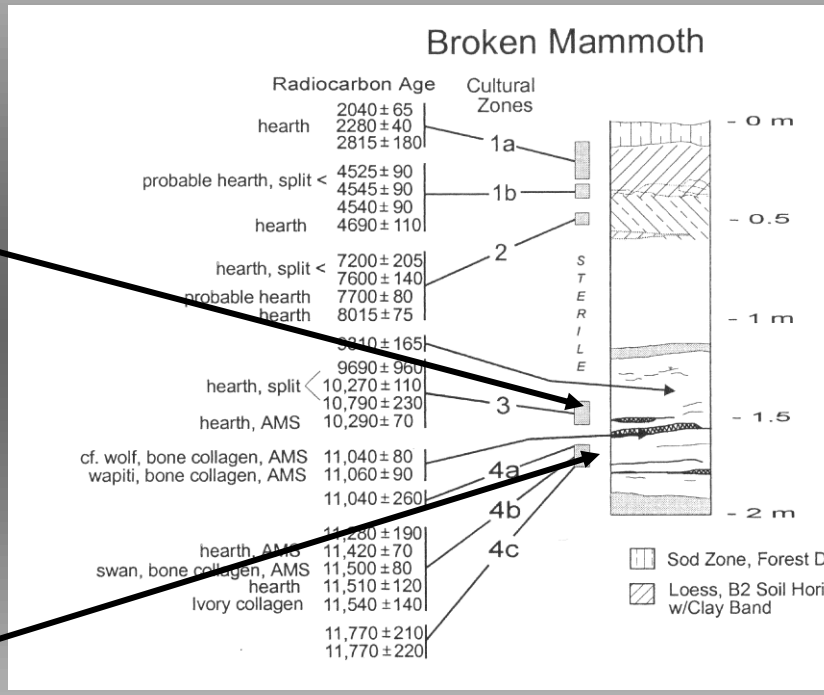


CZ 3: 12.5-11 cal ka

HIATUS

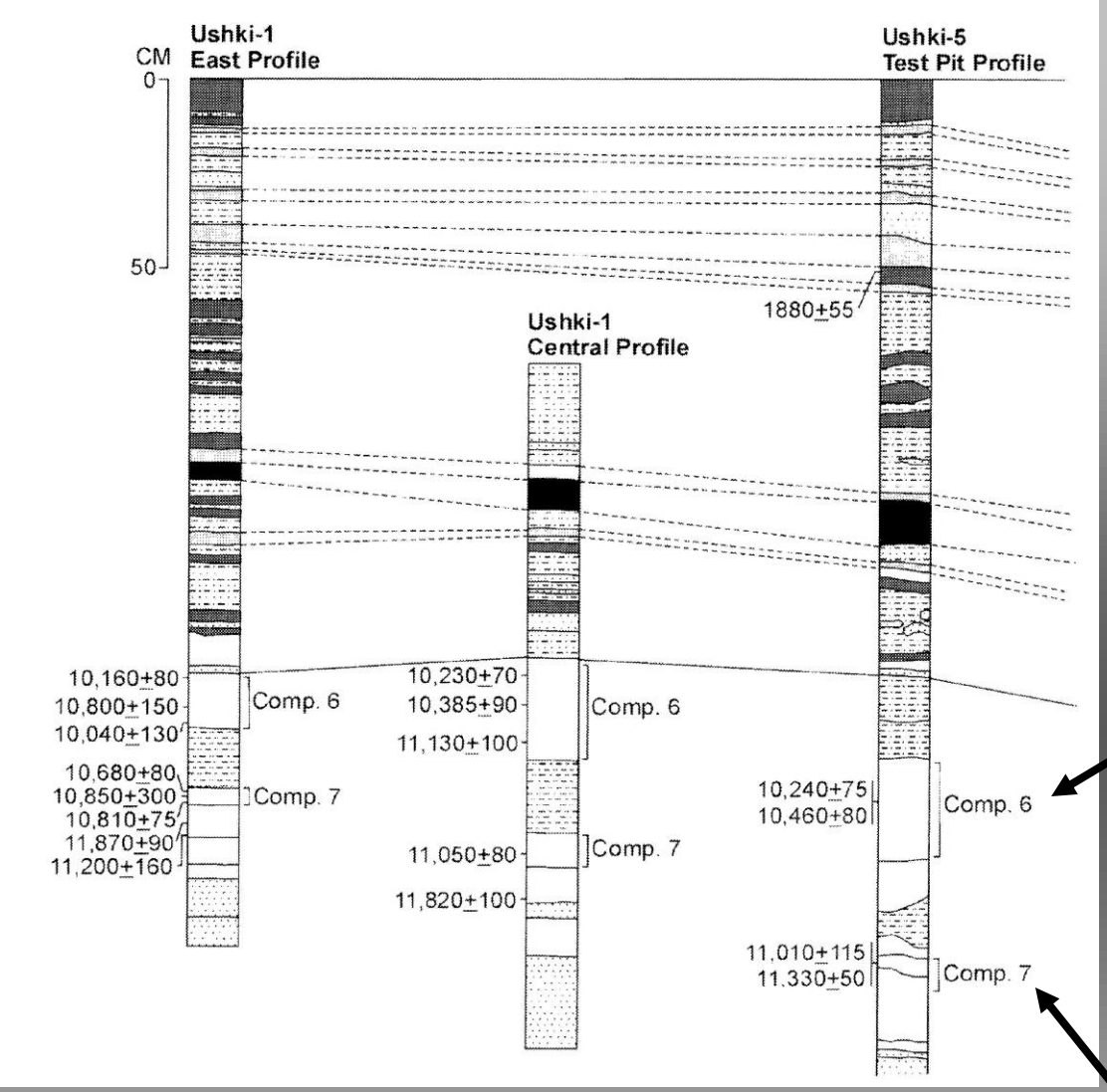
CZ 4: 14-13 cal ka

Dyuktai Culture

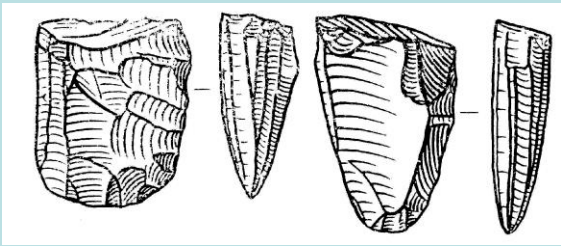


(Holmes 2001)

ARCHAEOLOGICAL STRATIGRAPHY OF USHKI: 13.1-11.9 cal ka



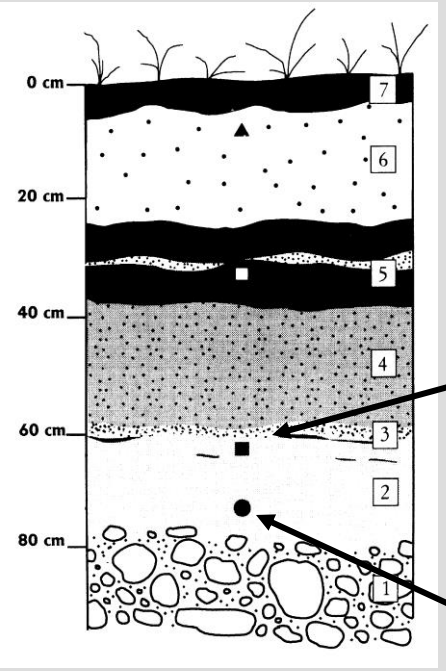
(Goebel et al. 2003: fig.3)



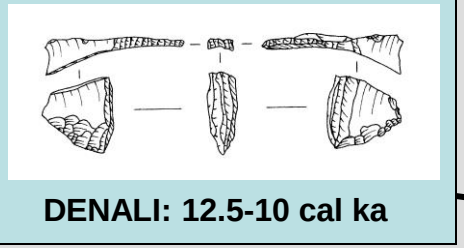
LAYER VI: 12.4-11.9 cal ka

LAYER VII: 13.1-12.9 cal ka

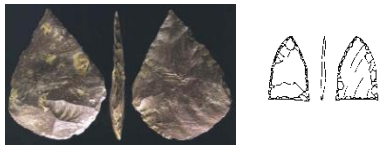
ARCHAEOLOGICAL STRATIGRAPHY OF THE NENANA VALLEY: 13.1-11 cal ka



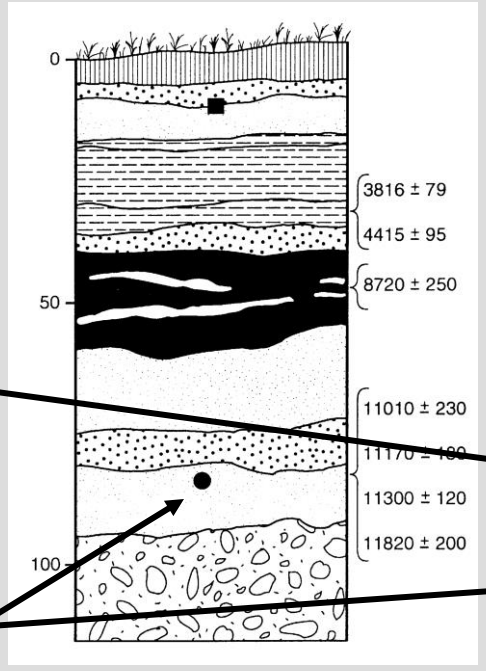
(Pearson 1999)



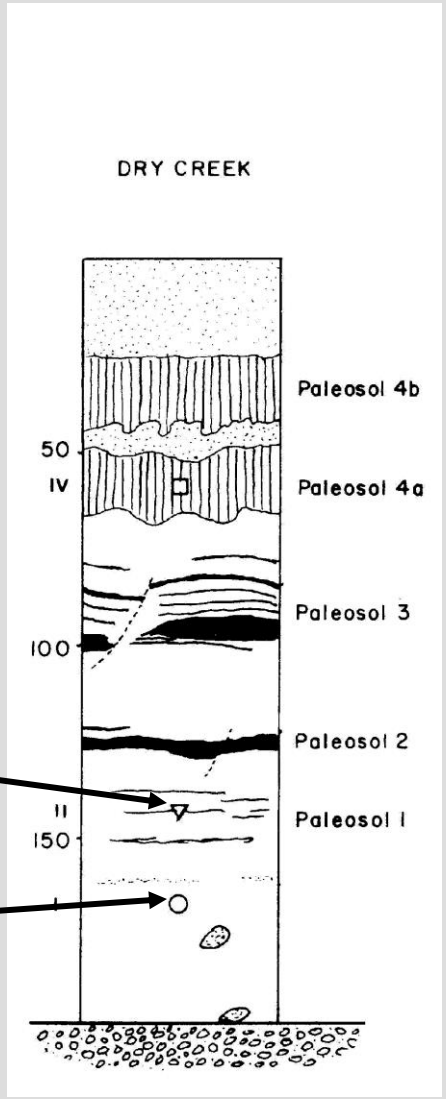
DENALI: 12.5-10 cal ka



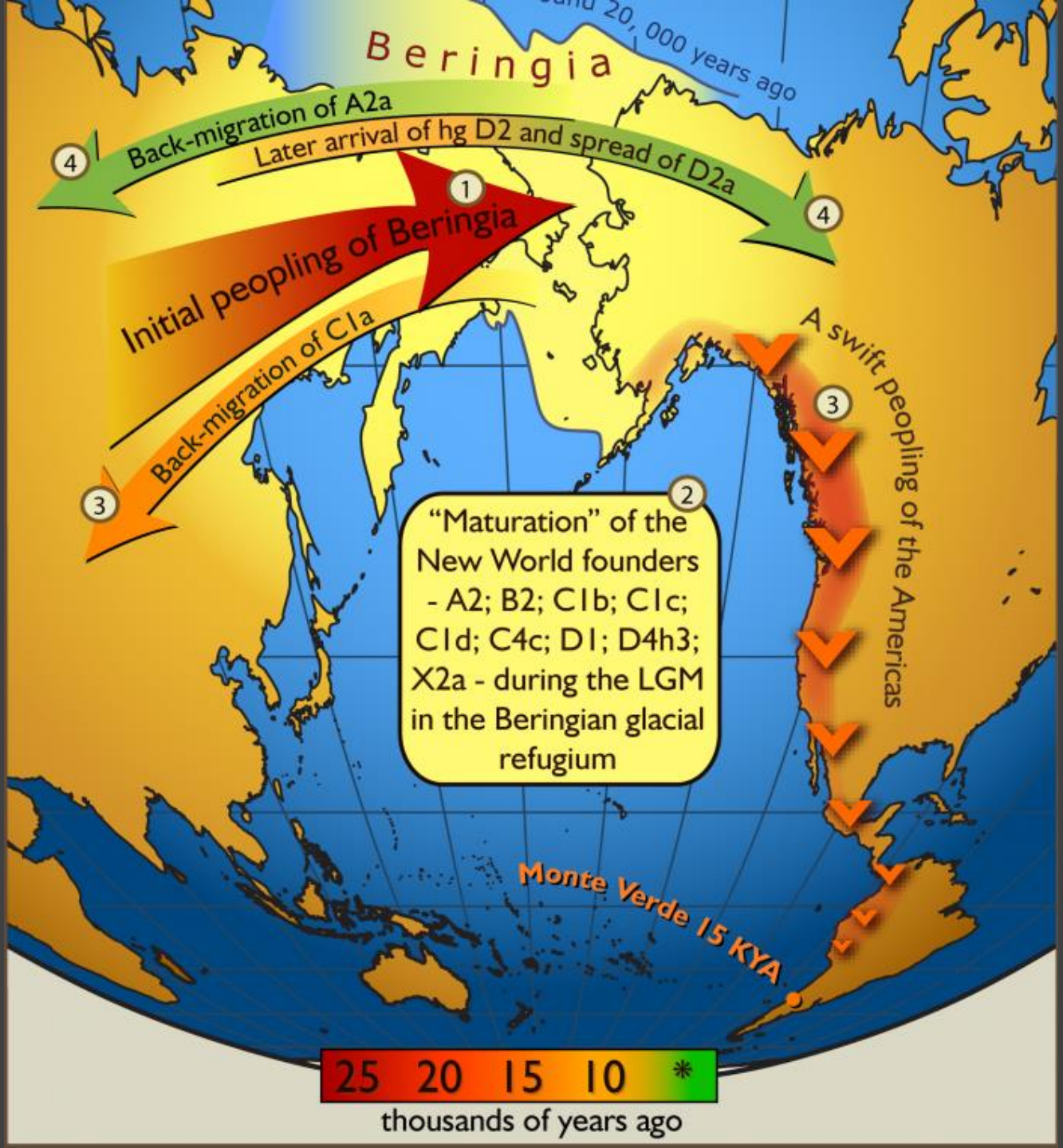
NENANA: 13.2-12.9 cal ka

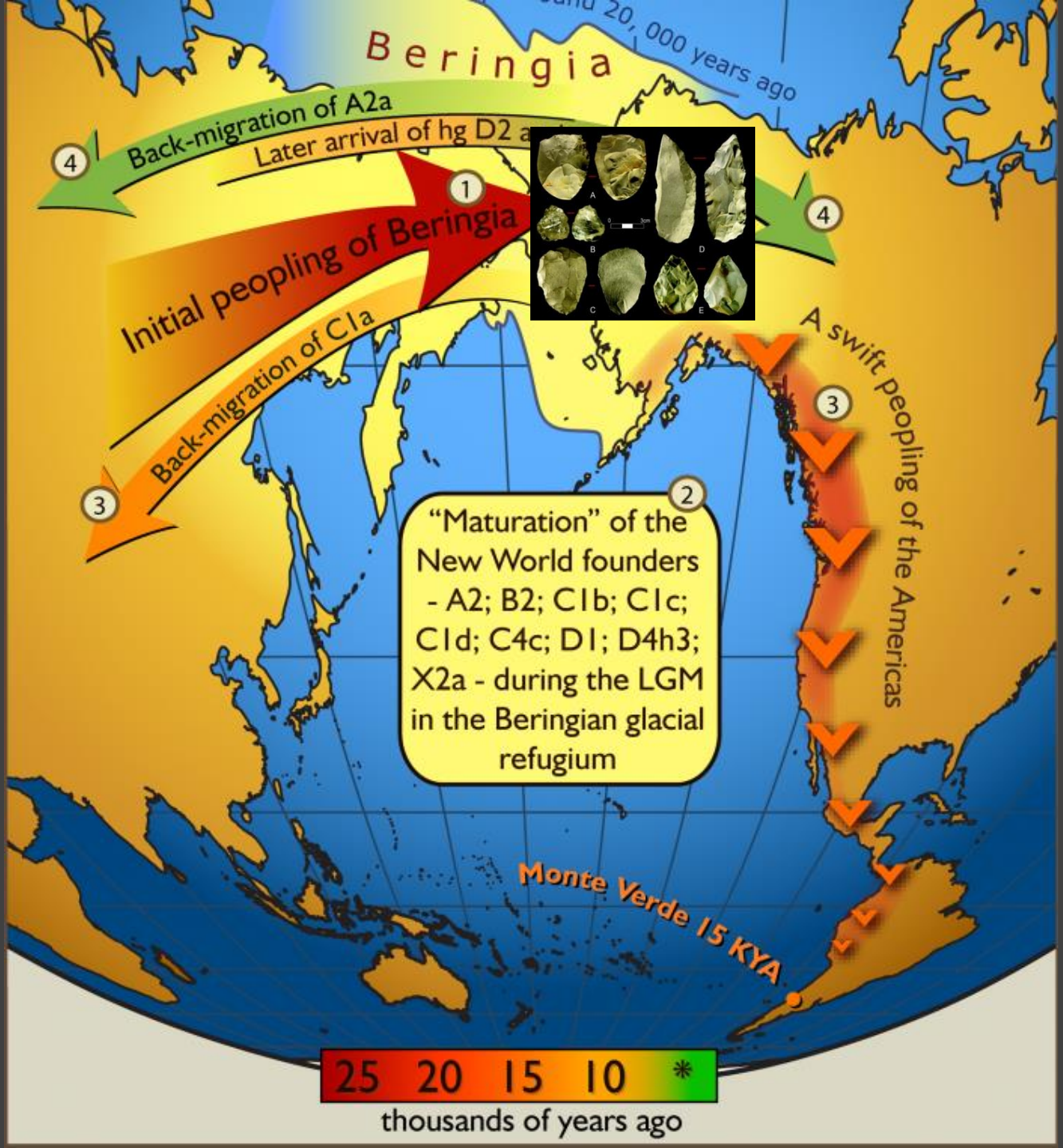


(Goebel et al. 1996)



PERIOD	NE ASIA: LENA BASIN	WESTERN BERINGIA CHUKOTKA/KOLYMA BASIN, ETC.	CENTRAL BERINGIA BERING LAND BRIDGE	EASTERN BERINGIA (ALASKA/YUKON)
LATE GLACIAL 14,000-12,000 cal BP	DYUKTAI CULTURE	DYUKTAI CULTURE USHKI LAYER VII	ABANDONED AFTER SEA LEVEL RISE	NENANA COMPLEX
LATE GLACIAL 16,000-14,000 cal BP	DYUKTAI CULTURE		BERINGIAN TRADITION	DYUKTAI CULTURE
LAST GLACIAL MAXIMUM (30,000-16,000 cal BP)	ABANDONED DURING LGM	ABANDONED DURING LGM	BERINGIAN TRADITION (SHRUB TUNDRA REFUGIUM)	ABANDONED DURING LGM
INTERSTADIAL (MIS 3) (>30,000 cal BP)	EARLY UPPER PALEOLITHIC	YANA SITE COMPLEX	YANA COMPLEX?	WORKED TUSK?


Beringia
Back-migration of A2a
Later arrival of hg D2 and spread of D2a
4
4
1
Initial peopling of Beringia
Back-migration of C1a
3
2
"Maturation" of the New World founders - A2; B2; C1b; C1c; C1d; C4c; D1; D4h3; X2a - during the LGM in the Beringian glacial refugium
A swift peopling of the Americas
3
Monte Verde 15 KYA
25 20 15 10 *
thousands of years ago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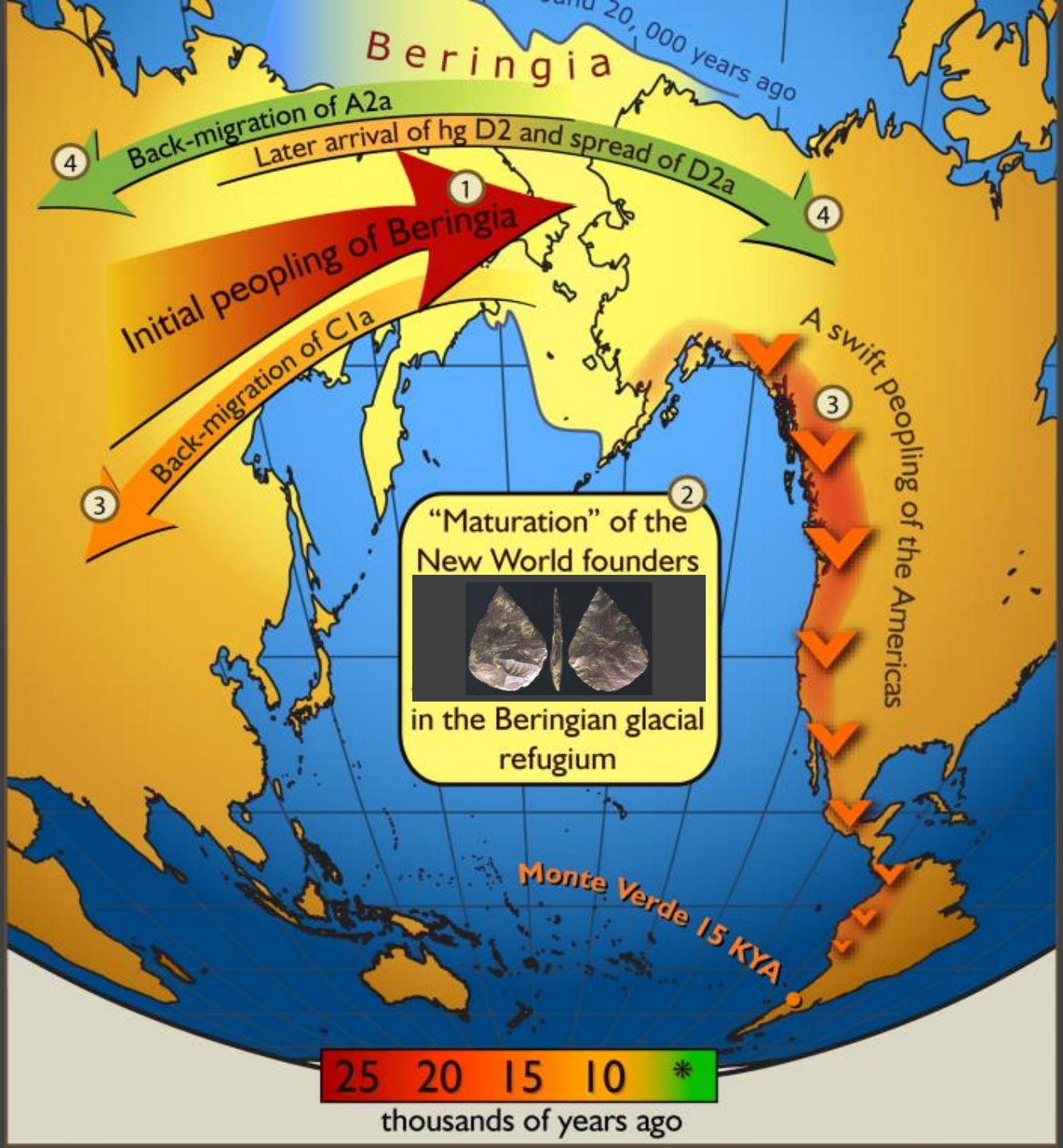
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Beringia

Back-migration of A2a

Later arrival of hg D2 and spread of D2a

Initial peopling of Beringia

Back-migration of C1a

A swift peopling of the Americas

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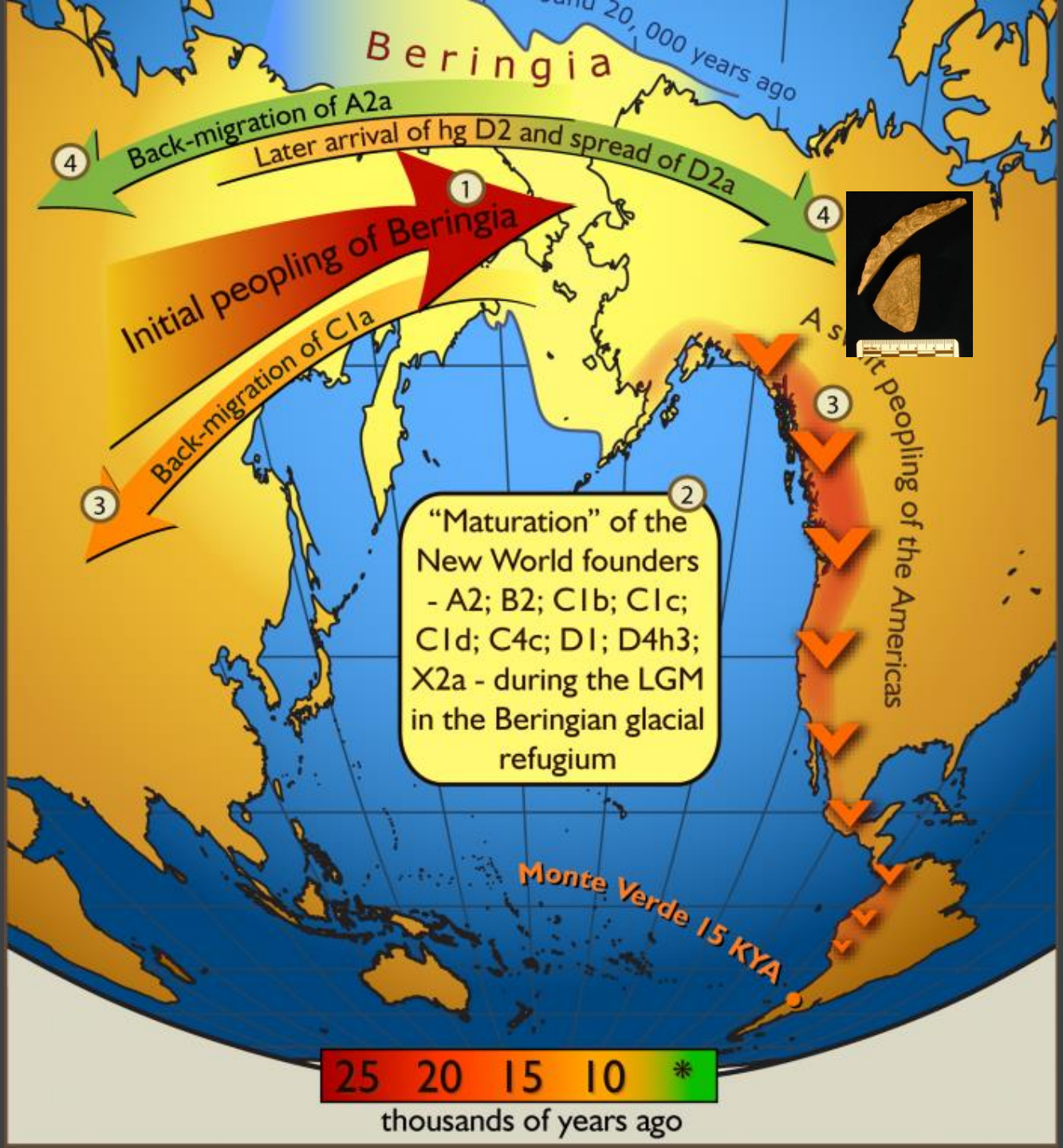
Monte Verde 15 KYA

25 20 15 10 *

thousands of years ago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