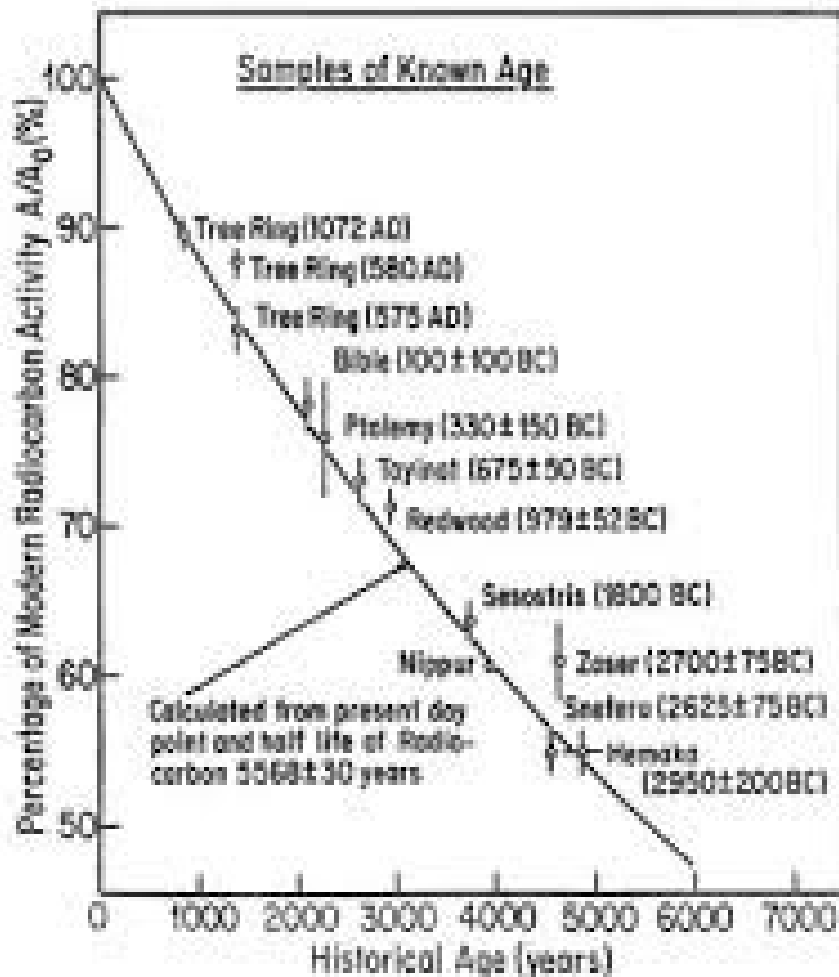


# Radiouhlíkové datování

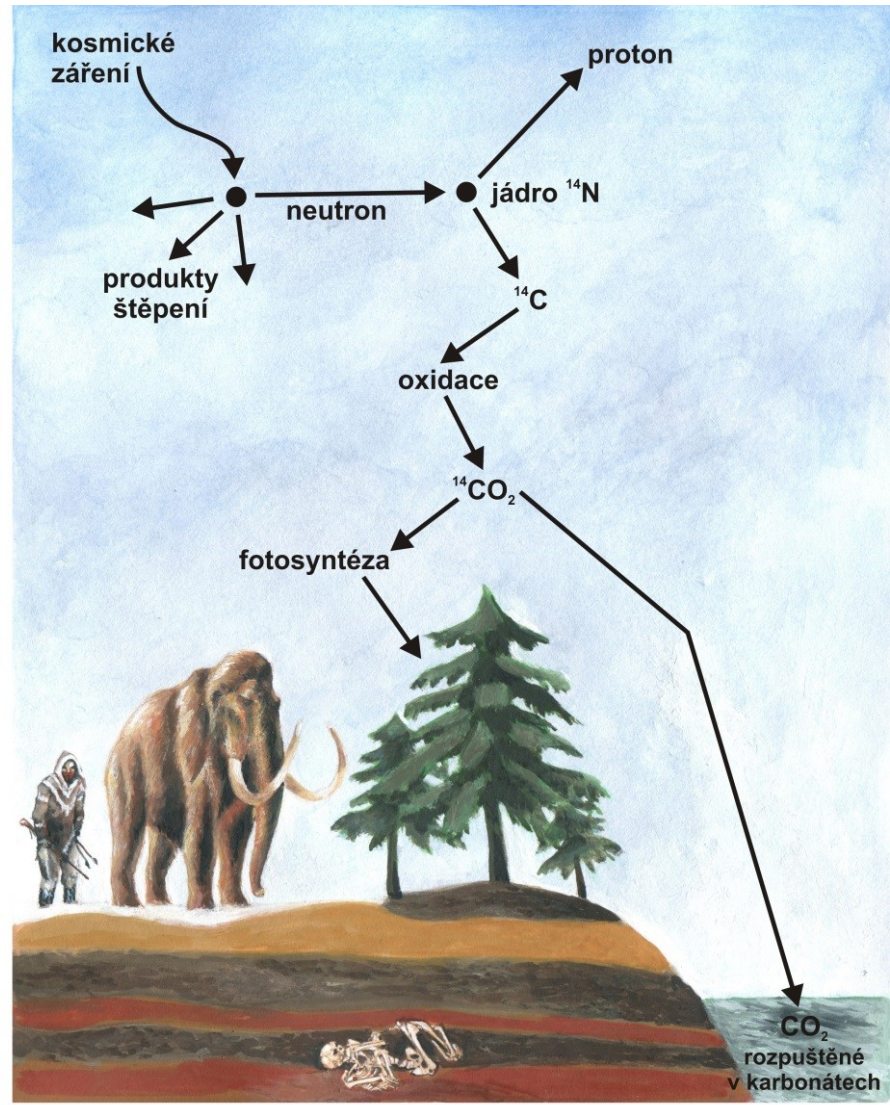


Willard Frank Libby

# Alternativní chronologie: datování s využitím izotopu uhlíku <sup>14</sup>C

## Alternative chronology: dating utilizing carbon isotope <sup>14</sup>C

PRODUKCE



DISTRIBUCE

rovnovážná koncentrace:  $\frac{^{14}\text{C}}{^{12}\text{C}} \approx 10^{-12}$

rozpad:  $^{14}\text{C} \rightarrow ^{14}\text{N} + e^- + \bar{\nu}^-$

poločas rozpadu: 5730 let

1 gram  $\rightarrow$  ~10 rozpadů za minutu

ROZPAD

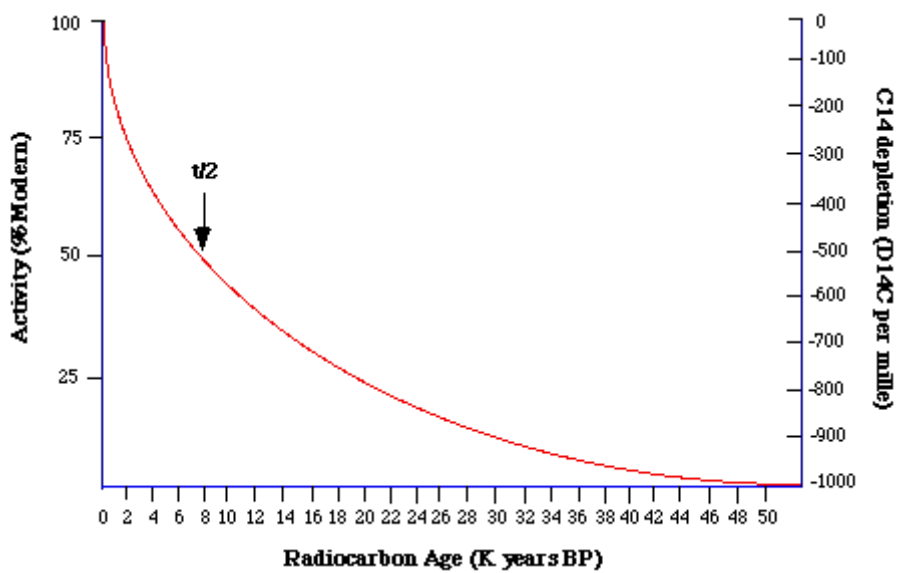
### Fyzikální podstata:

Izotop <sup>14</sup>C vzniká v horních vrstvách atmosféry;

Odtud přechází do živých organismů a ukládá se v nich po dobu jejich života;

Do flóry vlivem fotosyntézy, do fauny stravou;

Po úmrtí organismu se v něm izotop <sup>14</sup>C přestane ukládat a dochází k jeho pozvolnému rozpadu;

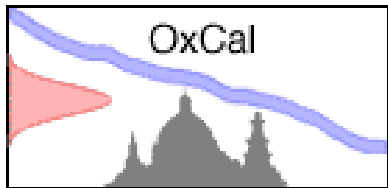
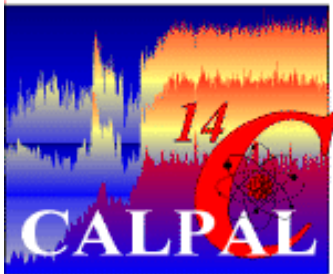


# Výsledky měření a problematika kalibrace

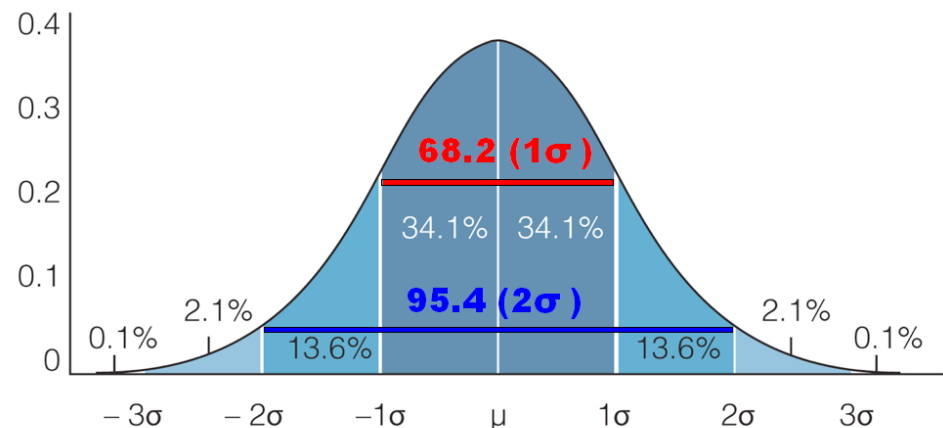
## Results and calibration issue

Laboratorní výsledek je udáván ve formě **střední hodnota  $\pm$  směrodatná odchylka** (s předpokladem normálního rozdělení) v radiokarbonových letech ( $^{14}\text{C}$  BP nebo BC, vztažených k roku 1950);

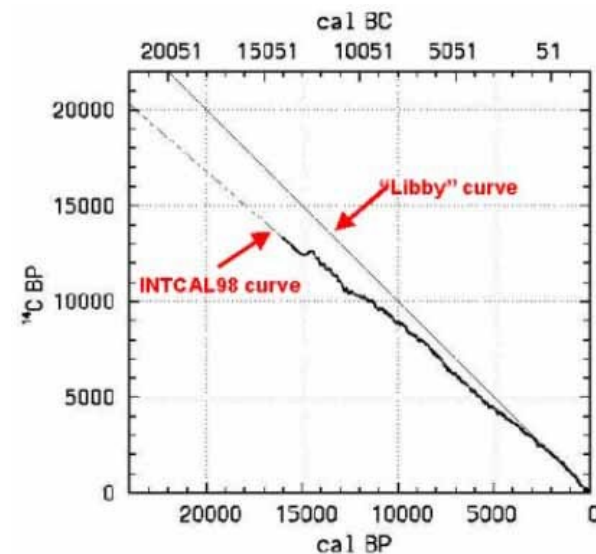
Jelikož radiokarbonové roky se liší od solárních let vlivem nehomogenní distribuce izotopu  $^{14}\text{C}$ , je data třeba data kalibrovat. Používají se k tomu kalibrační softwary (CalPal, OxCal, Calib) a kalibrační sety (IntCal04, IntCal09). Pro období neolitu jsou základem kalibrace dendrodata. Výsledky jsou pak udávány v intervalech pravděpodobnosti  $1\sigma$  (68,2 %) nebo  $2\sigma$  (95,4 %).



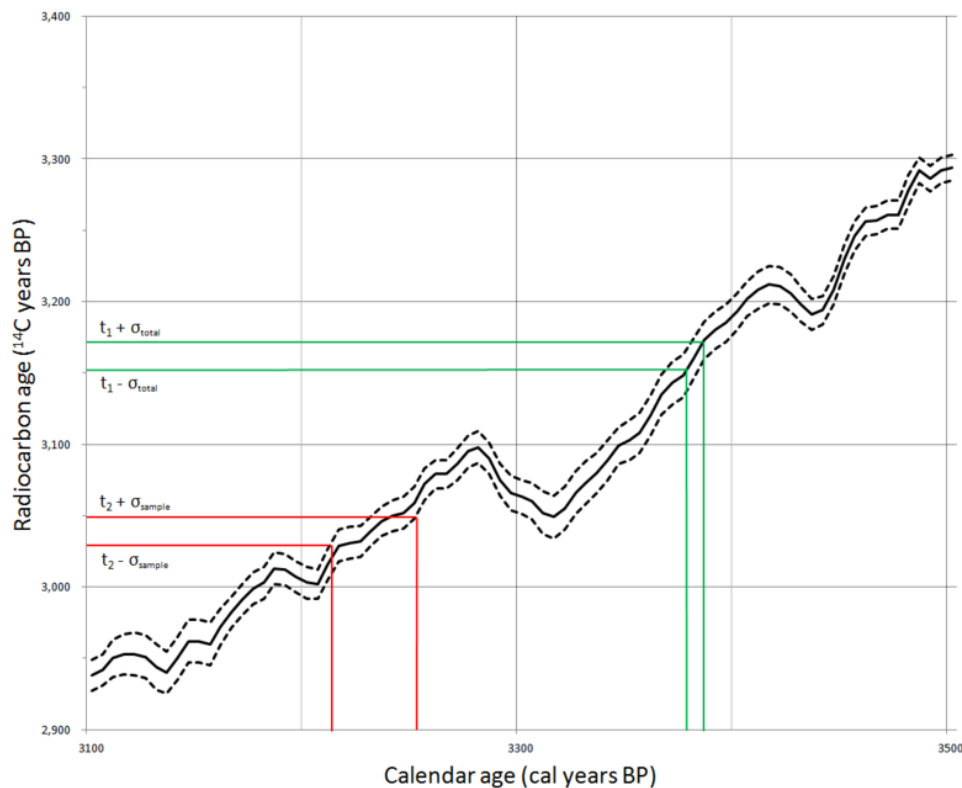
Gauss - Laplaceovo normální rozdělení  
rozptyl pravděpodobnosti



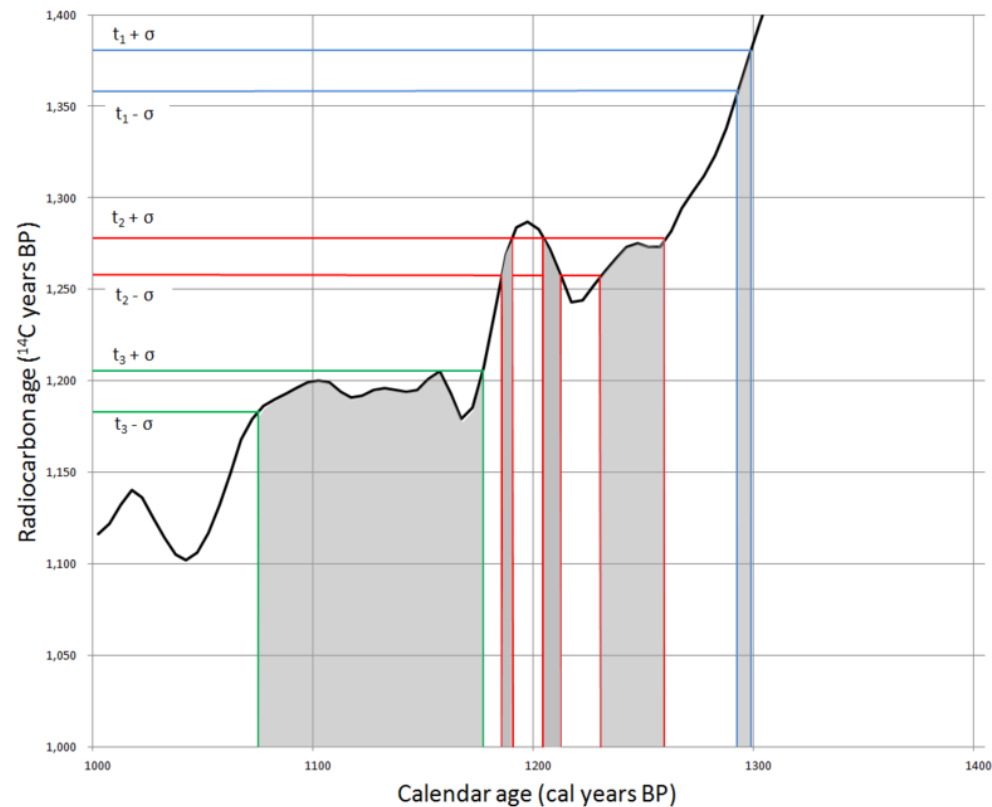
# Kalibrace radiouhlíkových dat



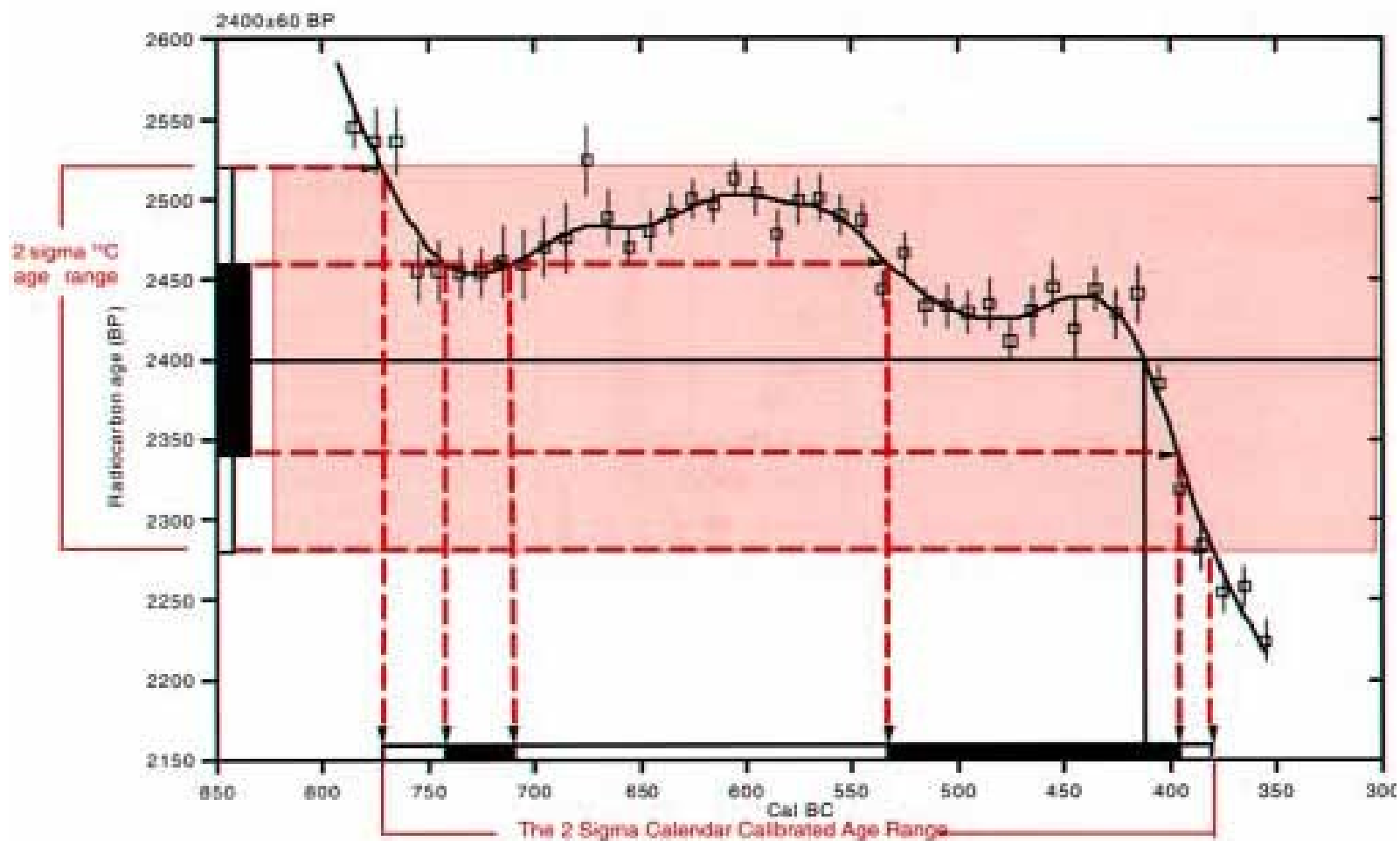
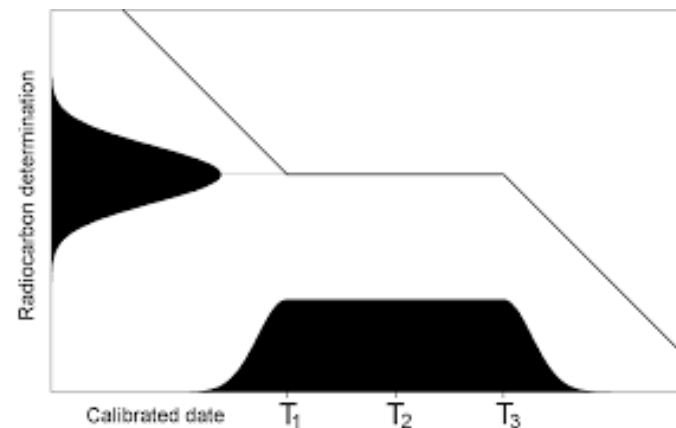
## Calibration error and measurement error



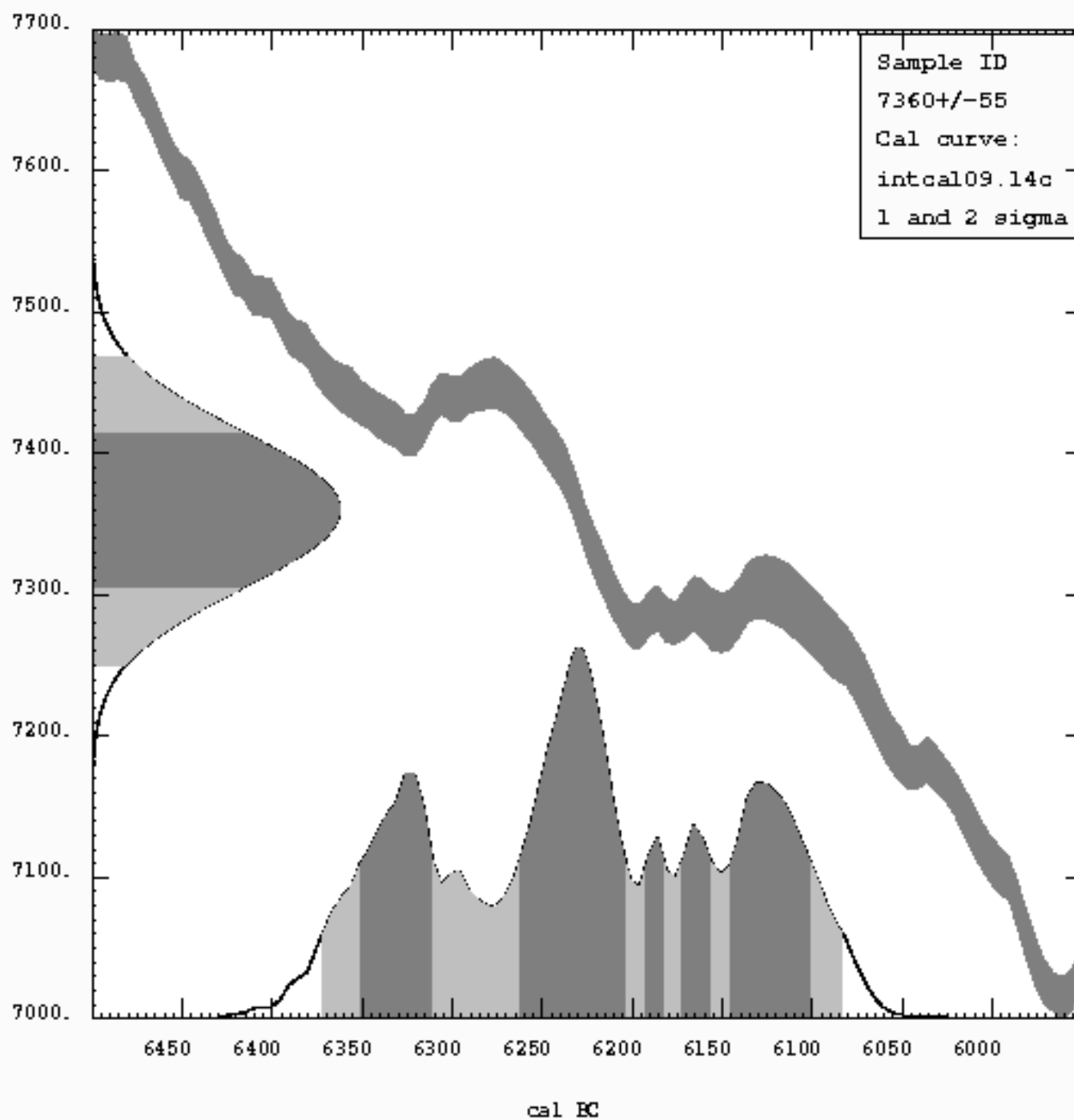
## Variations in calibration results



# Radiouhlíkové plató



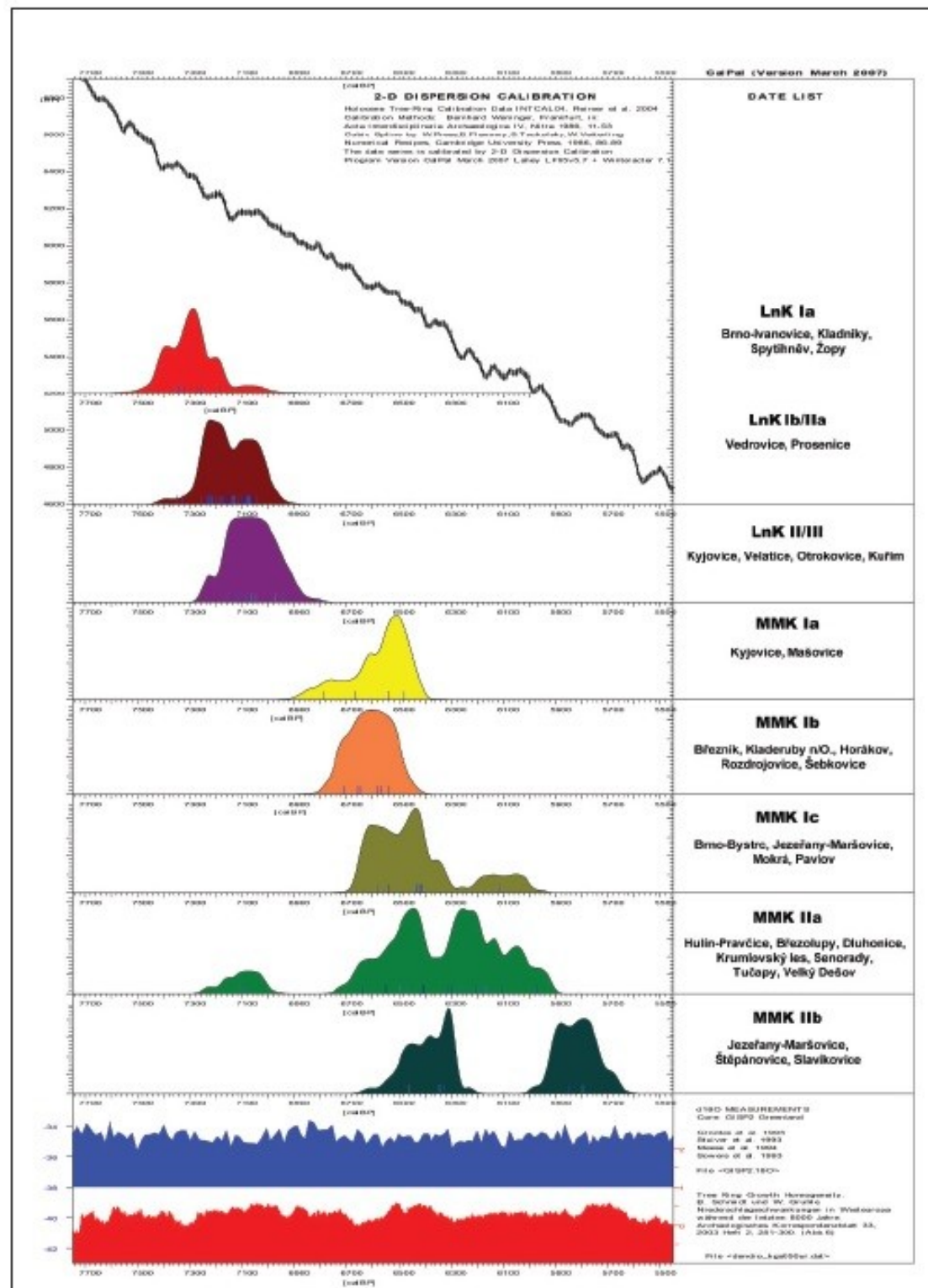
Radiocarbon Age vs. Calibrated Age





# Chronologie moravského neolitu

## The chronology of the Moravian Neolithic



# „Old wood“ problem

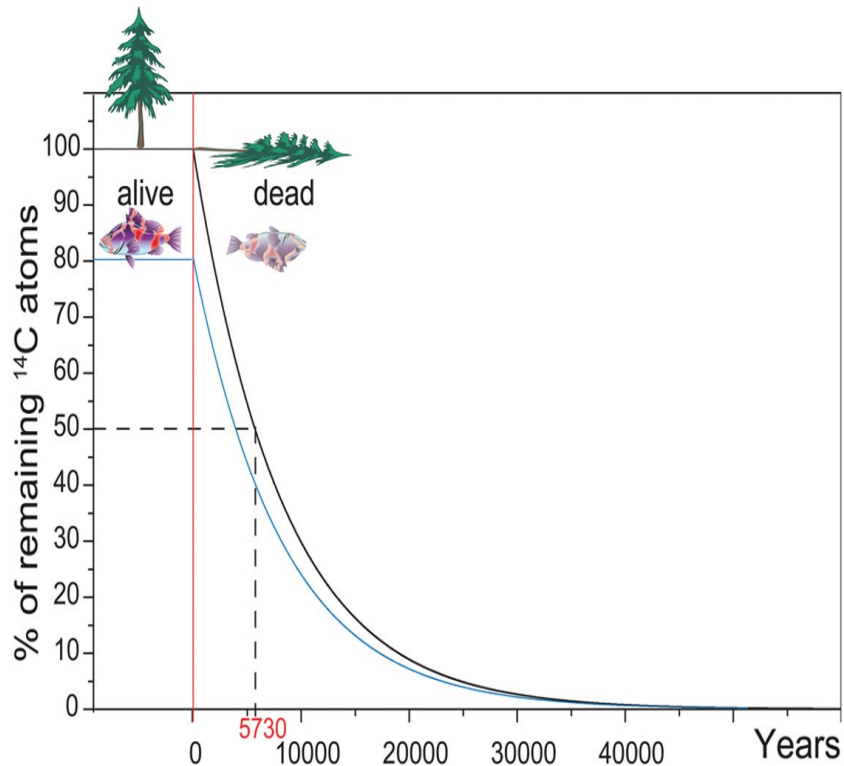
Materiál je mnohem starší než je doba jeho utilizace člověkem.



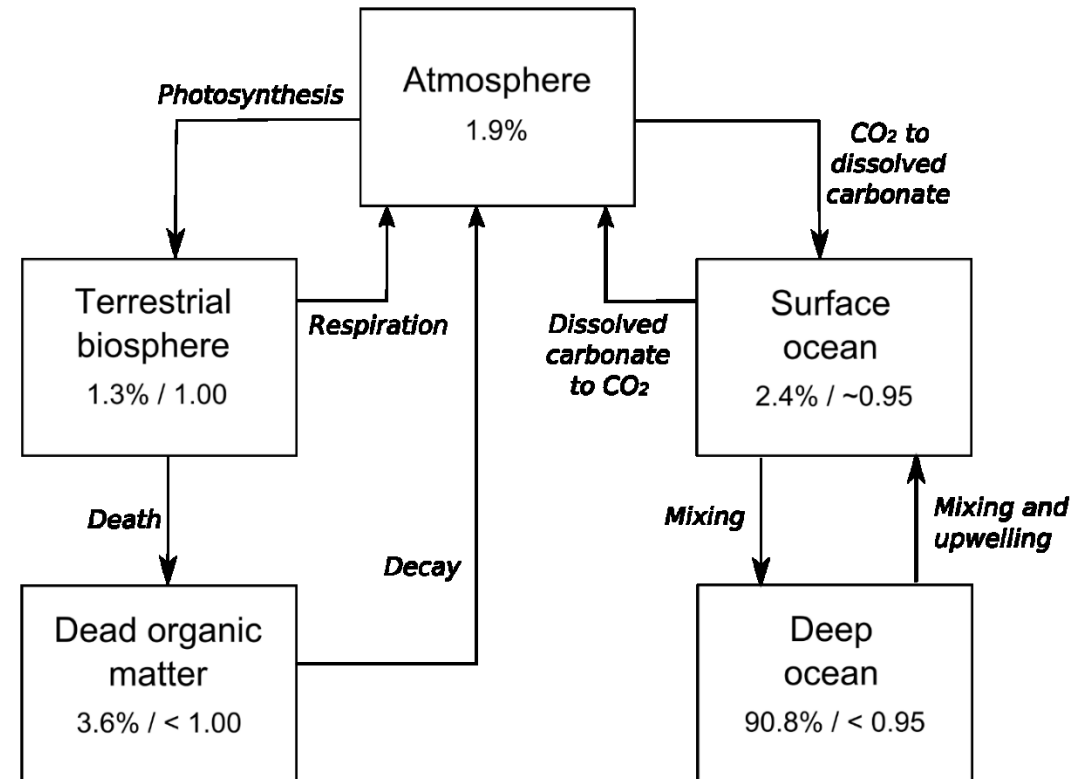
- dlouhověké dřeviny
- lidské pozůstatky
- lastury



# Rezervoárový efekt



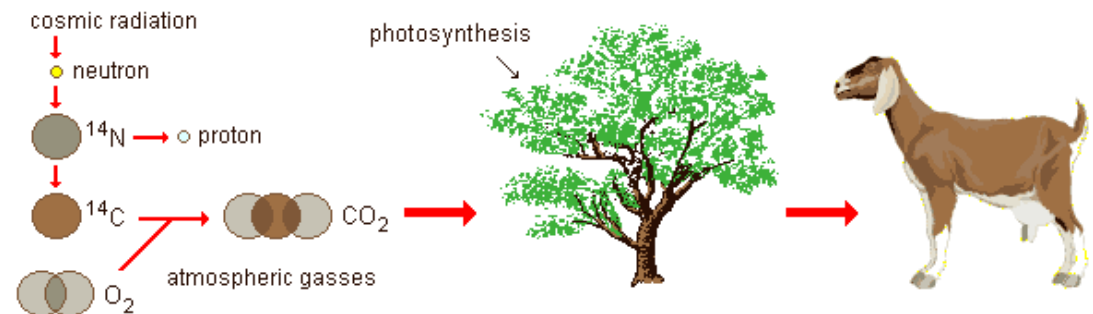
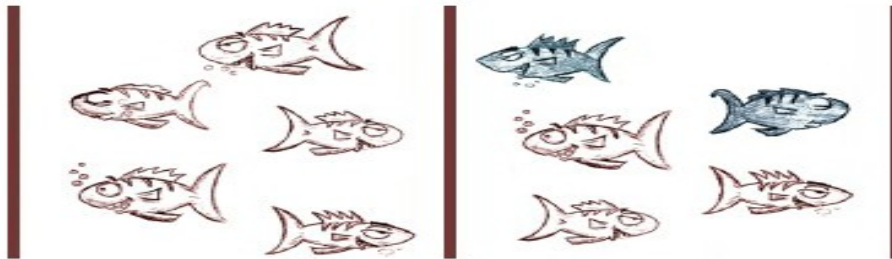
## Carbon exchange reservoirs (simplified)

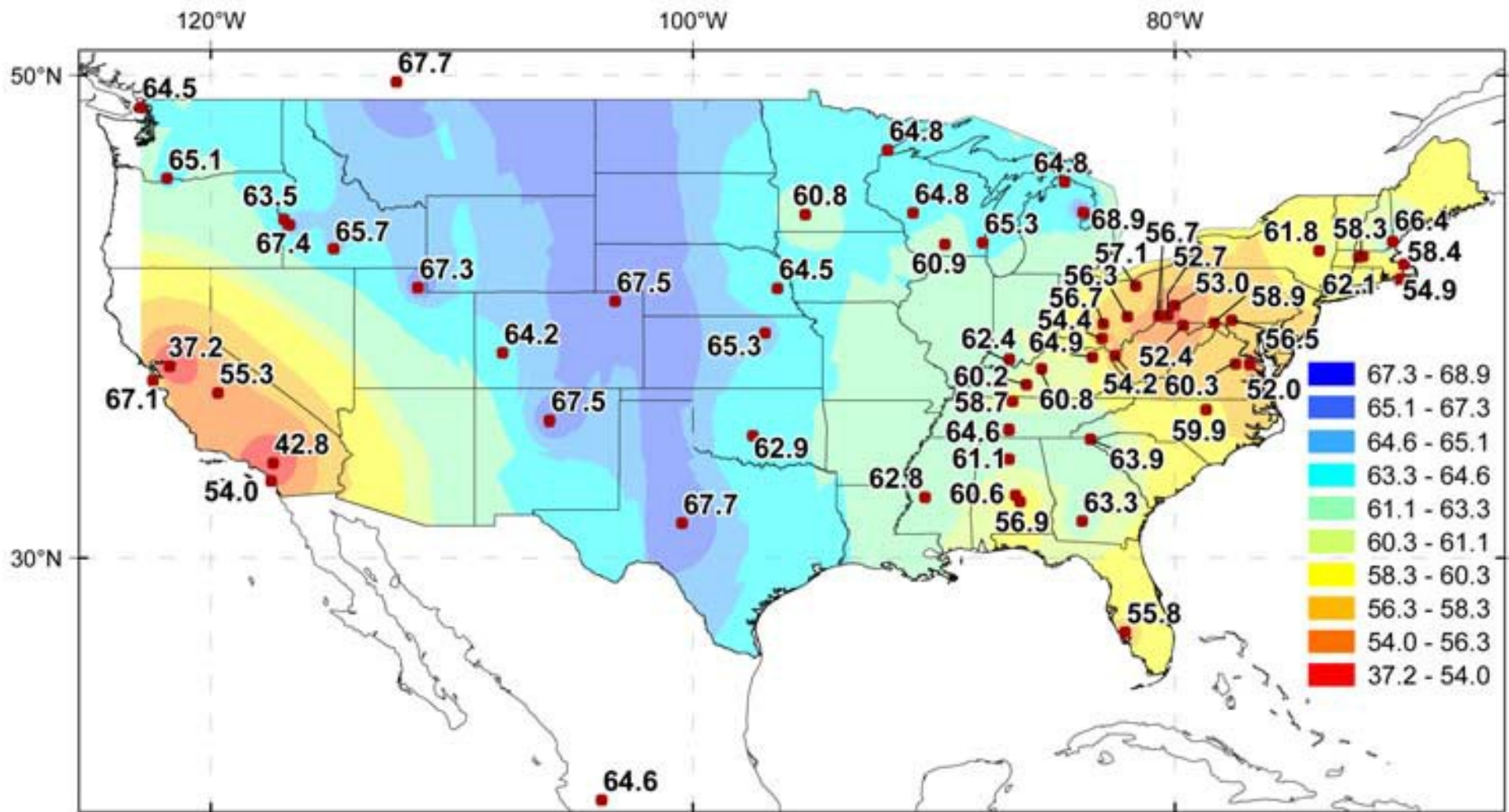


Percentages show the fraction of the total carbon reservoir of each type. Numbers after slash show ratio of  $^{14}\text{C}$  to  $^{12}\text{C}$  as fraction of atmospheric ratio.

# Fosilní paliva

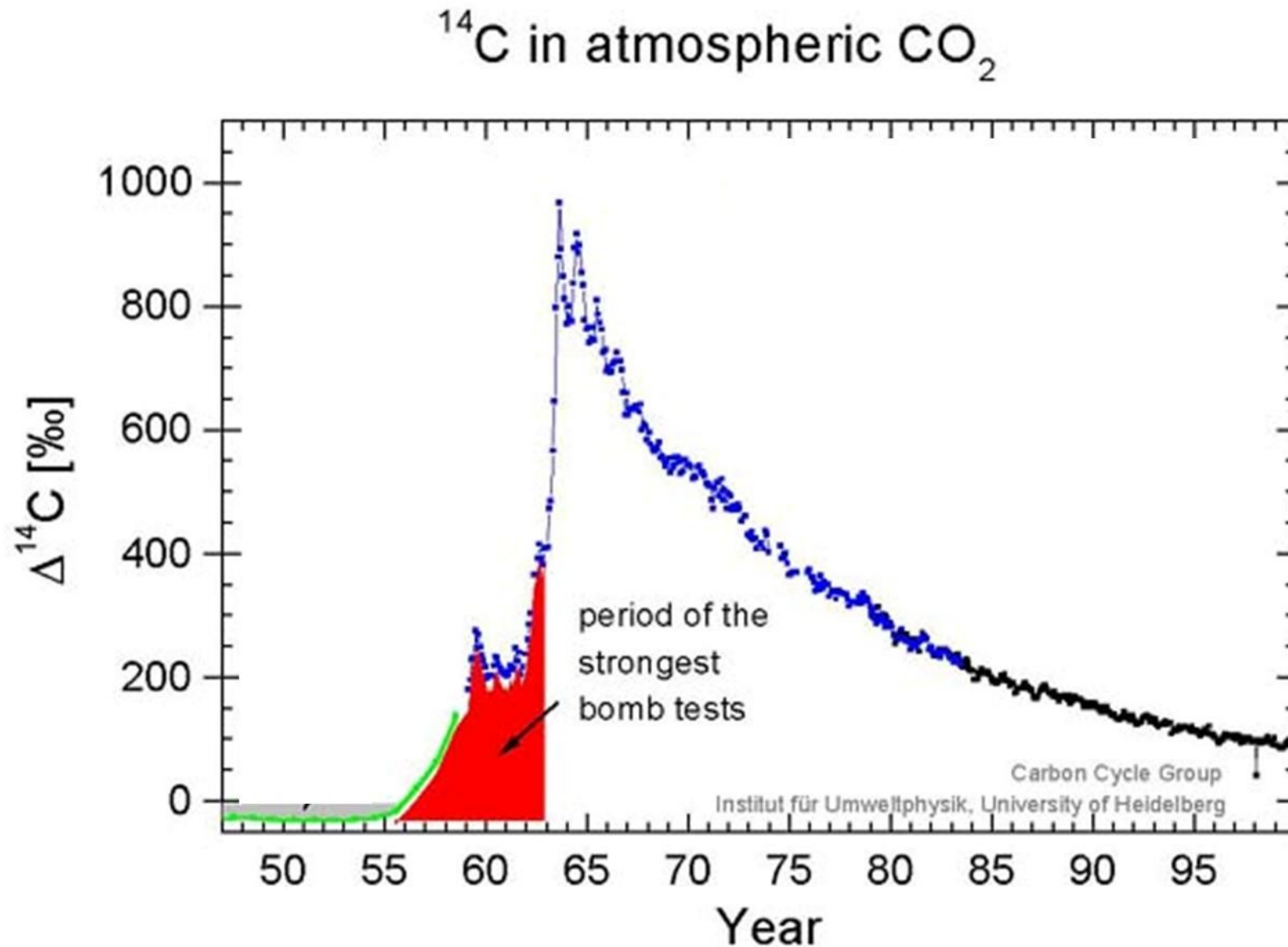
Fosilní paliva neobsahují žádný radiouhlík, exhalacemi CO<sub>2</sub> z jejich spalování dochází ke snižování relativního zastoupení radiouhlíku v atmosféře a vegetaci.





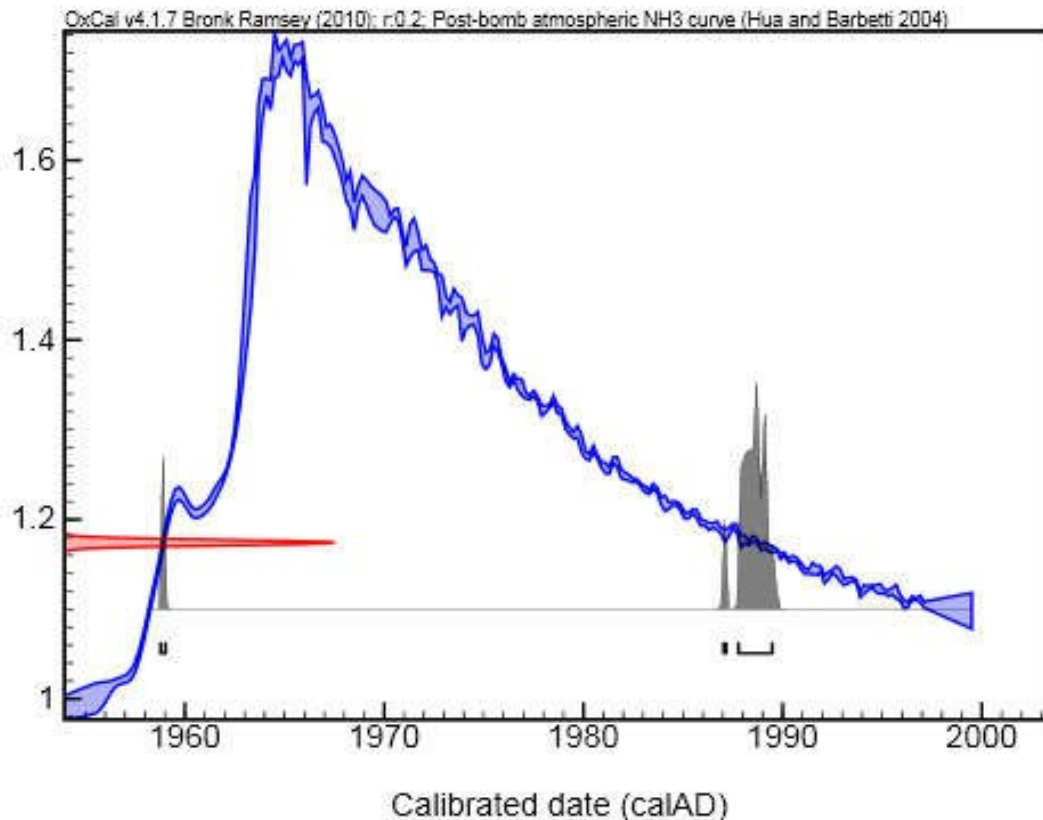
D14C measurements of corn (*Zea mays*) across North America during the summer of 2004 (in units of %). During this period, a decrease of 2.8% corresponded to approximately 1 ppm of added fossil fuel CO<sub>2</sub>.

# Bomb peak (bomb spike)





# Bomb peak (Bomb spike)



Geschlecht	Alter in Jahren <sup>a</sup>	% C-14 über dem Rezentwert		Quotient $\text{CO}_3^{2-}$ /Kollagen
		im $\text{CO}_3^{2-}$	im Kollagen	
w	20	$40,5 \pm 1,2$	$31,8 \pm 0,6$	1,3
gleiche Pers. andere Probe	20	$39,5 \pm 1,2$	$26,8 \pm 0,6$	1,5
w	30	—	$17,3 \pm 0,6$	—
m	61	$22,6 \pm 1,3$	$11,8 \pm 0,5$	1,9
m	65	$21,0 \pm 0,7$	$6,6 \pm 0,4$	3,2
w	65	$27,6 \pm 1,7$	$15,3 \pm 0,6$	1,8
w	65	$31,0 \pm 1,6$	$18,4 \pm 0,6$	1,7
m	69	$27,1 \pm 0,9$	$10,7 \pm 0,4$	2,5
w	70	$28,6 \pm 0,8$	$14,2 \pm 0,6$	2,0
w	75	$29,4 \pm 2,0$	$23,6 \pm 0,4$	1,2
m	79	$19,0 \pm 1,0$	$8,0 \pm 0,6$	2,4
Mittelwert f. Alter	60—80 a	$25,6 \pm 1,7$	$13,6 \pm 2,0$	$2,1 \pm 0,2$

<sup>a</sup> Beim Tod im September bis Oktober 1967.

# Ludwig Cave (Namibia)

Material	Laboratory ID	Fractionation-corrected pMC	$\delta^{13}\text{C}$ (‰ PDB)
Bone collagen	UGAMS-0022	$130.9 \pm 0.4$	$-19.5 \pm 0.1$
Bone collagen	UGAMS-0022B	$132.1 \pm 0.7$	$-19.5 \pm 0.1$
Tendon	UGAMS-0112	$136.4 \pm 0.7$	$-19.4 \pm 0.1$
Skin	UGAMS-132	$135.1 \pm 0.7$	$-19.6 \pm 0.1$

Table 2. Percentage of modern carbon in bone, tendon, and skin from a mummified adult female baboon in Ludwig Cave, Namibia

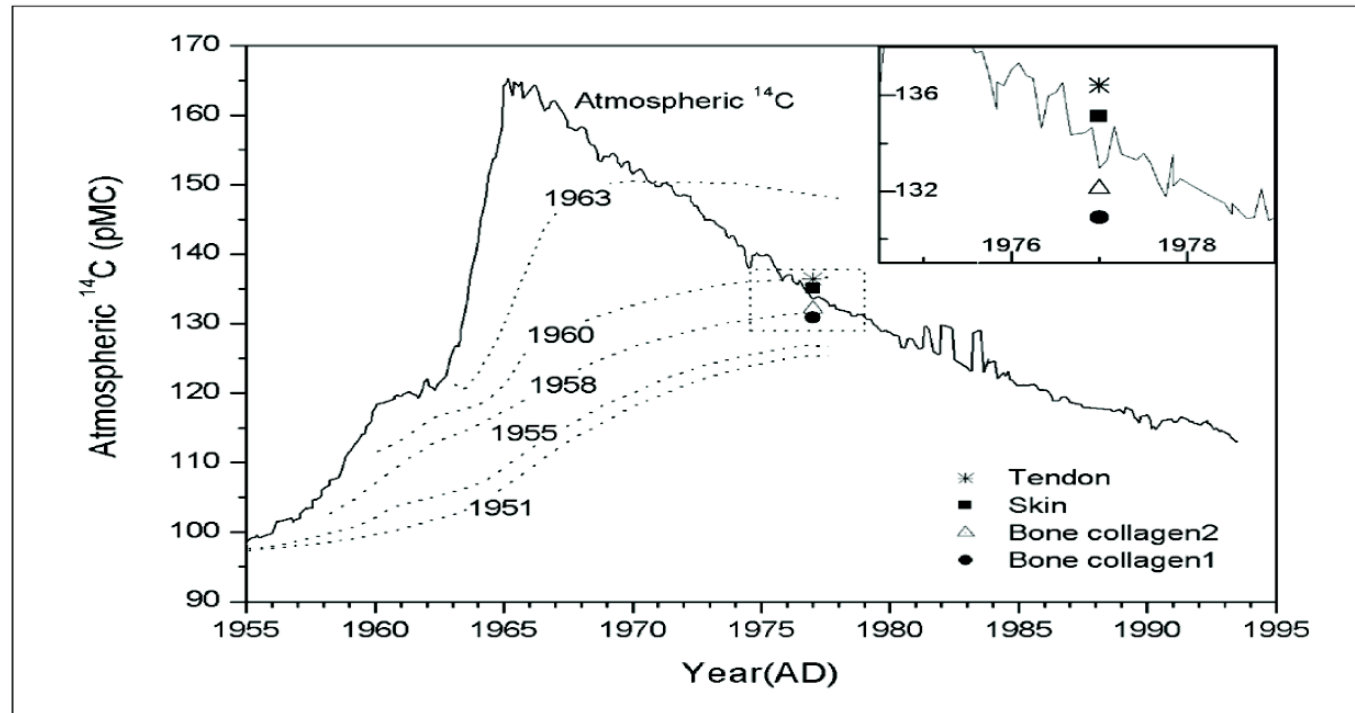
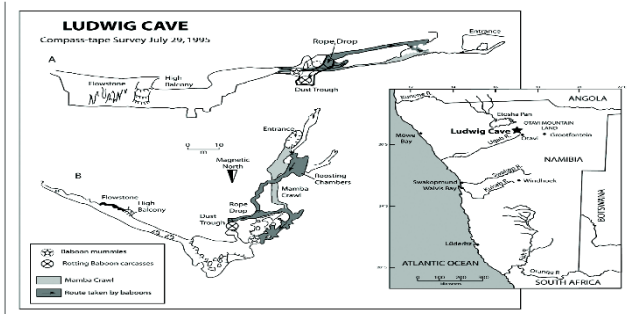
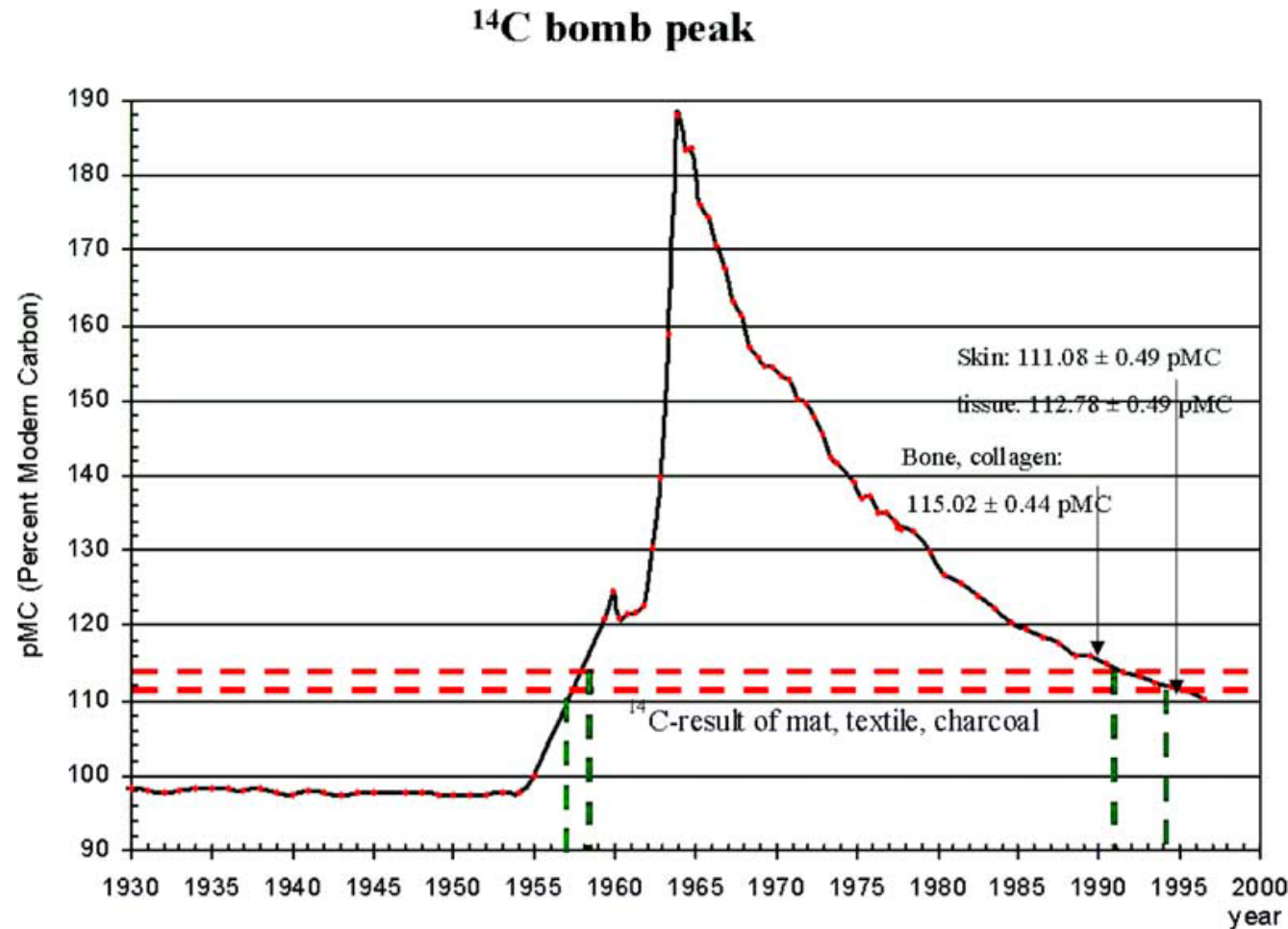


Fig. 3. Modeling changes in bone collagen radiocarbon content for different birth years based on atmospheric  $^{14}\text{C}$  levels for the Southern Hemisphere 1955-1994. The  $^{14}\text{C}$  data have been plotted as a 3 point running average of measurements made in Wellington, New Zealand and published in Manning et al. 1990, and Manning & Melhuish 1994. The bone, tendon, and skin  $^{14}\text{C}$  measurements are plotted on the curve. The Y error bars are contained within the symbols used. Models assume that the adult female baboon died in 1977. The best model suggests that the baboon was born in 1958, indicating an age at death of 19 years.

# Perská mumie



Konfiskována 2000 na černém trhu, podle nápisů by se mělo jednat o Ruduunu, dceru krále Xerxa (518-465 BC).



Jedinec zemřel AD 1994–1996, mumie je podvrh.

Table 1 Summary of the selected samples.

	Sample ID	Sample	Analyzed fraction
Male, 36 y 1973-2010	S1	Head hair	Hair keratin
	S2	Mandibular right canine	Dental enamel
	S3	Mandibular right second molar	Dental enamel
	S4	Pubic symphysis	Trabecular bone
	S5	Base of skull	Cortical bone

Table 2 Results of AMS  $^{14}\text{C}$  dating analyses.

Sample ID	Fraction modern ( $\pm 1\sigma$ )	Calibrated ages ( $1\sigma$ ranges)	Dates yr AD ( $1\sigma$ )
S1	$1.0493 \pm 0.0056$	2007–2011	$2009.0 \pm 2.0$
S2	$1.3632 \pm 0.0079$	1975.4 (May)–1976.7 (Sep)	$1976.0 \pm 0.7$
S3	$1.3182 \pm 0.0063$	1977.9 (Nov)–1979.3 (Apr)	$1978.6 \pm 0.7$
S4	$1.0674 \pm 0.0044$	2003 (Jan)–2006.7 (Sep)	$2004.9 \pm 1.9$
S5	$1.1463 \pm 0.0044$	1990.5 (Jun)–1992.8 (Oct)	$1991.6 \pm 1.1$

Summary of the first radiocarbon results from collagen fractions extracted from human bone (30-year old man, deceased in 1995) with the soft chemical method displayed in Fig. 2

Sample name	Sample preparation method	$\delta^{13}\text{C}^a$ (‰)	$^{14}\text{C}$ content <sup>a</sup> (pMC)	Calibrated age <sup>b</sup> (AD)
A	Collagen (insoluble fraction after EDTA treatment of bone powder)	$-22.3 \pm 0.7$	$126.2 \pm 1.0$	1958–1962 (0.23) 1980–1983 (0.77)
B	Insoluble collagen after pepsin digestion of sample A	$-22.8 \pm 0.7^c$	$123.3 \pm 0.6^c$	1958–1961 (0.51) 1982–1984 (0.49)
C	Soluble collagen fraction after pepsin digestion of sample A	$-22.2 \pm 1.5$	$125.1 \pm 1.1$	1958–1962 (0.36) 1980–1984 (0.64)
D	Collagen (method used in radiocarbon dating for the production of gelatin)	$-16.1 \pm 3.8$	$141.12 \pm 1.20$	1962 (0.04) 1973–1975 (0.96)
E	Long bone, lipid fraction	$-22.0 \pm 0.9$	$113.73 \pm 0.55$	1957–1958 (0.07) 1990–1994 (0.93)



	Raw $^{14}\text{C}$ data		Calibrated results (calendar year)				Police Invest.
	Lens	Nail	Lens	Nail	Span	Combined	
Baby #1	1.054(5)	1.078(4)	2006	2000–2004	2000	2003–2007	2004
Baby #2	1.165(5)	1.186(4)	1988–1990	1985–1988	1985–1990	1986–1988	1988
Baby #3	1.185(4)	1.194(4)	1986–1988	1985–1987	1985–1989	1985–1987	n.d.

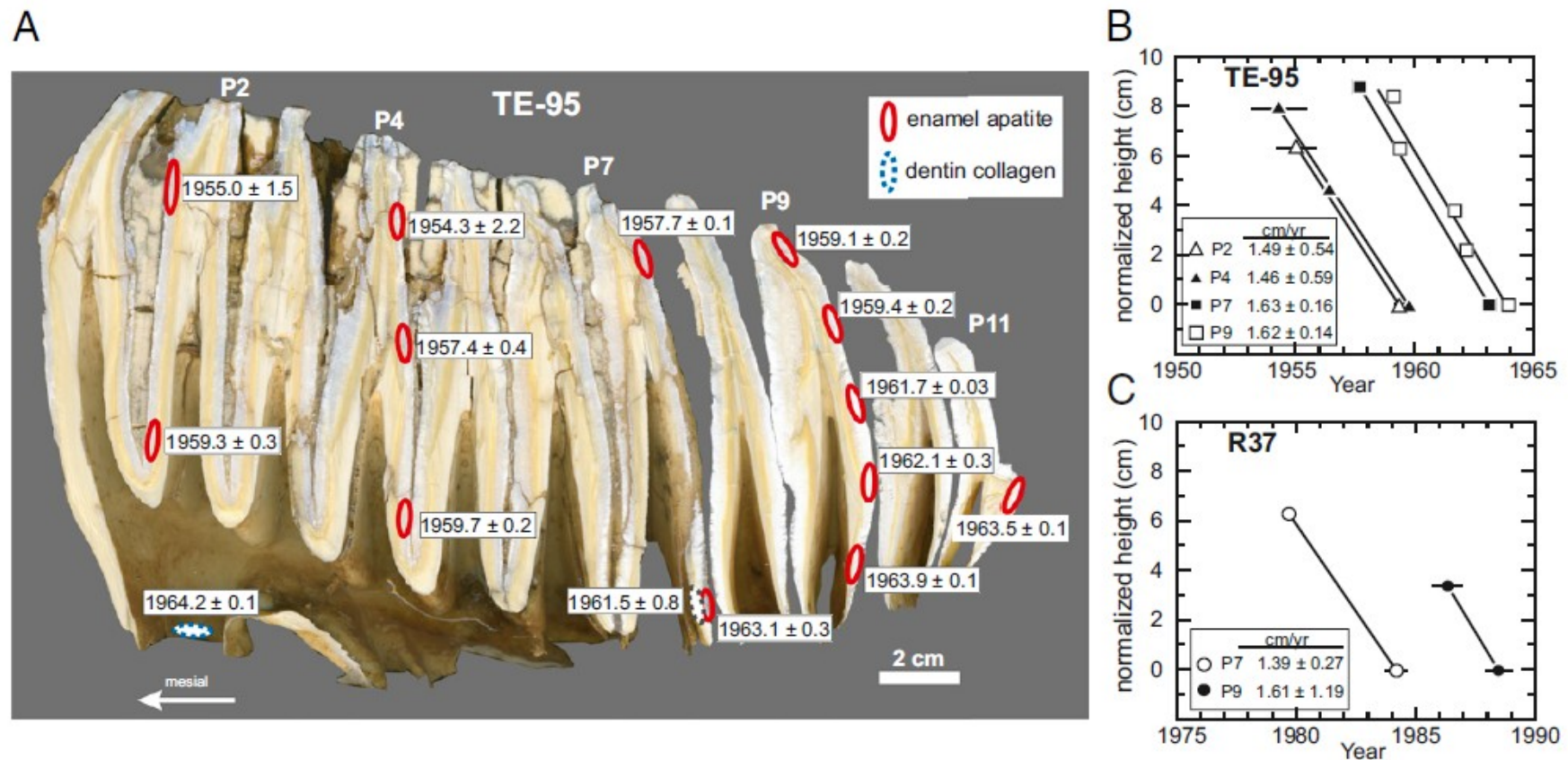
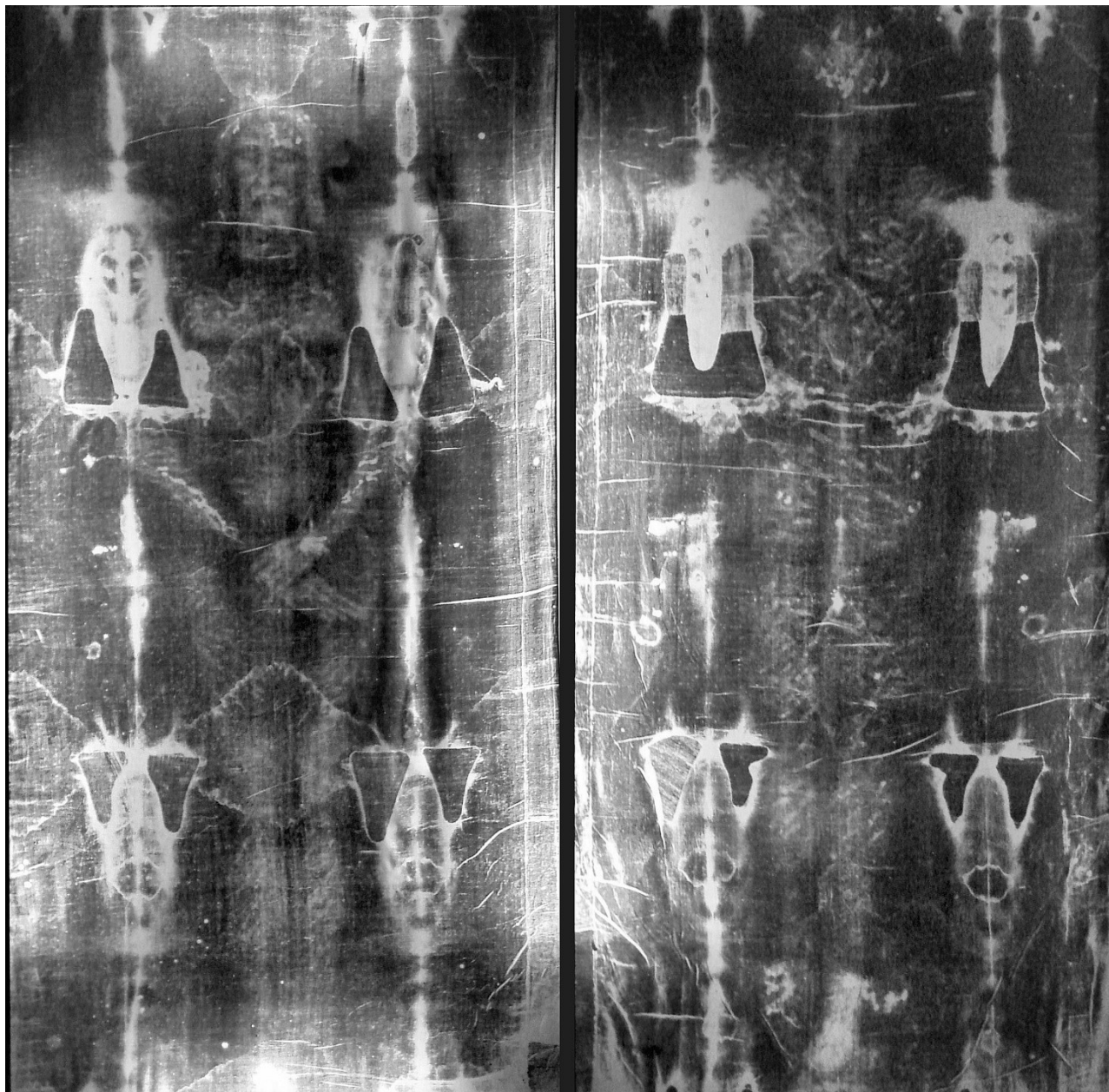


Fig. 3. (A) Longitudinally cut elephant molar (m3) from individual TE-95 showing calibrated  $^{14}\text{C}$  ages ( $\pm 2\sigma$ ) for 13 enamel apatite and 2 dentin collagen samples. Sample locations are outlined as ellipses. The molar consists of 11 enamel-covered plates (P1 to P11). (B) Vertical growth rates from four TE-95 molar plates shown in A are calculated from  $^{14}\text{C}$  ages. (C) Vertical growth rates in two molar plates from a lower third molar belonging to R37 (see text). Growth rates ( $\pm 2\sigma$ ) are calculated from slopes; height along a plate is normalized to the lowest sample location. Age uncertainty is  $2\sigma$  and if not shown is smaller than the symbol.

# Turínské plátno

Datování pomocí  
radiouhlíku problematické



# Fluorový test

Určení relativního stáří fosilních a subfosilních kostí n základě obsahu fluoru, jehož obsah se se stářím kostí zvyšuje.

Table 1. Fluorine contents of bones from various geological ages (Carnot)

	F (%)
Recent	< 0.3
Pleistocene	1.5
Tertiary	2.3
Mesozoic	3.4
Palaeozoic	3.7

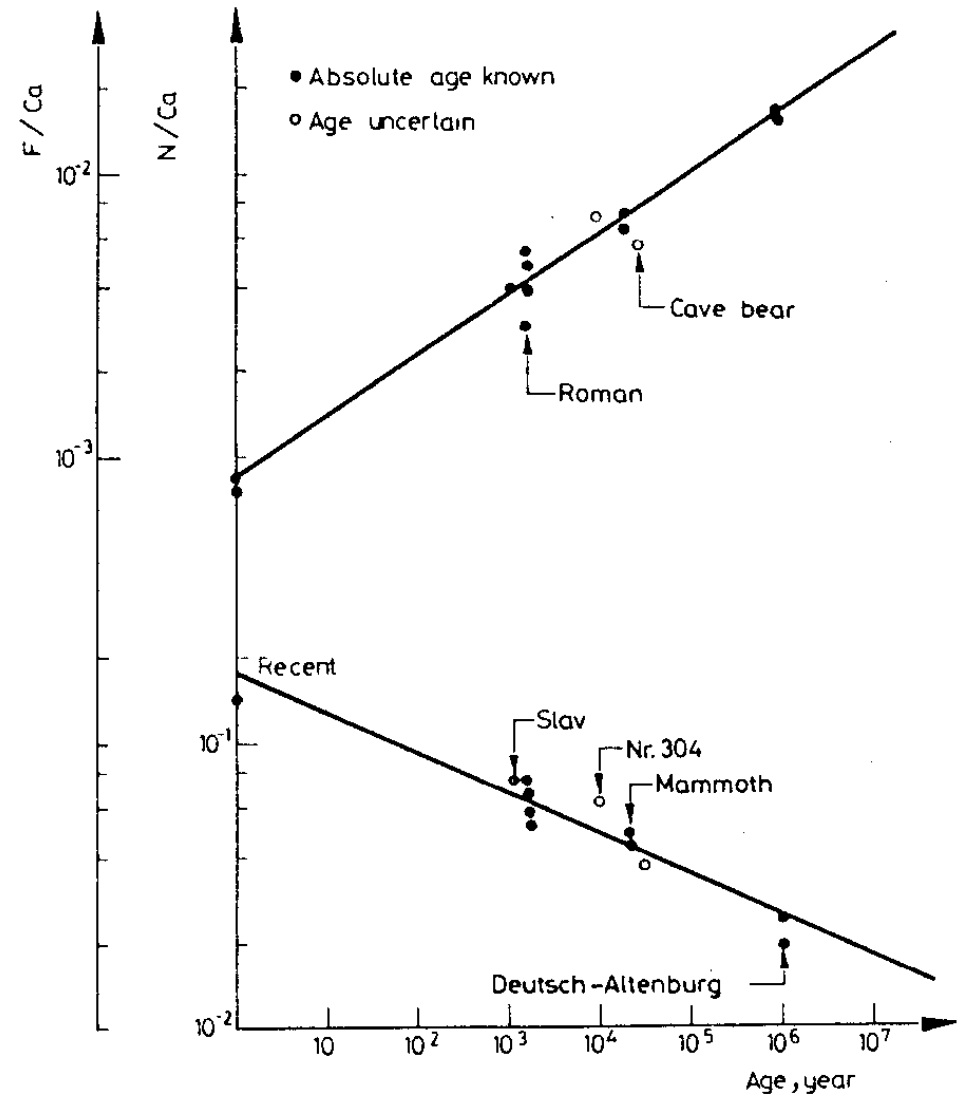


Fig. 3. Dependence of F/Ca and N/Ca-ratios on age



# Gánovce

Nález přirozeného travertinového vylitku mozku neandertálce.

Obsah fluoru může být ovlivněn prostředím – termálním pramenem.



$$\text{Index} = C_F / C_{PO4}$$

Fluorindex der Knochen in Gánovce-Profilen, streng stratifiziert

Alter	Kuppenrand und Schlamm im Liegenden	Kraterrand „Krater“	Kraterausfüllung
Holozän (Bronze)			Menschenschädel I 5,9 Menschenschädel II 6,1
W 2			Ren 9,0
W 1–2		Ceratus-Fauna 7,1	
W 1	Profil EF 4,6		
RW	Profil EF 4,6	Tier-Langknochen 9,0 Hominoide Langknochen 10,0 Menschen-Schädel 12,6 Tier-Wirbel 16,3	
R 3 ?	Schlamm im Liegenden 9,6 9,8		

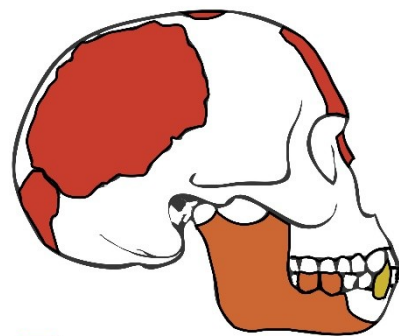
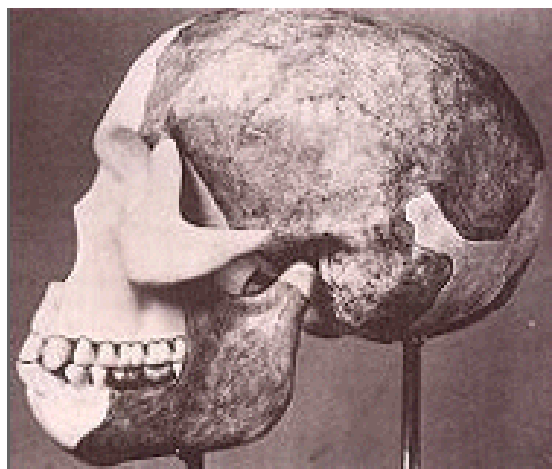
Durch den ziemlich hohen Fluorindex 12,6 der Menschen-Calva von Gánovce wird dieser Fund eindeutig in das Travertingestein der zweiten Hälfte des letzten Interglazials eingereiht.



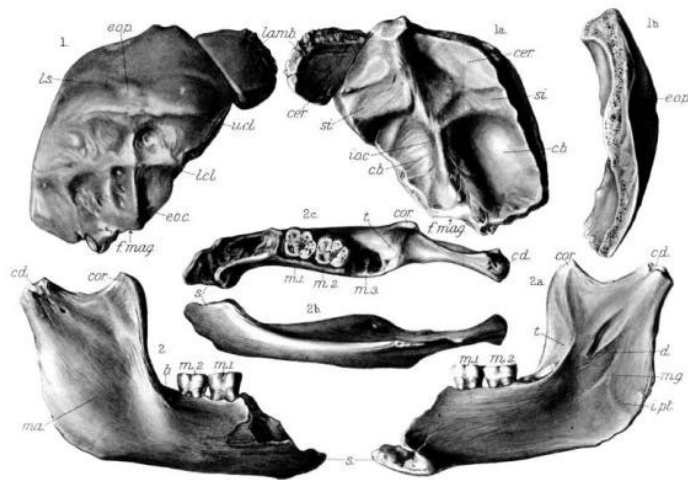


# Eoanthropus dawsoni

Fosilní pozůstatky, objevené v Anglii v roce 1910–12, později odhaleny jako padělek.



■ Skull Bones  
■ Mandible and Two Molar Teeth  
■ Canine Teeth (from "hard de Chardin")



## ANALYSES OF FOSSIL MATERIALS FROM PILTDOWN

	Fluorine %	P <sub>2</sub> O <sub>5</sub> %	%F / %P <sub>2</sub> O <sub>5</sub> × 100	Iron %
<b>Eoanthropus I</b>				
P.1 L. parieto-frontal (E.590)†	0.1 (2)*	21	0.5	7
P.2 L. temporal (E.591)	0.4	18	2.2	7
P.3 R. parietal (E.592)	0.3	17	1.8	6
P.4 Occipital (E.593)	0.2	28	0.7	5
P.5 R. mandibular ramus (E.594)	0.2 (5)	20	1.0	6
P.17 Canine (E.611)	<0.1	27	0.4	Trace
P.42 Molar (m <sub>1</sub> ) (E.594)	<0.1	23	0.4	Trace
<b>Eoanthropus II</b>				
P.30 R. frontal (E.646)	0.1	13	0.8	12
P.31 Occipital (E.647)	0.1 (2)	17	0.6	17
P.32 Molar (m <sub>1</sub> ) (E.648)	0.4 (2)	30	1.3	Trace
<b>Other Mammalian Remains</b>				
<b>LOWER PLEISTOCENE</b>				
P.6 Molar, <i>Mastodon cf. arvernensis</i> (E.595)	1.9	23	8.3	5
P.7 Molar, <i>Elephas cf. planifrons</i> (E.596)	2.7 (2)	33	8.2	3
P.8 Molar, <i>Elephas cf. planifrons</i> (E.597)	2.5	34	7.4	1
P.23 Molar, <i>Elephas cf. planifrons</i> (E.620)	3.1	39	7.9	4
P.25 Molar, <i>Mastodon arvernensis</i> (E.622)	2.3	36	6.4	4
P.26 Premolar, <i>Rhinoceros cf. etruscus</i> (E.623)	2.0	24	8.3	6
<b>POSSIBLY MIDDLE AND UPPER PLEISTOCENE</b>				
P.9 Molar, <i>Hippopotamus</i> sp. (E.598)	0.1 (3)	37	0.3	3
P.10 Premolar, <i>Hippopotamus</i> sp. (E.599)	1.1 (3)	29	3.8	5
P.11 Antler, <i>Cervus elaphus</i> (E.600)	1.5 (3)	28	5.4	3
P.12 Metatarsal, <i>Cervus</i> sp. (E.601)	0.1	27	0.4	4
P.13 Molar, <i>Equus</i> sp. (E.602)	0.4 (3)	25	1.6	2
P.14 Molar, <i>Castor fiber</i> (E.603)	0.4	30	1.3	3
P.18 Femur, <i>Elephas cf. antiquus</i> (E.615)	1.3 (3)	30	4.3	2
P.19 Indet. bone from basal clay (E.616)	1.4	33	4.2	1
P.21 Incisor, <i>Castor fiber</i> (E.618)	0.1	27	0.4	10
P.22 Mandible, <i>Castor fiber</i> (E.619)	0.3	18	1.7	6
P.24 Fragment of enamel, <i>Elephas</i> sp. indet. (E.621)	0.8 (3)	36	2.2	1
<b>Holocene or Pleistocene</b>				
P.36 Tibia, <i>Cervus</i> sp. (E.1383)	<0.1	35	0.3	1
P.37 Caprine molar (E.1384)	0.3 (3)	22	1.4	2
P.39 Bovine long-bone (E.1385)	0.1 (3)	30	0.3	9
P.40 Indet. bone (sub-fossil) (E.1386)	0.1	30	0.3	Trace
P.41 Indet. bone (sub-fossil) (E.1387)	0.3	42	0.7	2
<b>Holocene (Recent)</b>				
P.33 Fragment of fresh bone from soil	<0.1	33	0.3	Trace
P.34 Pelvis, <i>Bos taurus</i>	<0.1	24	0.4	4
P.35 Metatarsal, <i>Bos taurus</i> (E.1388)	<0.1	27	0.4	2
P.38 Ungual phalange, <i>Bos taurus</i> (E.1389)	0.3	32	0.9	5

\* Where more than one determination of fluorine content has been made, indicated by the number in brackets, the value recorded is the average.

† The register numbers of specimens in the Department of Geology, British Museum (Nat. Hist.), are given in brackets after the description.

# Datování

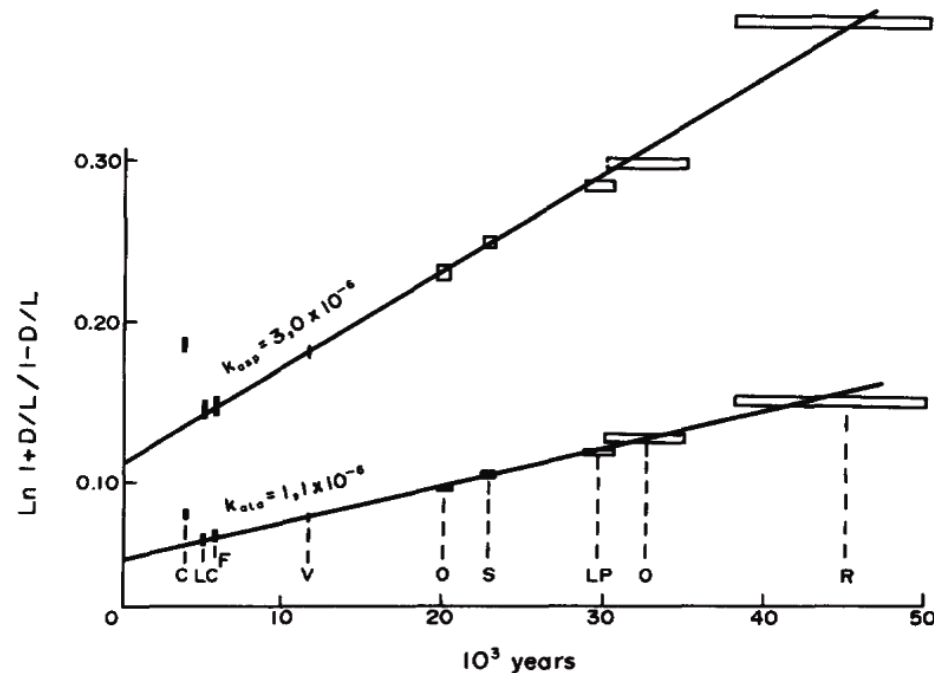
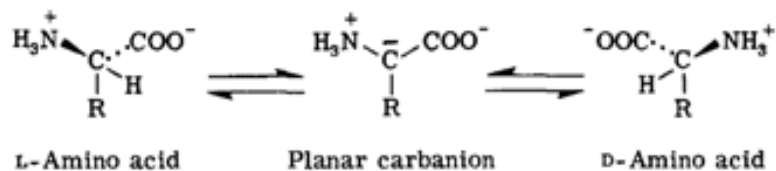


FIG. 2. Rate of racemization of Asp and Ala versus fossil bone age.  
 Legend: C = La Couronne      O = Oullins  
           LC = Les Cohons        S = Salpêtrière  
           F = Fontbrégoua      LP = Abri des Pêcheurs  
           V = Valorgues         R = Rigabe.

D/L ratios of amino acids from bone samples of the Yuha skeleton

Bone type	Valine	Alanine	Leucine	Proline	Aspartic acid	Phenylalanine	Glutamic acid	$\frac{D\text{-alloisoleucine}}{L \text{ isoleucine}}$
Clavicle (spongeosa) *	0.12	0.26	0.13	0.13	0.44	0.19	0.31	0.10
Metatarsal (spongeosa) *	0.08	0.26	0.09	0.14	0.41	0.12	0.32	0.07
Femur (compacta) *	0.12	0.28	0.16	0.12	0.52	0.17	0.34	n a
Femur (compacta) **	0.083	0.47	n a	0.076	0.56	n a	0.33	n a
Unclassified fragment (compacta) ***	0.09	0.35	0.15	0.21	0.54	0.20	0.35	—

\* Analyzed by K Kvenvolden and D Blunt, U S Geological Survey, Menlo Park, Ca

\*\* Analyzed by J Bada and E Hoopes, University of California, San Diego, Ca

\*\*\* Analyzed by E Peterson, Ames Research Center, Sunnyvale, Ca

# Určení věku

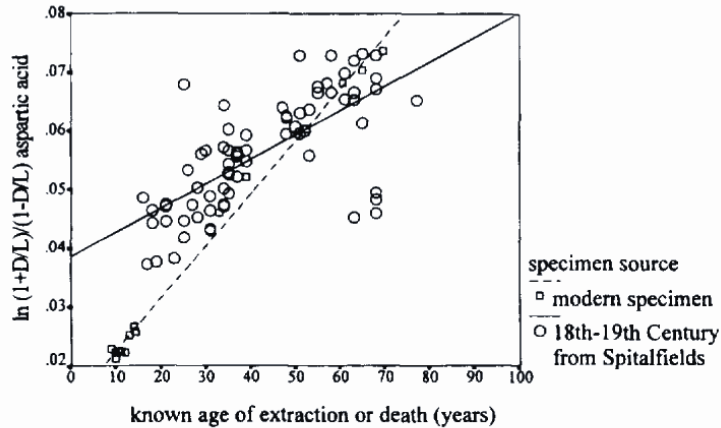


FIG. 5—Plot of  $\ln\{(1 + (D/L))/(1 - (D/L))\}$  aspartic acid with regression lines depicted for 18th C. specimens (Spitalfields) and modern specimens.

L-methionin nepodléhá racemizaci in vivo, lze ho použít jako vnitřní standard: poměr D-Asp/D-Met eliminuje efekt racemizace během přípravy vzorku.

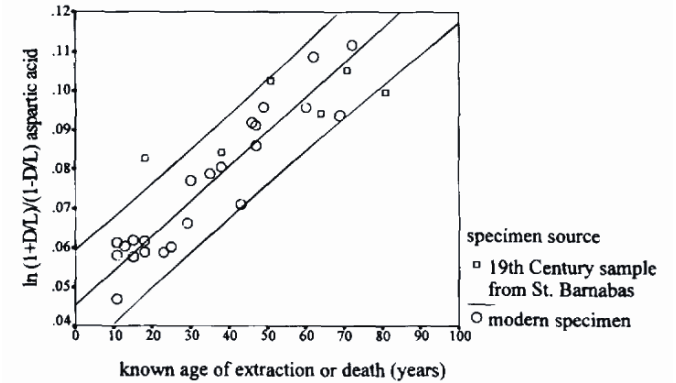


FIG. 1—Plot of  $\ln\{(1 + (D/L))/(1 - (D/L))\}$  aspartic acid against age with 95% confidence bands for St. Barnabas (19th C.) and modern dental samples.

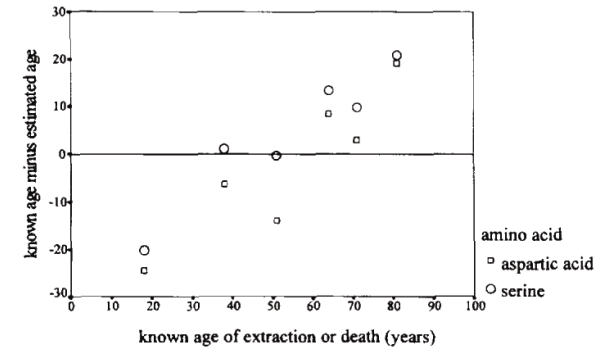


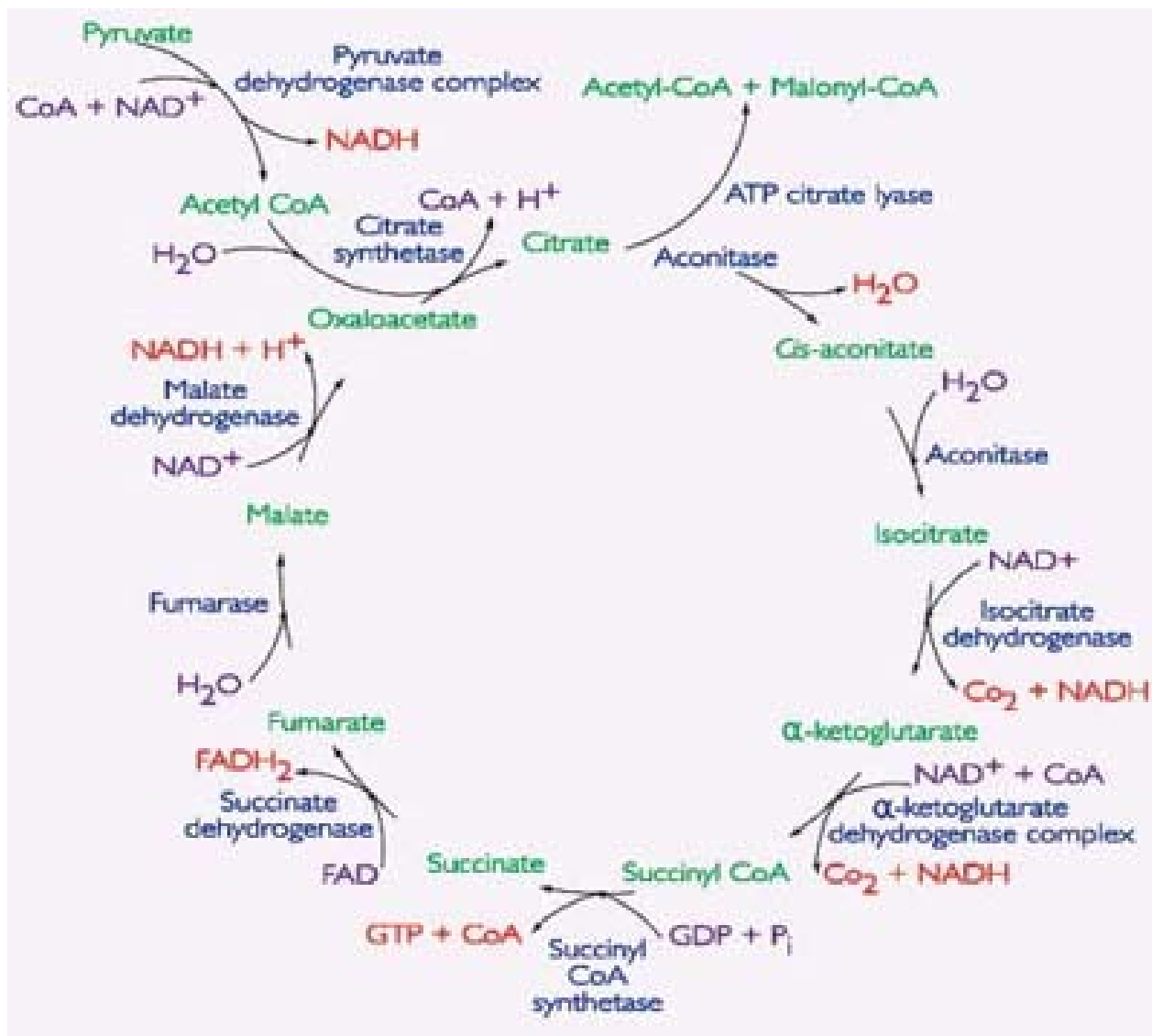
FIG. 4—Plot of known age against true error in estimated age for aspartic acid and serine for six 19th Century specimens. (Estimated age obtained by using the modern data as a calibration curve for the 19th C. samples. True error is difference between estimated age and known age).

Cca 1600 let stará (14C 370-390 ± 90 let) zmrzlá „mumie“ eskymácké ženy, nalezená 1972 na St. Lawrence Island (Aljaška). Morfologicky (atrofie prsou a vaječníků, otřetí zubů, choroba koronárních cév) byl věk odhadnut na 50-60 let. Analýza racemizace Asp v dentinu indikovala věk 53 ± 5 let. Mrtvola ležela ve věčně zmrzlé půdě, vliv postmortálních změn na racemizaci je minimální.





# Metabolismus kyseliny citronové



# Vazba citrátu v kosti

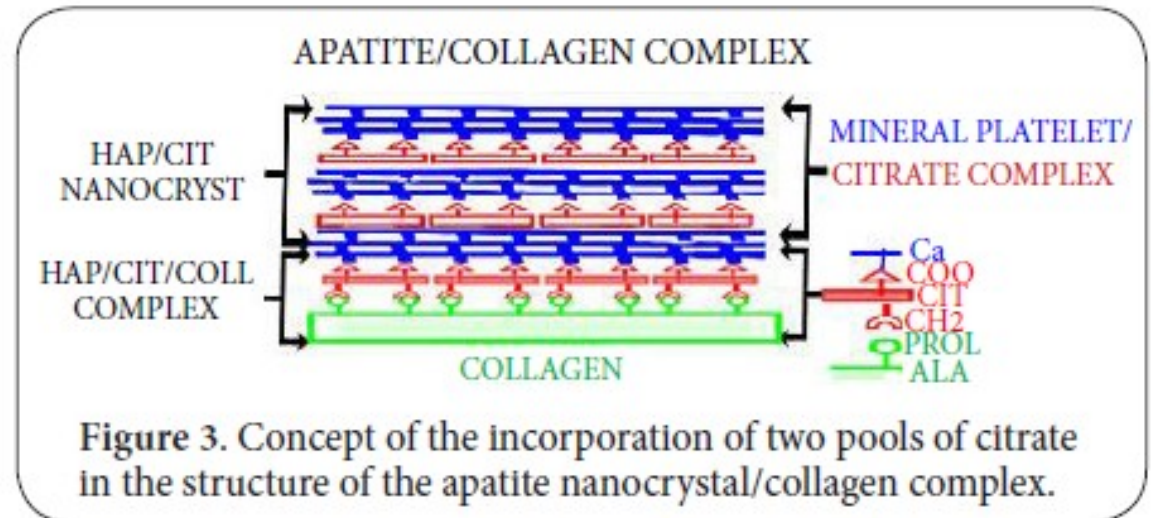
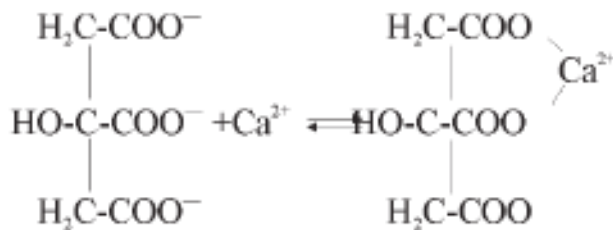
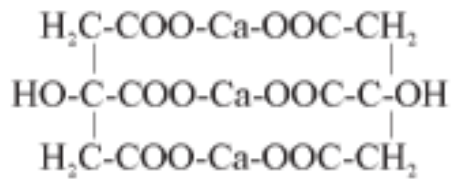
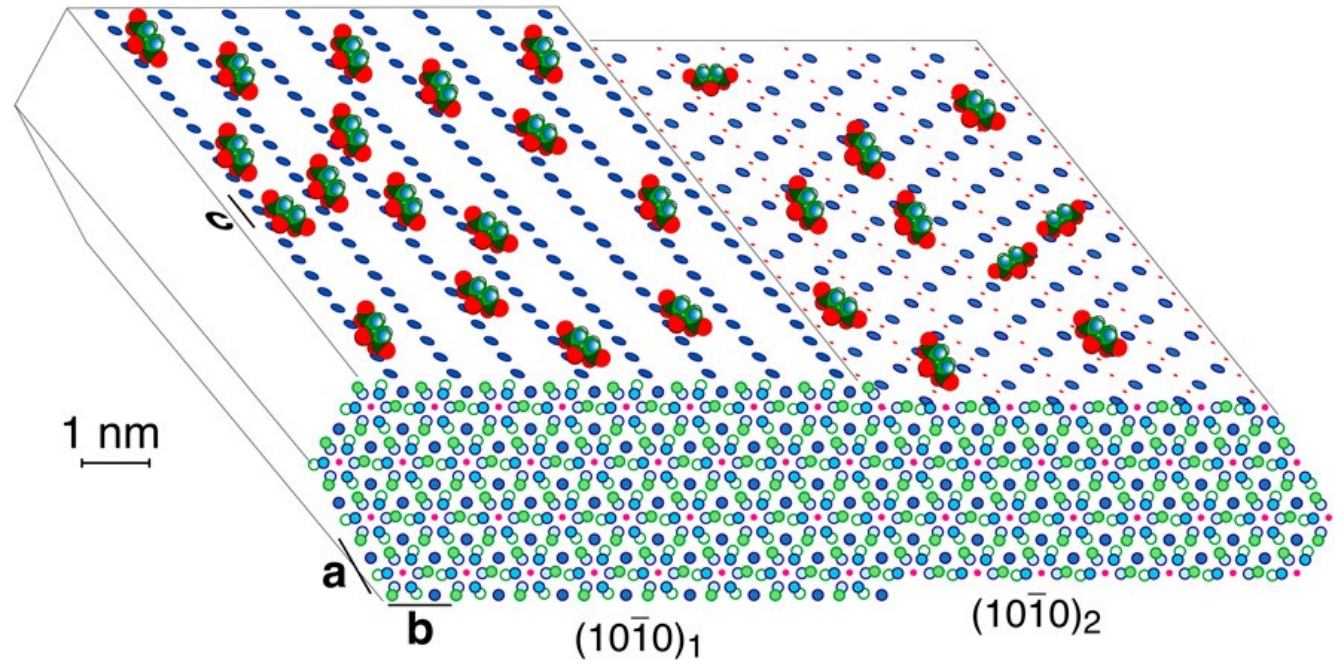


Figure 3. Concept of the incorporation of two pools of citrate in the structure of the apatite nanocrystal/collagen complex.

# Distribuce citrátu v tkáních

*Citrate content of teeth*

TYPE OF SAMPLE	MG. PER 100 GM. (CITRIC ACID EQUIVALENT)
Whole human teeth.....	680
Human dentin.....	800
Human enamel.....	90
Whole dog teeth.....	510
Dog dentin.....	540
Dog enamel.....	110

Table 1. Bone citrate average ash weight in grams percent (g %)

Animal	N	Citrate ash weight
Fish	2	1.68
Turtle	6	0.29
Frog	4	0.43
Polar Bear	1	2.05
Man	15	1.38
Elephant	1	1.35
Monkey	3	1.04
Cat	1	1.22
Horse	3	1.26
Dog	10	0.96
Cow	5	0.83
Guinea-pig	2	0.95
Rabbit	2	0.82
Rat	12	0.56
Chicken	4	1.09
Goose (feral)	2	0.61
Mean		1.03

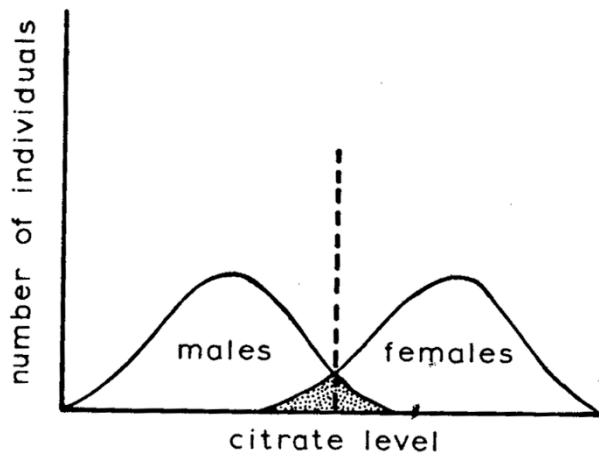
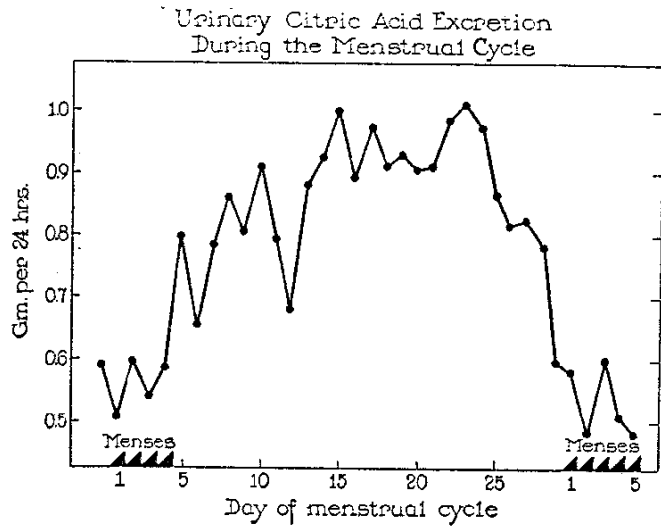
*Organic Acids in Beef, Dog, and Rabbit Bones, Egg Shells, and Rat Liver*  
The values are given in mg. per 100 gm.

Tissue	Type of bone	Organic acid in fresh tissue*				
		Fumaric	Succinic	Aconitic	Malic	Citric
Bone, beef	Cancellous	0.2	1.8	2.7	5.2	475
“ Dog A	Compact	0.2	2.7	3.6	6.6	852
“ “ B	Cancellous	0.2	3.0	3.3	3.9	609
“ “ B	Compact	0.1	1.7	3.8	5.0	966
“ Rabbit A	Cancellous	0.2		1.6	4.9	553
“ “ B	Compact	0.2	3.6	2.6	6.3	565
“ “ B	Cancellous	0.2	3.1	2.2	5.3	394
“ “ B	Compact	0.2	1.3	3.6	4.6	627
“ “ B	Cancellous	0.2	2.6	2.0	8.0	509
Egg shell A		0.0	0.0	0.0	2.9	66
“ “ B		0.0	0.0	0.0	0.8	11
Rat liver		0.5	2.5	0.1	1.6	3.3

Table 2. Bone citrate levels in the domestic chicken at different reproductive stages

Bone	Citrate ash weight (g %)				
<b>Low-citrate</b>					
Cervical vertebrae	1.90	2.09	1.76	2.00	1.70
Scapula	1.94	1.70	1.76	2.01	1.79
Coracoid	1.72	1.71	1.87	1.93	1.71
Humerus	1.57	1.53	1.46	1.72	1.36
Radius	1.69	1.55	1.55	1.72	1.87
Ulna	1.41	1.38	1.36	1.55	1.55
Carpometacarpus; phalanges	1.83	1.60	1.51	1.77	1.61
Femur	1.59	1.40	1.32	1.46	1.42
Tibiotarsus	1.61	1.43	1.47	1.67	1.59
Tarsometatarsus	2.02	1.75	1.65	2.10	1.81
<b>High-citrate</b>					
Skull	2.36	2.58	2.21	2.68	2.54
Ribs	2.51	2.28	2.22	2.49	1.96
Sternum	2.71	2.47	2.62	2.87	2.30
Pelvis	2.76	2.29	2.30	2.45	2.16
Foot phalanges	2.49	2.30	2.37	2.72	2.60
Mean	2.01	1.87	1.83	2.07	1.86

# Pohlavní rozdíly v obsahu citrátů



-Normal distribution curves of citrate levels (g.%) showing sexual separation.

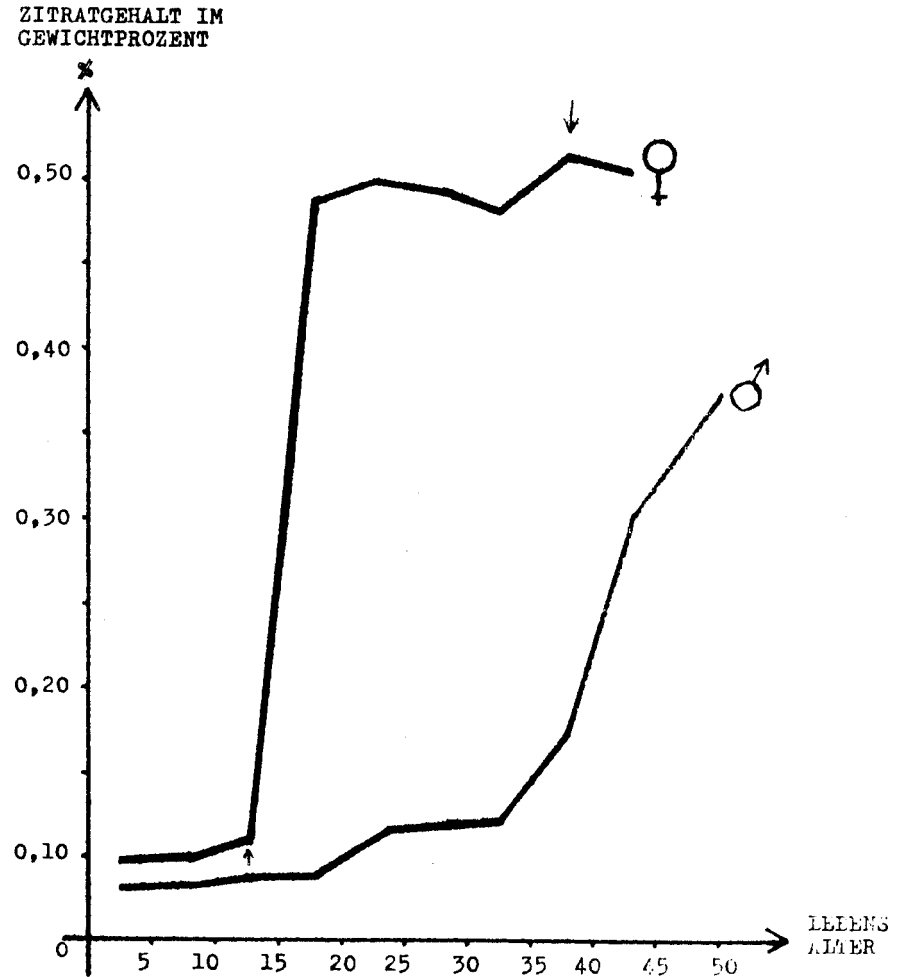


Abb. 2.

Änderungen des Zitratgehaltes vom Knochengewebe in der Verteilung nach Geschlechtes und Altersunterschieden.



# Vliv diagenese

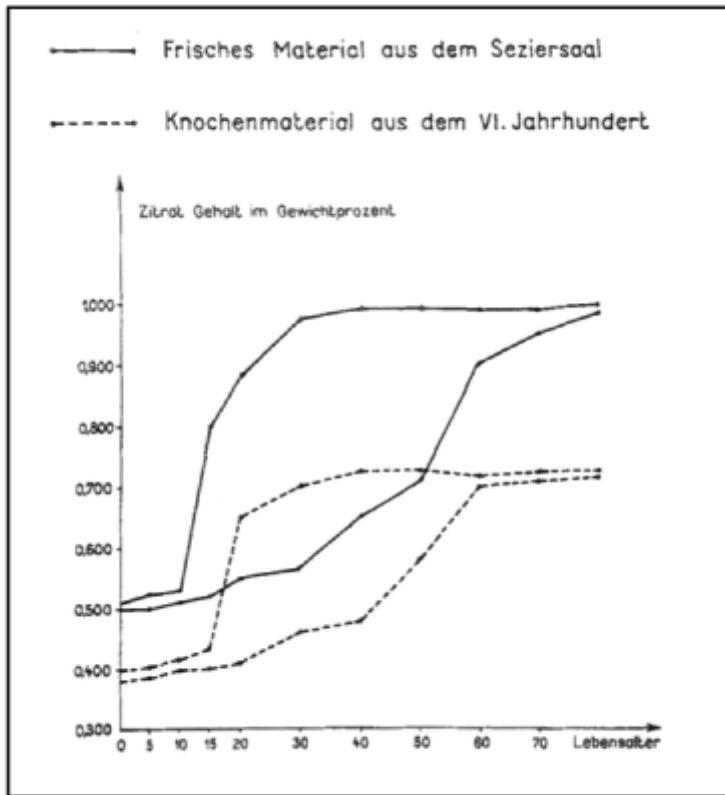


Abbildung 3: Veränderungen des Zitratgehaltes in Abhängigkeit von Geschlecht, Lebensalter und Liegezeit (aus LENGYEL 1972)

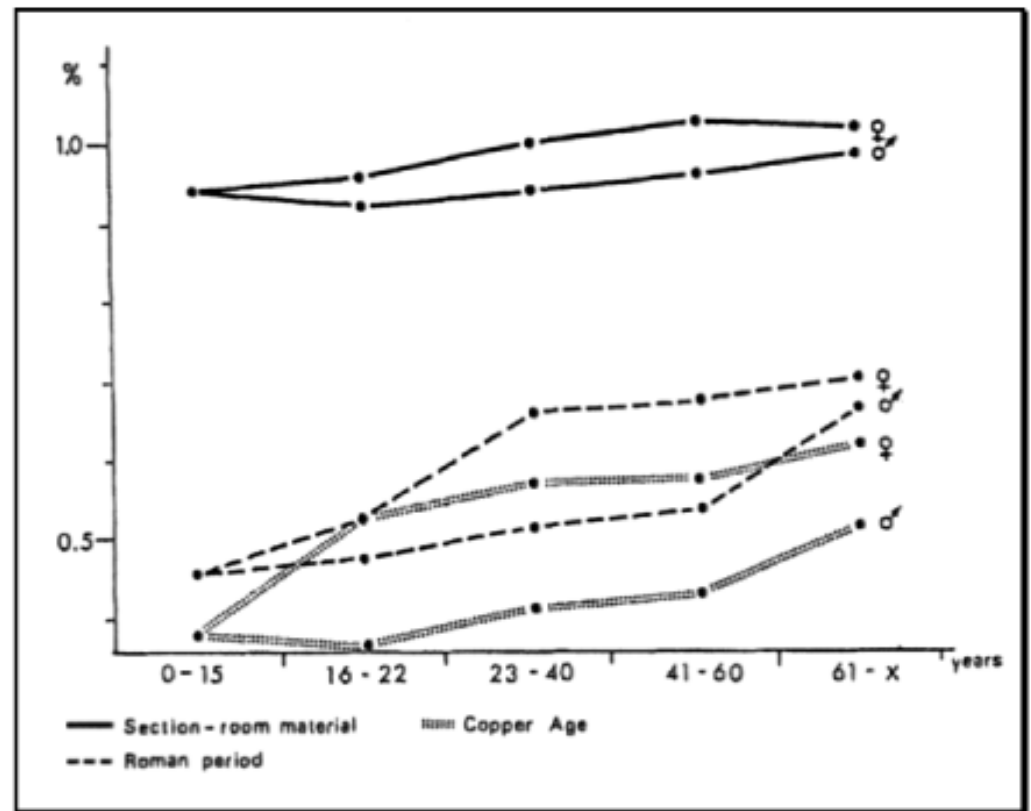


Abbildung 1: Veränderungen des Zitratgehaltes in Abhängigkeit von Geschlecht, Lebensalter, Herkunft und Liegezeit (aus LENGYEL, in BROTHWELL 1968)

Table 7. Citrate preservation in prehistoric mammoth preserved under various conditions compared to modern elephant values (g %)

	Modern elephant	Mammoth			
		In ice	Permafrost	Tar pit	Fossil
Citrate	1.35	0.05	1.43	0.05	0.03
Hydroxyproline	2.89	2.56	2.54	2.23	0.00



# Určení pohlaví spálených kosterních pozůstatků

Frisches Material	2. Jt. n. Chr.	Deutschland	0,52%	1,04%
Grödig	6./7. Jh. n. Chr.	Österreich	0,56%	0,86%
Pleidelsheim	5.-7. Jh. n. Chr.	Deutschland	0,42%	0,77%
Kamid el-Loz	5./4. Jh. n. Chr.	Libanon	0,33%	0,58%
Münster-Gittrup	ca. 1 Jt. v. Chr.	Deutschland	0,26%	0,53%
Trebur-Hinkelstein	5. Jt. v. Chr.	Deutschland	0,21%	0,40%
Trebur-Großgartach	5. Jt. v. Chr.	Deutschland	0,24%	0,42%

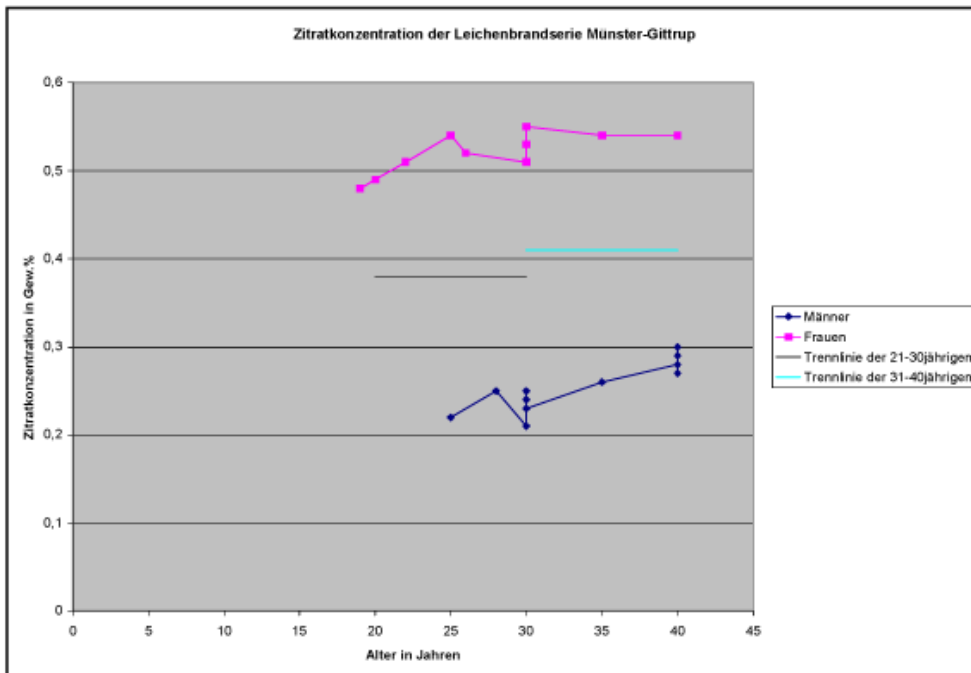


Abbildung 26: Zitratkonzentration des Knochenmaterials der Leichenbrandserie Münster-Gittrup in Abhängigkeit von Lebensalter und Geschlecht

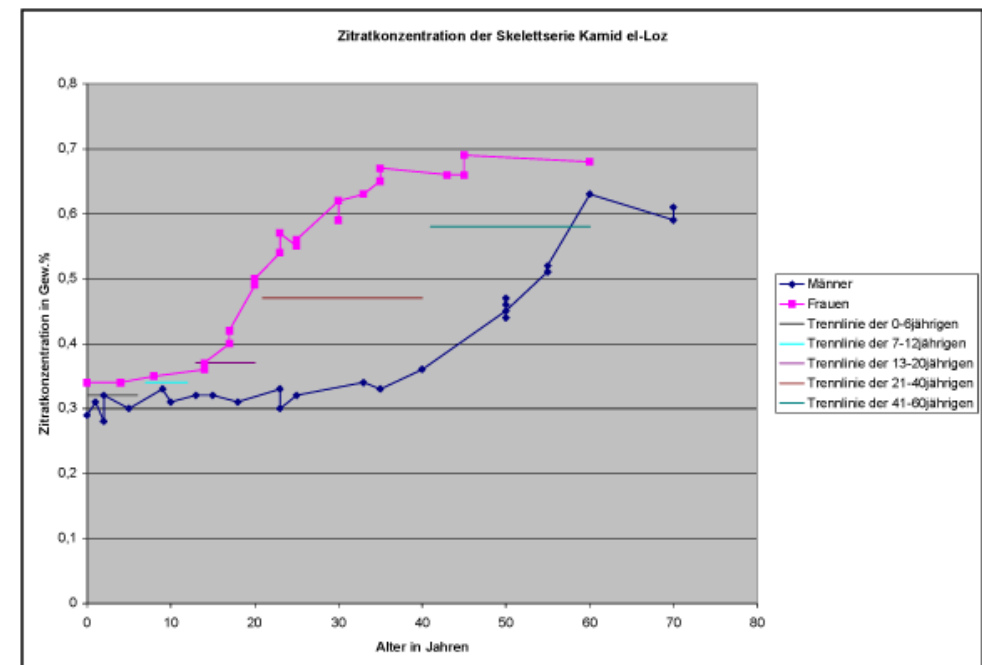


Abbildung 25: Zitratkonzentration des Knochenmaterials der Skelettserie Kamid el-Loz in Abhängigkeit von Lebensalter und Geschlecht

Porównanie wyników określenia płci i wieku szczątków ciała palnych metodą morfologiczną i biochemiczną

Lp.	Stopień spalenia kości	Nr grobu	Całkowita ilość materiału	Kompleks białkowo-wielocukrowy w mg%	Grupy krwi	Zawartość kwasu cytrynowego w mg%	Płeć	Płeć (morfolog.)	CO <sub>3</sub> g%	Ca g%	PO <sub>4</sub> <sup>3-</sup> P g% (x3)	Kollagen kostny g%	Wiek biologiczny	Wiek określony metodą morfologiczną	
1	2	3	4	5	5	7	8	9	10	11	12	13	14	15	
1	miernie	1	11,5	Tylko ślady, poniżej 0,010 mg%	Brak pozytywnej reakcji we wszystkich przypadkach.	0,61	K	?	1,65	23,90	4,10	2,15	40—50	Ad/Mt?	
2	d. silnie	2	2,1			0,18	?	?	0,60	22,15	5,40	2,00	5—10	Inf. I.	
3	d. silnie	3	5,5			0,20	?	?	0,55	21,10	6,50	1,70	0—5	Inf. I.	
4	miernie	4-a	11,0			0,67	K	M	0,90	22,60	5,00	2,05	25—35	Ad?	
5	miernie	4-b	4,3												
6	miernie	5	10,2			0,23	M	K?	1,15	23,15	3,90	2,10	45—55	Jv?	
7	d. silnie	6	6,4			0,63	K	?	0,65	21,60	5,15	1,85	5—15	Inf. I.	
8	d. silnie	8	10,6			0,16	?	?	0,60	22,00	5,35	1,80	5—10	Inf. I.	
9	miernie	12	9,6			0,54	?	?	0,95	22,05	4,80	2,00	30—40	Inf. I.	
10	d. silnie	13	7,0			0,60	K	?	0,75	23,15	5,05	2,00	15—20	Inf. I.	
11	d. silnie	15	14,2			0,65	K	?	0,90	23,50	4,95	2,10	25—35	Jv/Ad?	
12	miernie	16	12,1			0,35	M	M	0,85	22,80	5,10	2,05	20—30	Jv	
13	miernie	17-a	5,3			0,30	M	?	0,80	23,30	5,05	2,30	20—30	Inf. I.	
14	miernie	17-b	4,5												
15	miernie	18	7,3			0,40	M	K	0,95	23,45	4,60	2,10	35—45	Jv?	
16	d. silnie	19	14,1			0,60	?	?	1,60	23,85	4,15	2,00	40—50	Jv	
17	miernie	20-1	11,0												
18	miernie	20-2	6,5			0,31	M	M	1,95	23,60	3,90	1,90	45—55	Jv/Ad	
19	miernie	20-3	8,2												
20	miernie	21-1	9,5			0,68	K	K?	0,95	23,95	4,50	2,15	35—45	Inf. II/Jv	
21	miernie	21-2	7,2												
22	miernie	22-1	5,1			0,37	M	K	0,80	23,20	4,75	2,10	30—40	Ad	
23	miernie	22-2	8,3												
24	miernie	24	7,0			0,62	K	K?	0,75	22,90	4,90	2,10	25—35	Ad	
25	miernie	26	12,2	0,41	M	K?	1,95	21,60	3,60	2,00	50—60	Jv/Ad			
26	miernie	27	14,2	0,43	M	M	1,90	21,45	3,40	1,80	50—60	Ad?			
27	miernie	30	17,1	0,44	M	?	0,70	23,30	5,00	2,60	25—35	Inf. I.			
28	miernie	31	10,5	0,67	K	K?	1,10	22,90	4,00	2,00	45—55	Inf. II/Jv			
29	miernie	32	8,3	0,64	K	?	1,90	21,85	3,45	2,00	50—60	Inf. I.			
30	miernie	33	16,1	0,40	M	M	1,85	21,50	3,60	1,70	50—60	Jv			



# DNA v paleodemografii

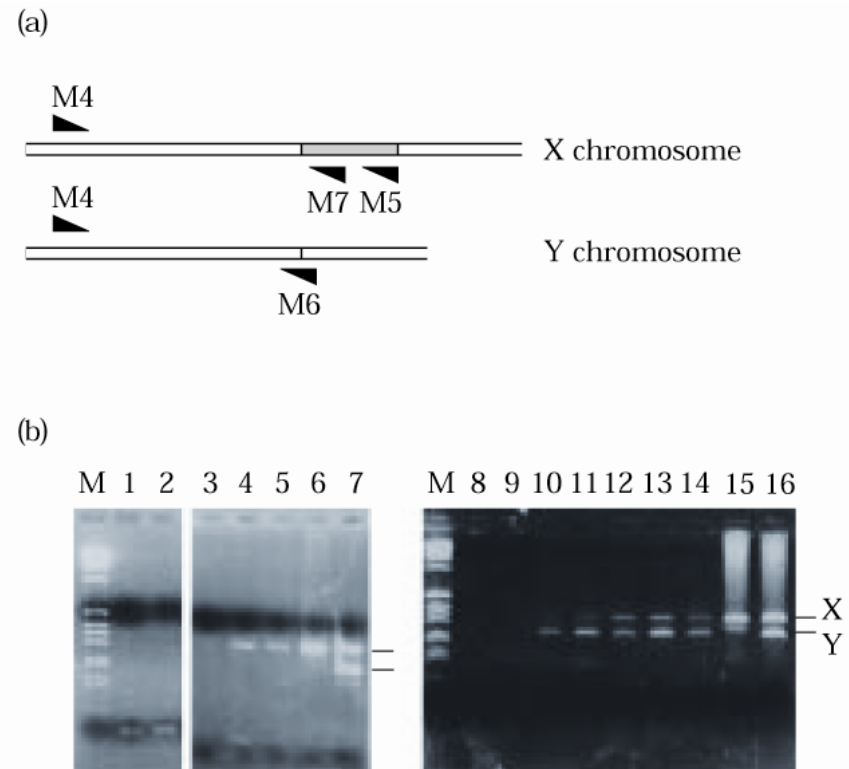
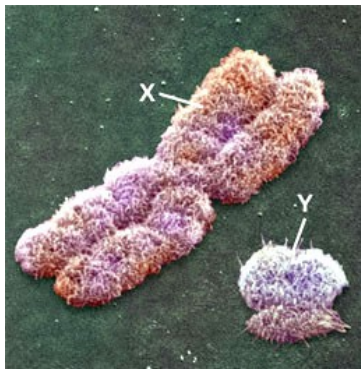
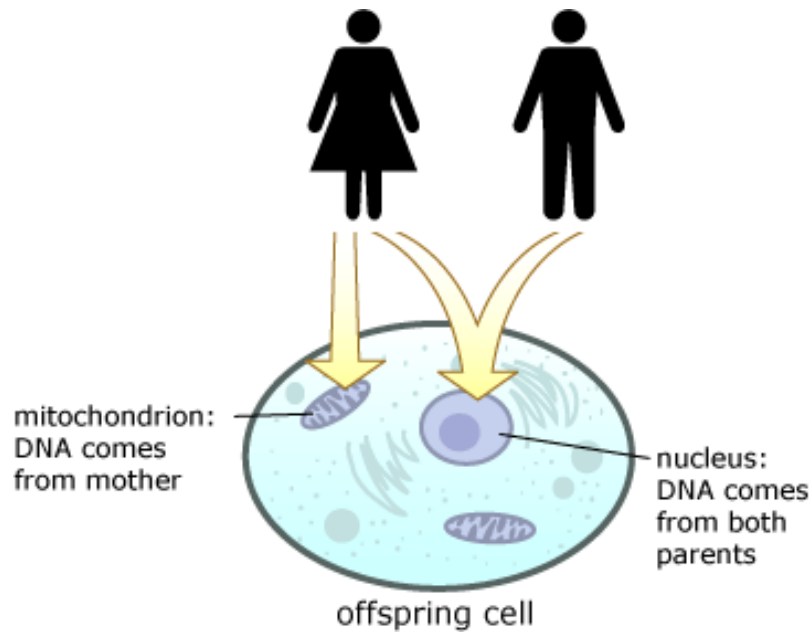


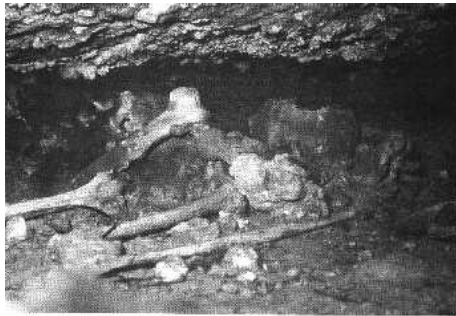
Figure 2. (a) Part of the amelogenin encoding gene showing the location of the PCR primers. Fragment deleted in the Y chromosome is indicated. (b) Sex identification of Ashkelon infants: M—size marker (1 kb DNA ladder); lanes 1, 8, “no DNA” PCR control; lane 2, “blank extraction” control; lanes 3–5, specimen No. 100; lanes 9–11, specimen No. 94; lanes 12–14, specimen No. 96; positive controls: lanes 6, 15, modern female DNA; lanes 7, 16, modern male DNA.

# Určování příbuznosti

## Liechtenstein Höhle

Dorste, Dolní Sasko, mladší doba bronzová

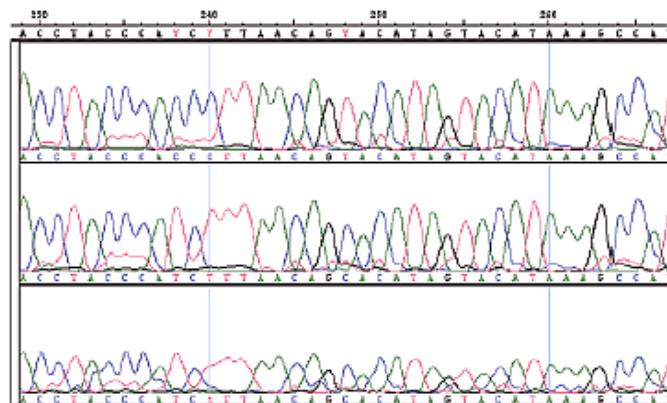
Kultiště? Rodová hrobka?



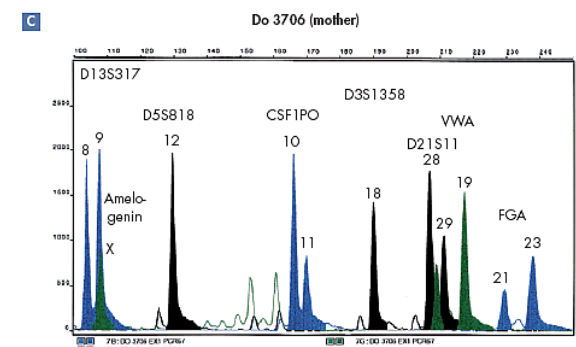
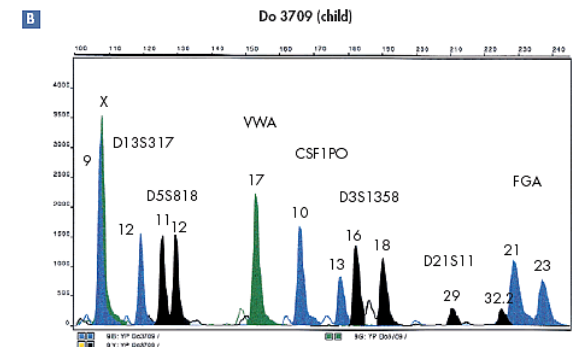
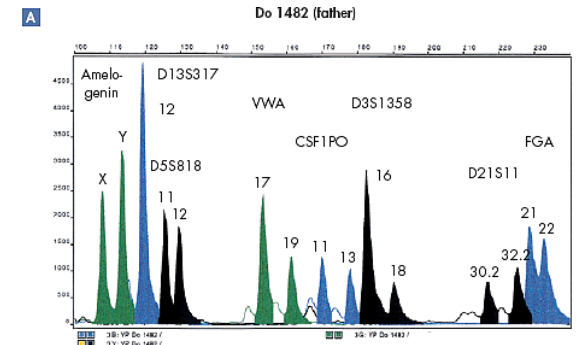
Do 1482  
(father)  
Haplogroup H

Do 3709  
(child)  
Haplogroup T

Do 3706  
(mother)  
Haplogroup T



Polymorphic sites



# Archeozoologie

## Dudley Castle, Leceistershire

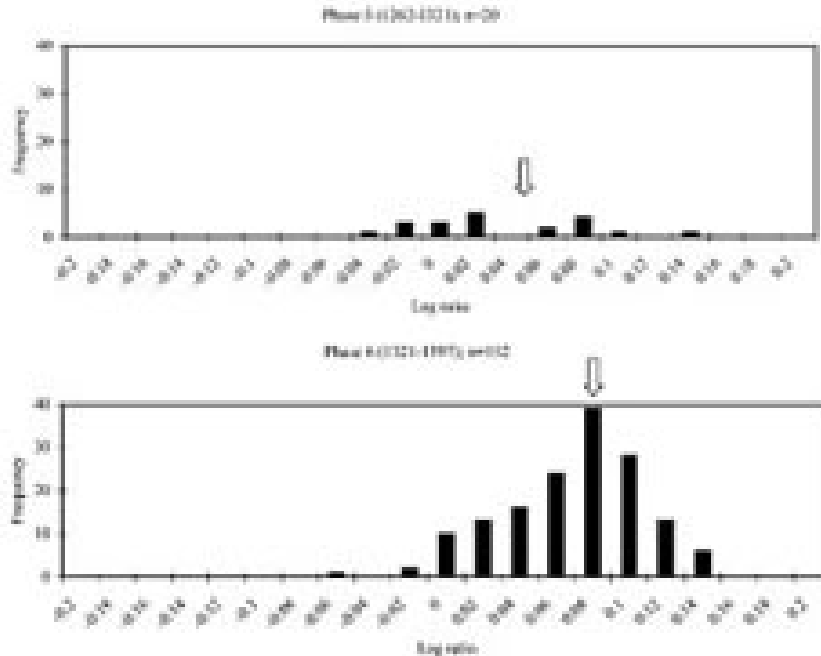


Fig. 2. Log ratios of cattle width measurements at Dudley Castle by phase. The standard is derived from measurements taken on fifteenth-century cattle bones from Llancofen Castle (Albarella and Davis, 1996). An arrow indicates the mean of each dataset. Measurements included: tibia Bd, metapodial GL1, Bd, DU (after von den Driesch, 1976); humerus BT, HTC (after Bull and Payne, 1989); metapodial GL, SD, Bd, a, b, 1, 3, 4 (after Davis, 1992).



From Thomas *et al.* 2005: 77

# Fylogenetická příbuznost pleistocénních medvědů

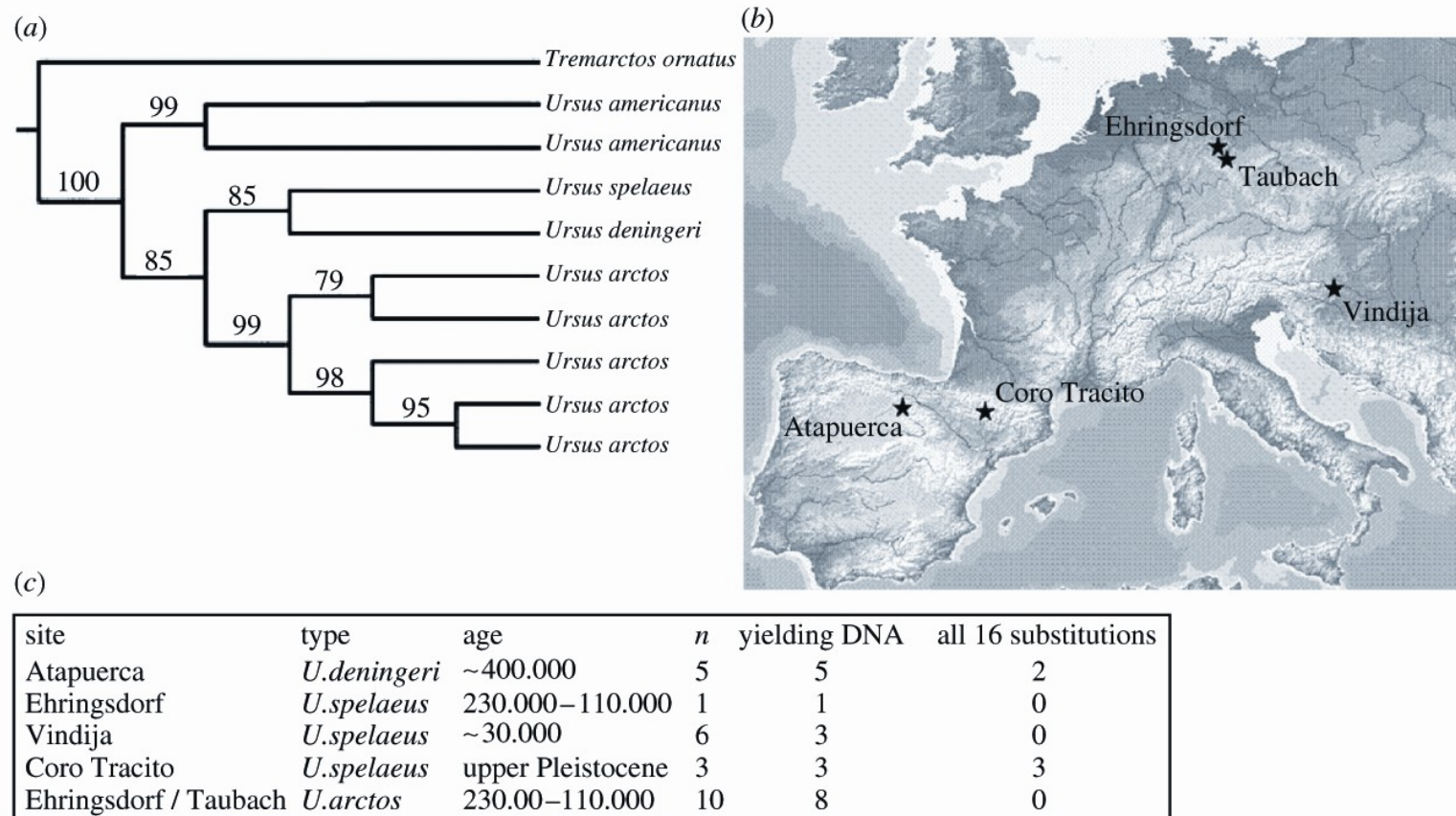


Figure 1. (a) Phylogenetic position of *Ursus deningeri*. Maximum parsimony tree using molecular data from cytochrome *b*. The grouping of *U. deningeri* and *U. spelaeus* was well supported (1000 replicates). (b) Sites for the caves with bear samples (c) Out of 25 samples, 20 yielded bear DNA, out of which 5 yielded all 16 polymorphic sites.



# „Molekulární hodiny“

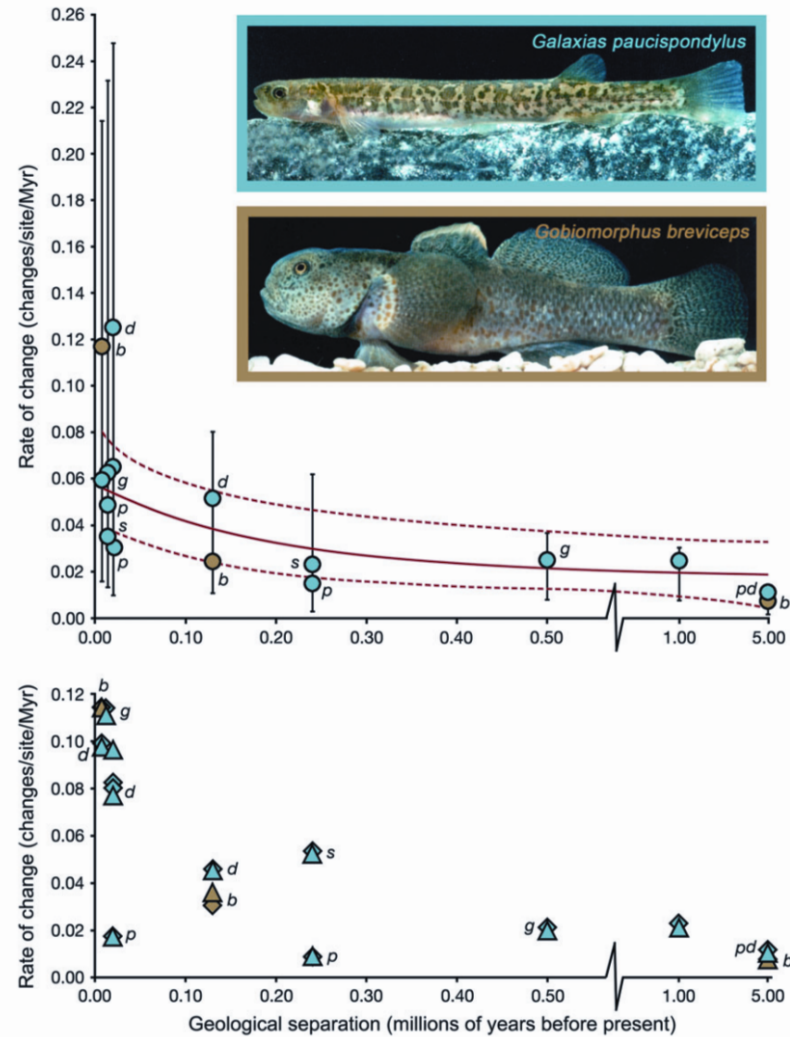
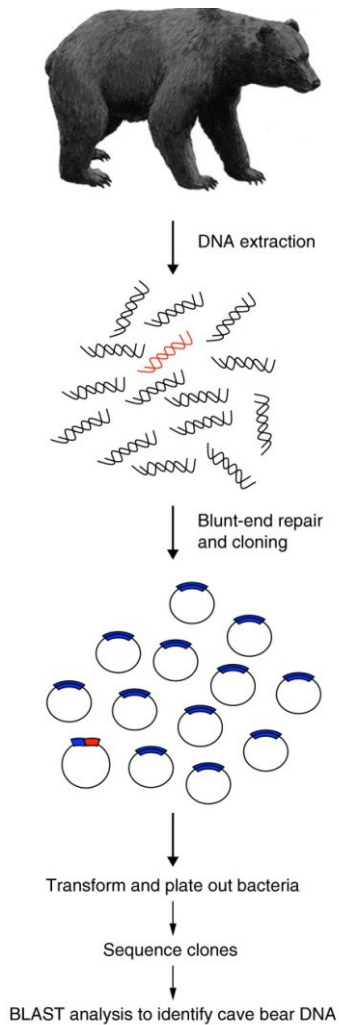


FIG. 3.—Molecular clock calibrations (nucleotide changes/site/Myr) derived from dated isolation events of New Zealand freshwater fish populations. Blue symbols represent galaxiid divergences (Galaxiidae), and brown symbols represent *Gobiomorphus breviceps* (Eleotridae). Letters indicate rates derived from multiple events for the same species (g, *Galaxias gollumoides*; d, *Galaxias divergens*; s, *Galaxias 'southern'*; p, *Galaxias paucispondylus*; b, *Gobiomorphus breviceps*). Where ages are represented by both minimum and maximum estimates (table 1), we employed the latter, yielding minimum estimates of rates. The top graph represents coalescent-based estimates (error bars are the 90% highest posterior density). The red lines are vertically translated exponential decay curves for galaxiid data representing best-fit estimates (solid line,  $y = 0.01876 + 0.03911 \times e^{-5.25878x}$ ) and upper and lower 95% confidence intervals of model parameters (supplementary text S1, Supplementary Material online). The bottom graph represents “simple” rates based on net sequence divergences under either uncorrected (*p* distance, triangles) or HKY (diamonds) models of nucleotide substitution. Two young calibration events yielded negative simple rates (maximum intracatchment divergence exceeded intercatchment divergence, table 1) and are not shown on the lower graph.

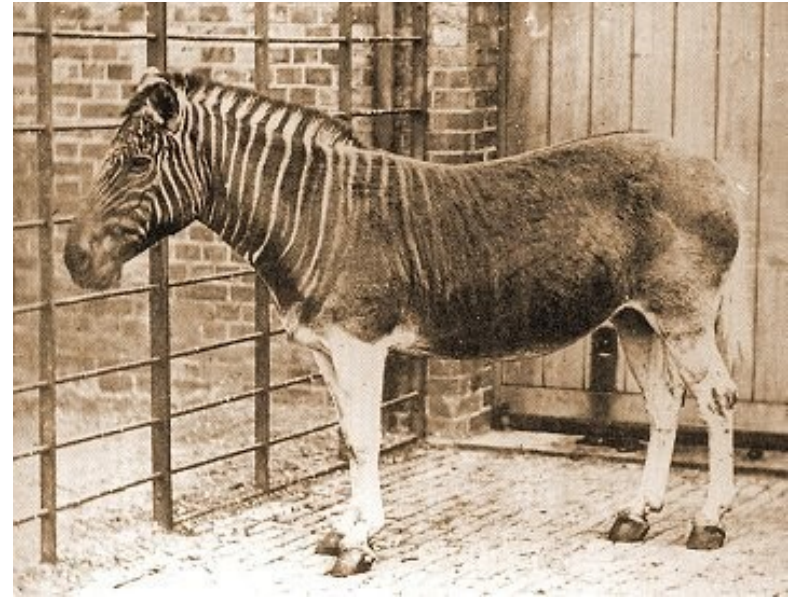
# Klonování vyhynulých živočichů



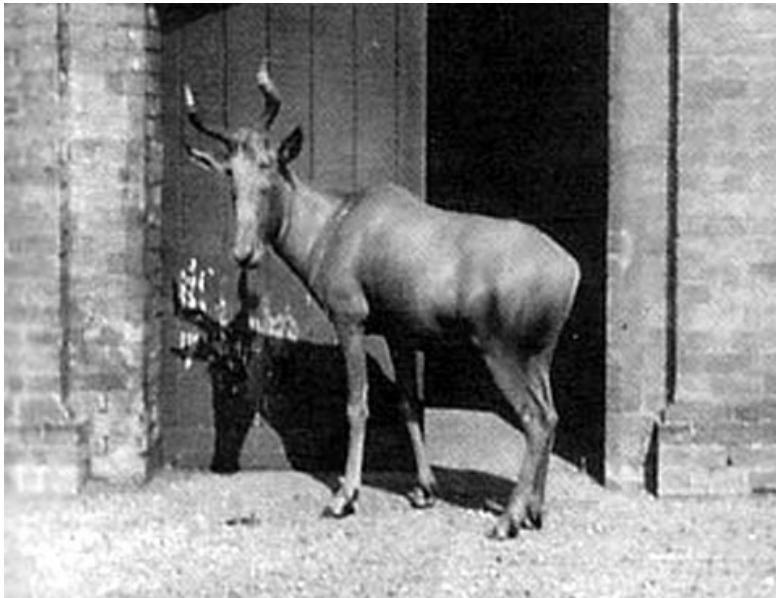
Medvěd jeskynní



Holub stěhovavý (1914)



Zebra qagga (1883)



Buvolec stepní (1923)



Vakovlk (tasmánský tygr) (1930)



Poslední pyrenejský  
kozorožec, samice Celia, byla  
nalezena mrtvá pod padlým  
stromem v lednu 2000.



Kozorožec pyrenejský (2000)

Jedná se o první druh, který byl klonován, ale mládě uhynulo pouhých 7 minut po narození na defekt plic.

