Instructor: David Polly

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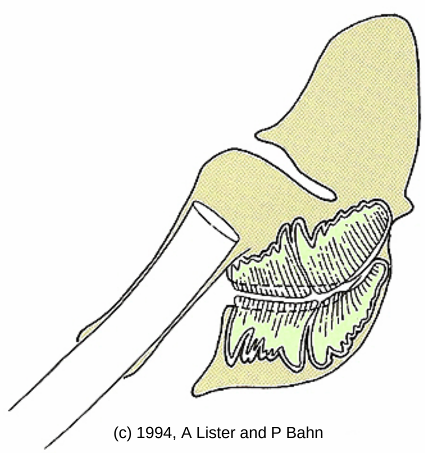
Associate Instructor:
Rituparna Bose

Office: 524 Geology Building
Email: ribose@indiana.edu
Office hours: Tues. 11:00-12:00 noon

Course Website:
http://www.indiana.edu/~g112/

Mammuthus primigenius
Woolly mammoth
Indiana

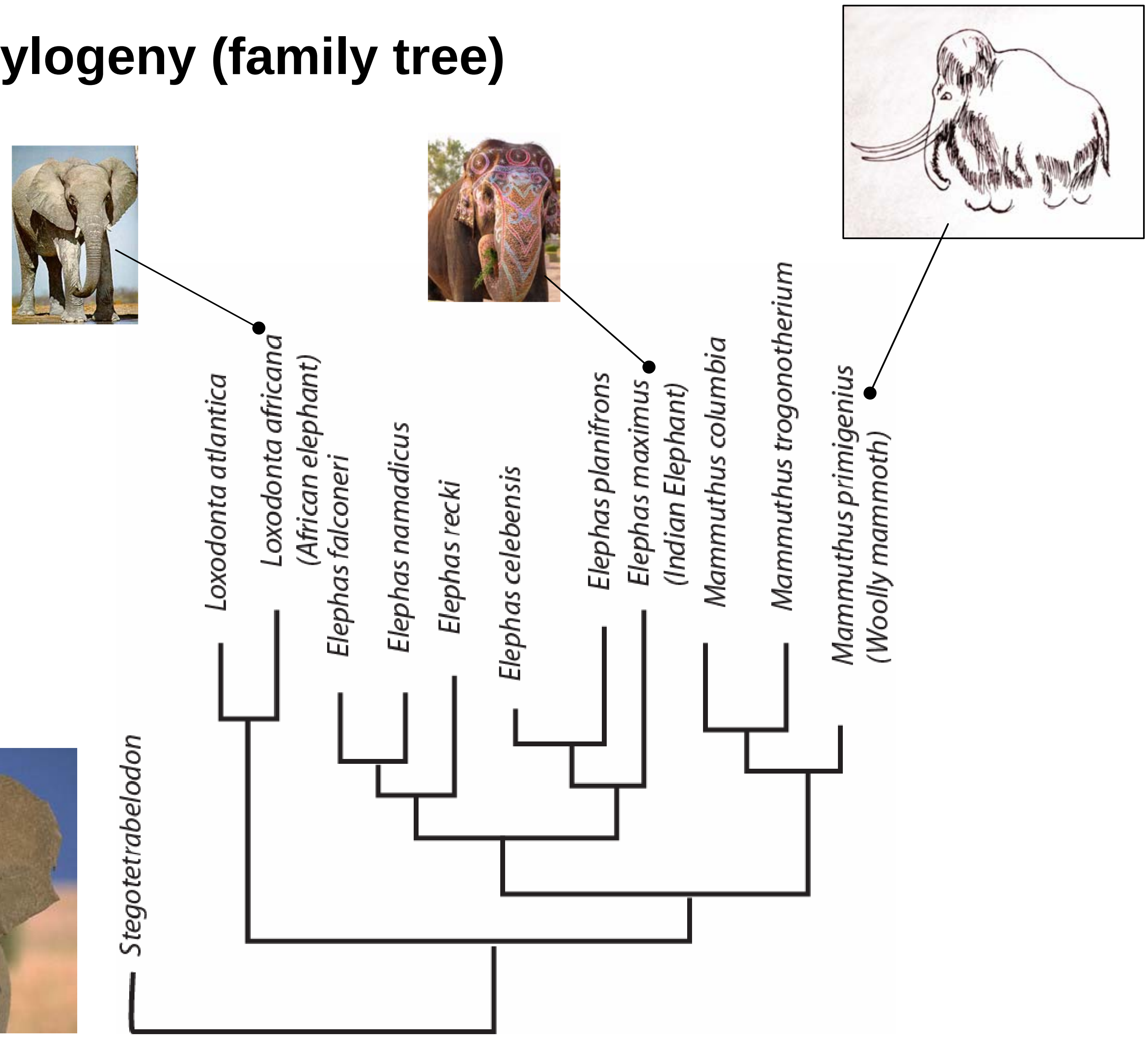


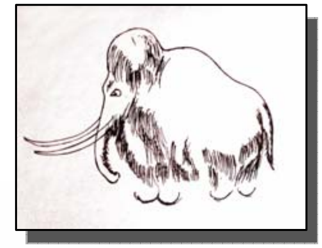
(c) 1994, A Lister and P Bahn

Mammuthus primigenius
Woolly mammoth
Southern England

(c) 1999, D Yalden and P Barrett

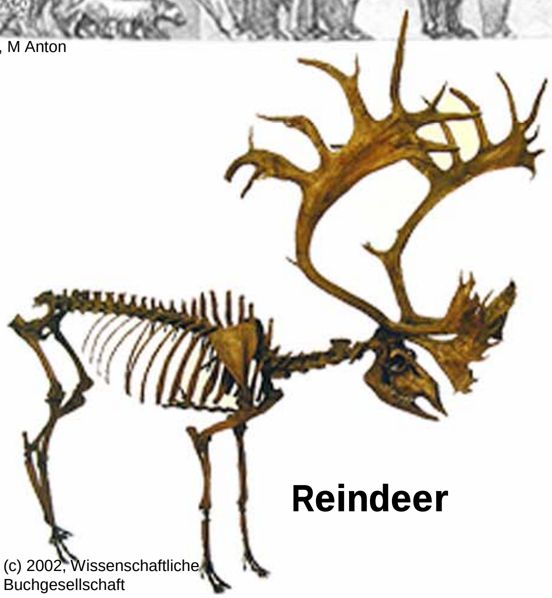
Elephant phylogeny (family tree)





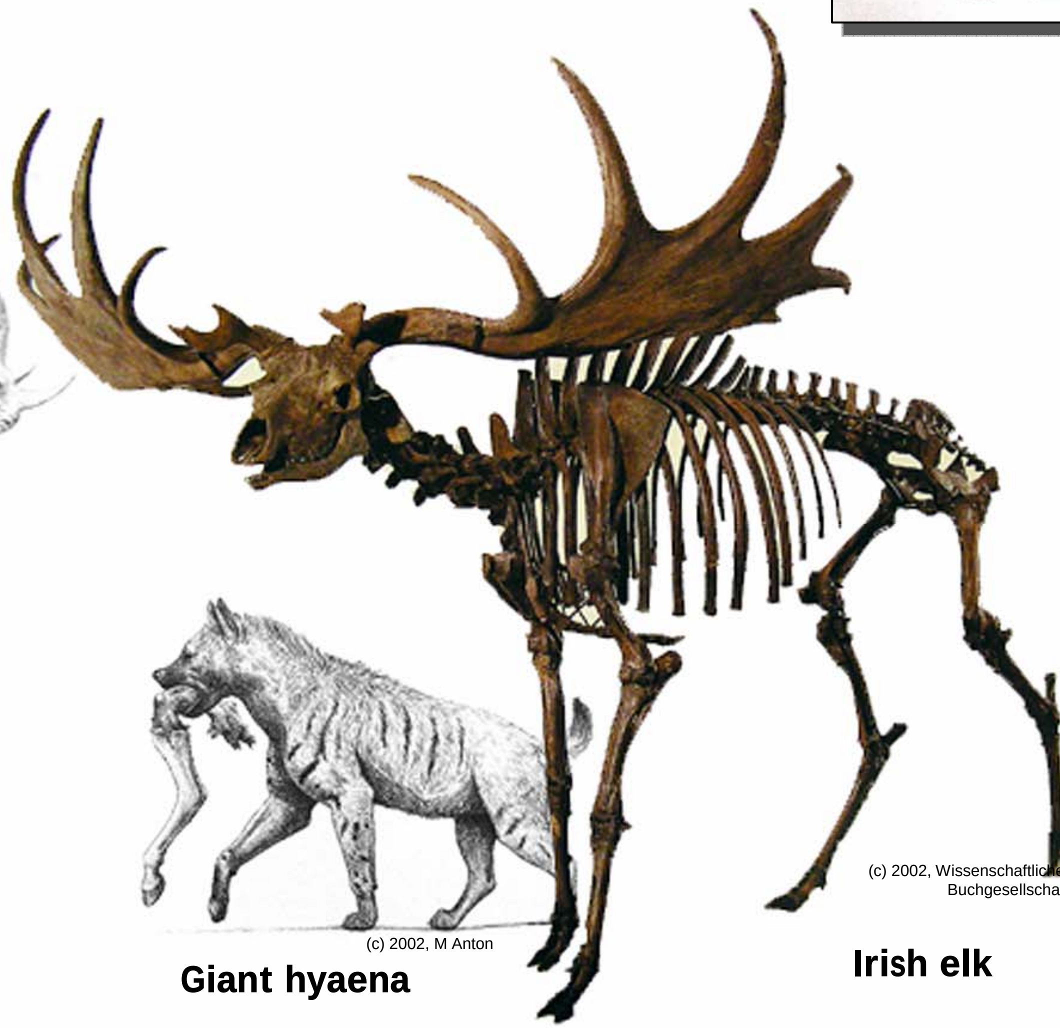
‘Ice age’ mammals

(c) 2002, M Anton



Reindeer

(c) 2002, Wissenschaftliche Buchgesellschaft



(c) 2002, M Anton

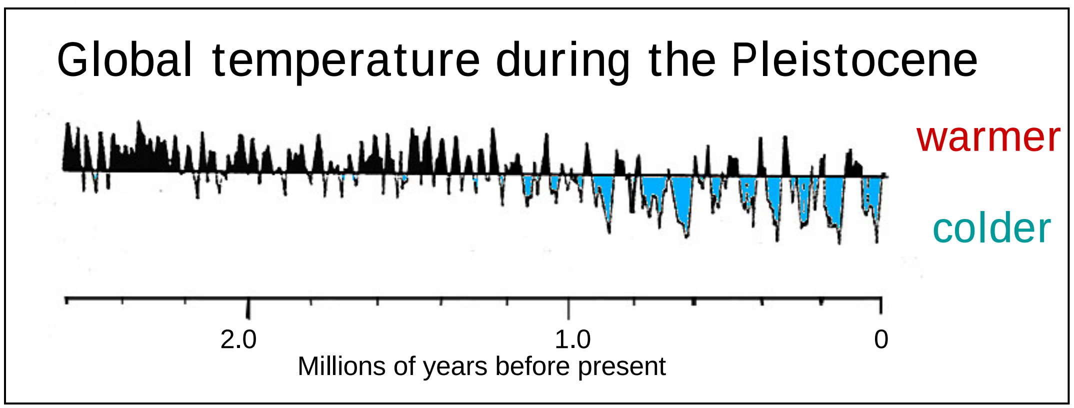
Giant hyaena

(c) 2002, Wissenschaftliche Buchgesellschaft

Irish elk

What was the 'Ice Age'?

- Geological period known as the Pleistocene
- A period of climatic fluctuations: 15-20 cold glacial cycles with warm interglacial periods between them (we now live in an interglacial called the Holocene)
- Began 1.8 million years ago
- Ended 10,000 years ago
- Many of today's animal and plant species originated during the Pleistocene
- Many Pleistocene species became extinct at the end of the Pleistocene



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Geologic Time Scale

- Time chart of earth history
- Outline form shown at right
- Relates names of time periods to their age (usually in millions of years)
- One of the main tools of geologists
- Oldest at bottom, youngest at top (like layers of rocks)

Era	Period	Epoch	Age (millions of years ago)
Cenozoic	Quaternary	Holocene Pleistocene	1.8
	Neogene	Pliocene Miocene	24
	Paleogene	Oligocene Eocene Paleocene	65
Mesozoic	Cretaceous		142
	Jurassic		202
	Triassic		251
Paleozoic	Permian		292
	Pennsylvanian		320
	Mississippian		354
	Devonian		417
	Silurian		440
	Ordovician		495
	Cambrian		545
Proterozoic			2.5 billion
Archean			4.6 billion

How old is 4.6 billion years?

1

First level of magnification

YBP

0 – 2006

Attack on World Trade Centers

10 – 1996

End of Soviet Union, 1st Gulf War
Most IU Students born

20 – 1986

Revolution in Iran

30 – 1976

Vietnam War ends

1st people on the moon
I was born

40 – 1966

Sputnik, the first satellite, launched

50 – 1956

Helical DNA structure discovered

60 – 1946

WWII ends

70 – 1936

Hitler becomes German Chancellor

80 – 1926

Soviet Union founded

90 – 1916

Model T Ford introduced

100 – 1906

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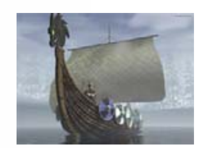
2

Second level of magnification

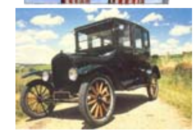
YBP		
0 –	2006	Attack on World Trade Centers
10 –	1996	End of Soviet Union, 1st Gulf War Most IU Students born
20 –	1986	Revolution in Iran
30 –	1976	Vietnam War ends 1st people on the moon
40 –	1966	I was born Sputnik, the first satellite, launched
50 –	1956	Helical DNA structure discovered
60 –	1946	WWII ends
70 –	1936	Hitler becomes German Chancellor
80 –	1926	Soviet Union founded
90 –	1916	Model T Ford introduced
100 –	1906	



3

third level of magnification

YBP		Year	Event
0	–	2006	Attack on World Trade Centers
100	–	1906	Model T Ford introduced
			Darwin publishes *Origin of Species*
			British army burns US Capitol
200	–	1806	
			US Declaration of Independence
300	–	1706	Johann Sebastian Bach at his prime
			Pilgrims land at Plymouth rock
400	–	1606	
			Desoto discovers Mississippi River
500	–	1506	
			Columbus crosses the Atlantic
			Joan of Arc burnt as a witch
600	–	1406	
700	–	1306	Robert the Bruce king of Scotland
			Magna Carta signed
800	–	1206	
			Explosives invented in China
900	–	1106	
			First Crusade
11000	–	1006	Leif Ericsson explores NA coast

4

Fourth level of magnification

YBP		
0 –	AD 2006	Attack on World Trade Centers
1000 –	AD 1006	Leif Ericsson explores NA coast
		Julius Caeser assassinated
2000 –	AD 6	Darius rules Persia
		David first king of Judah
3000 –	BC 1006	Rameses II Pharoah of Egypt
4000 –	BC 2006	Empire of Ur
5000 –	BC 3006	Bricks first used in Egypt
6000 –	BC 4006	Rice farming culture in China
7000 –	BC 5006	
8000 –	BC 6006	
9000 –	BC 7006	Walled settlement at Jericho
10,000 –	BC 8006	Agriculture develops, sheep and cattle domesticated

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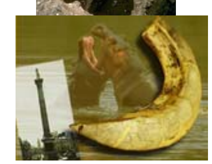

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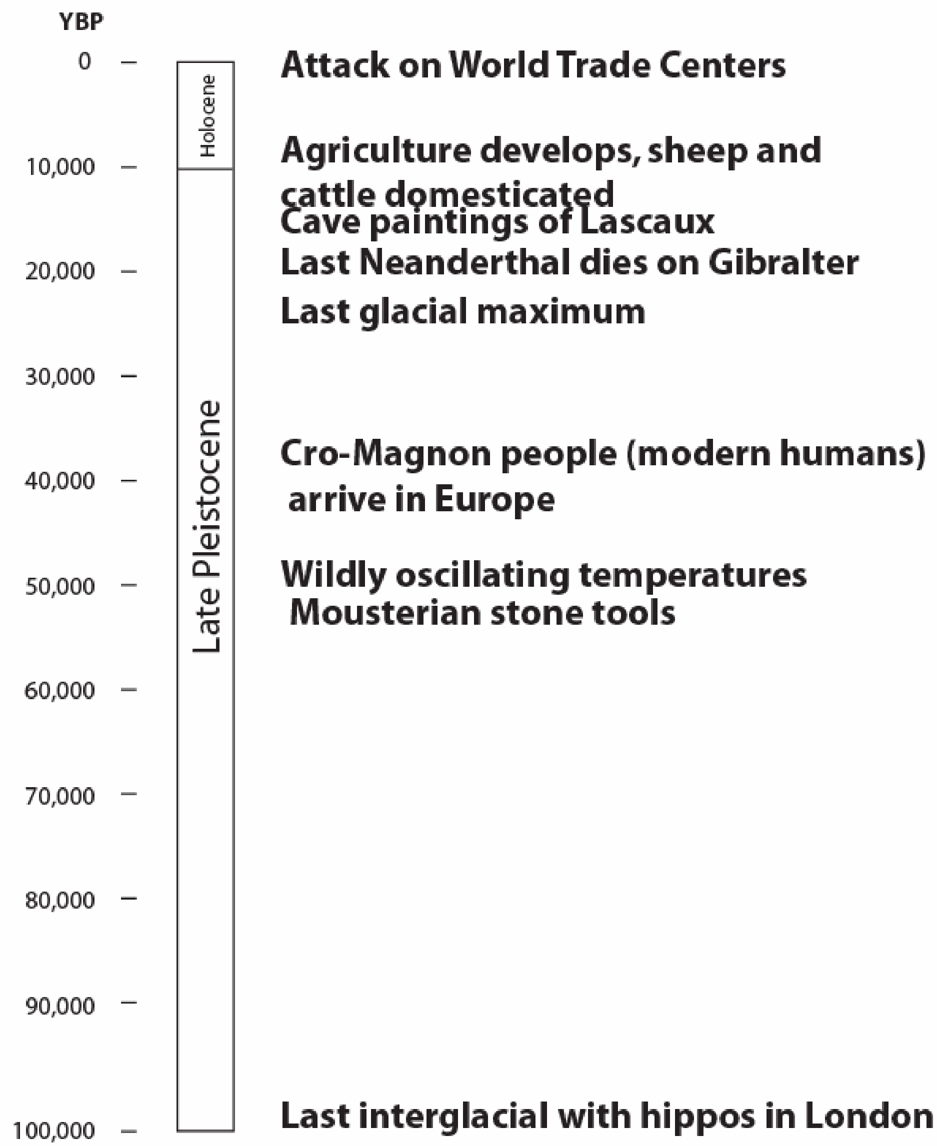
5

Fifth level of magnification



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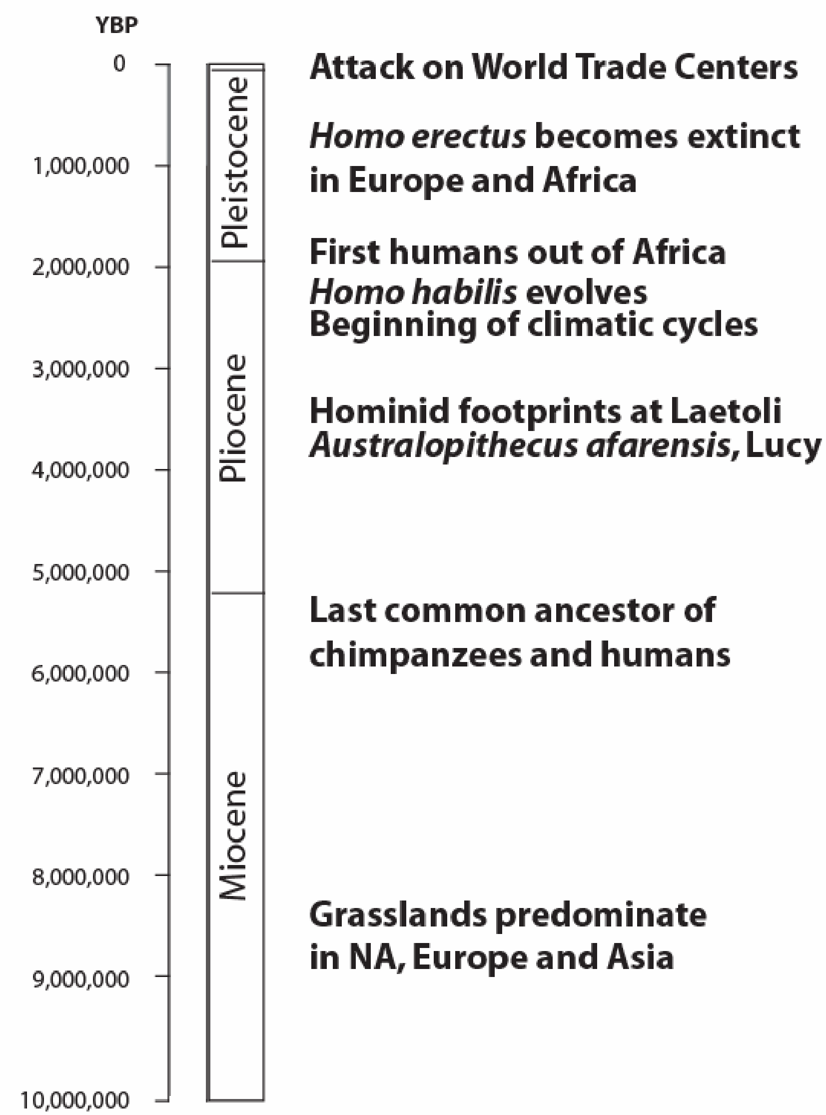
6

Sixth level of magnification



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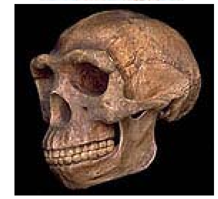
7

Seventh level of magnification

YBP		
0		Attack on World Trade Centers
	Miocene	Grasslands predominate in NA, Europe and Asia
10,000,000		
20,000,000		er
	Oligocene	
30,000,000		Glaciations when Antarctica and South America split
		mans)
40,000,000	Eocene	Warm tropical period in North America
50,000,000		
	Paleocene	First primates
60,000,000		Extinction of Dinosaurs
70,000,000	Cretaceous	
80,000,000		
90,000,000		
100,000,000		ondon



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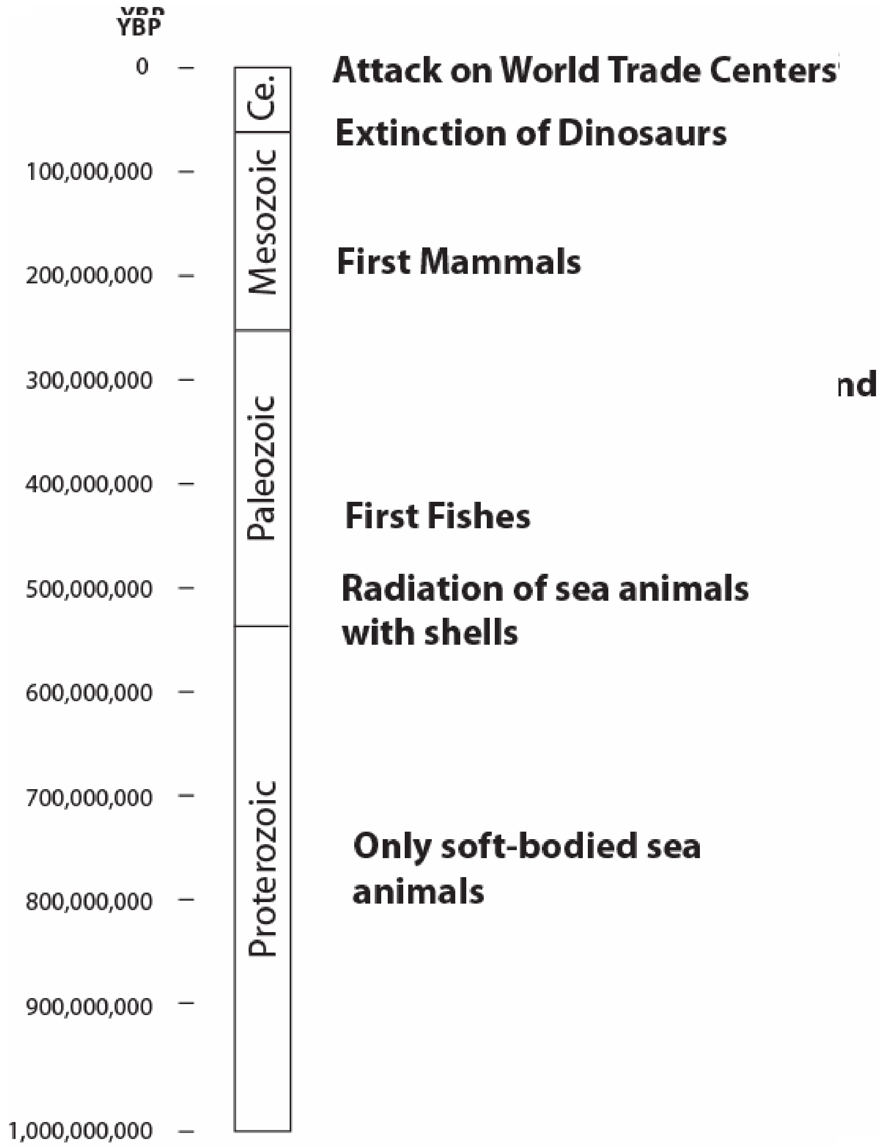
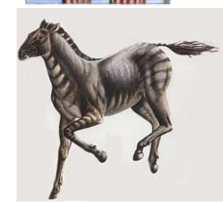
8

Eigth level of magnification





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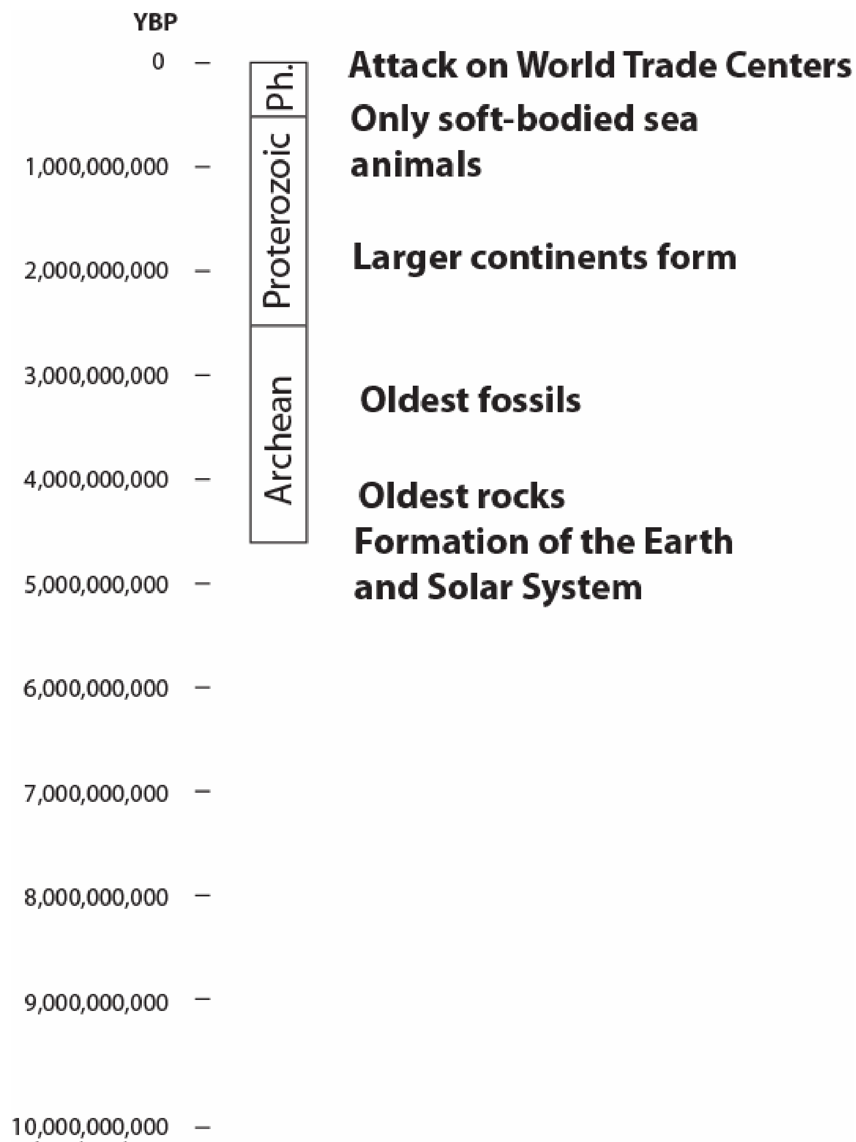
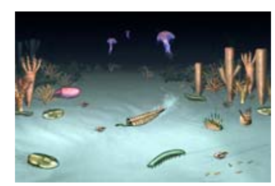
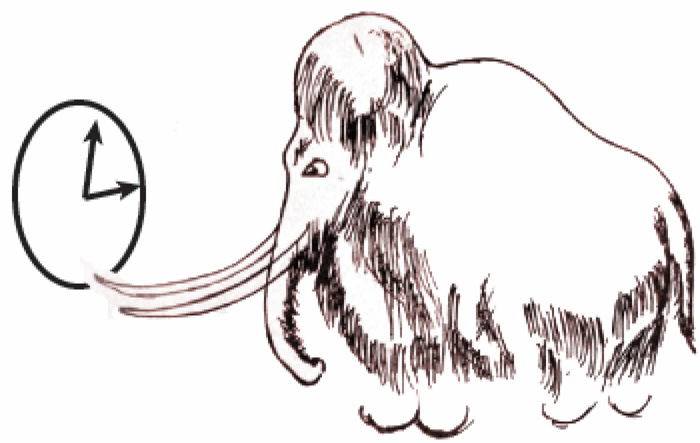
9

Ninth level of magnification

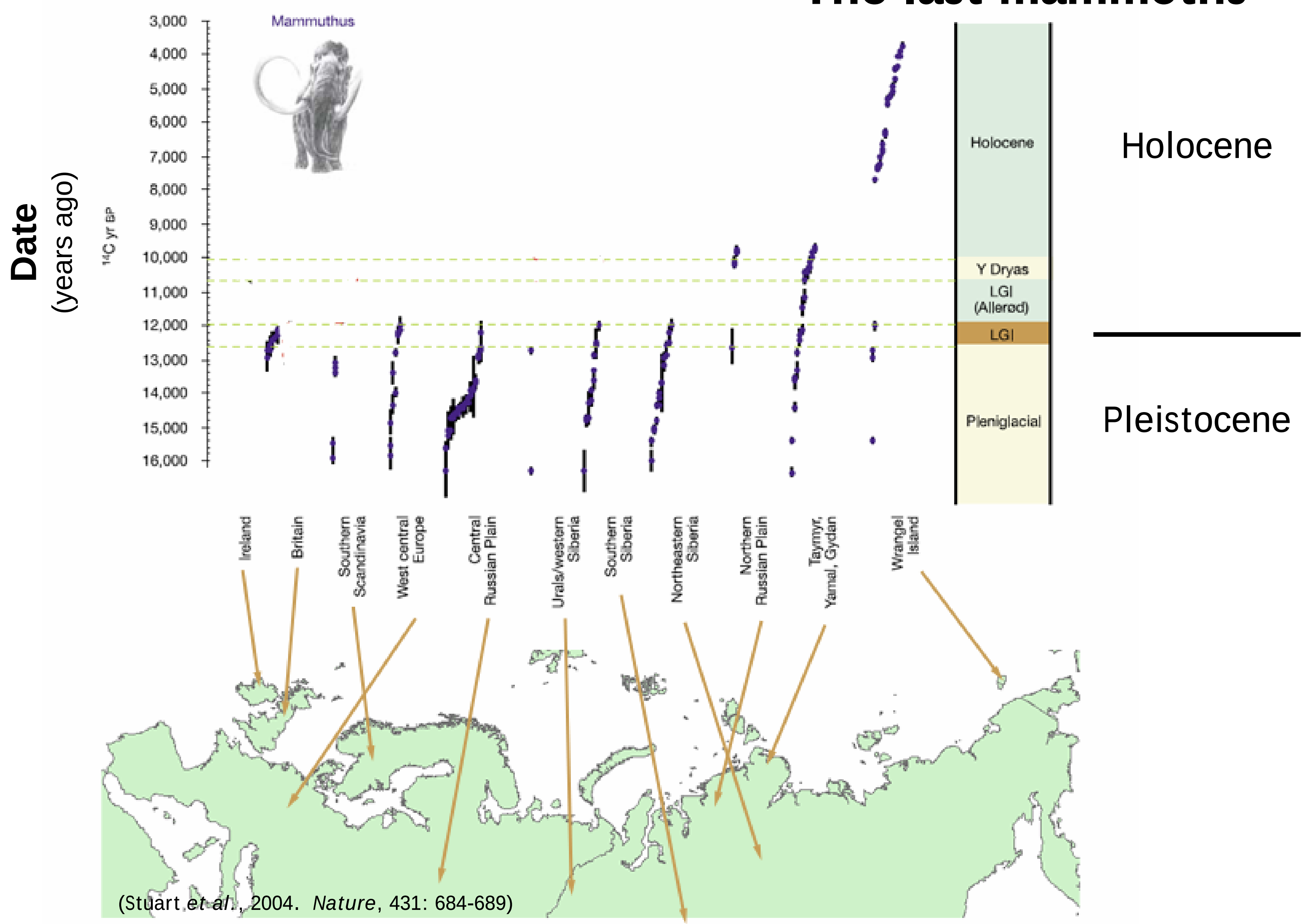




Where do the last mammoths fit in?



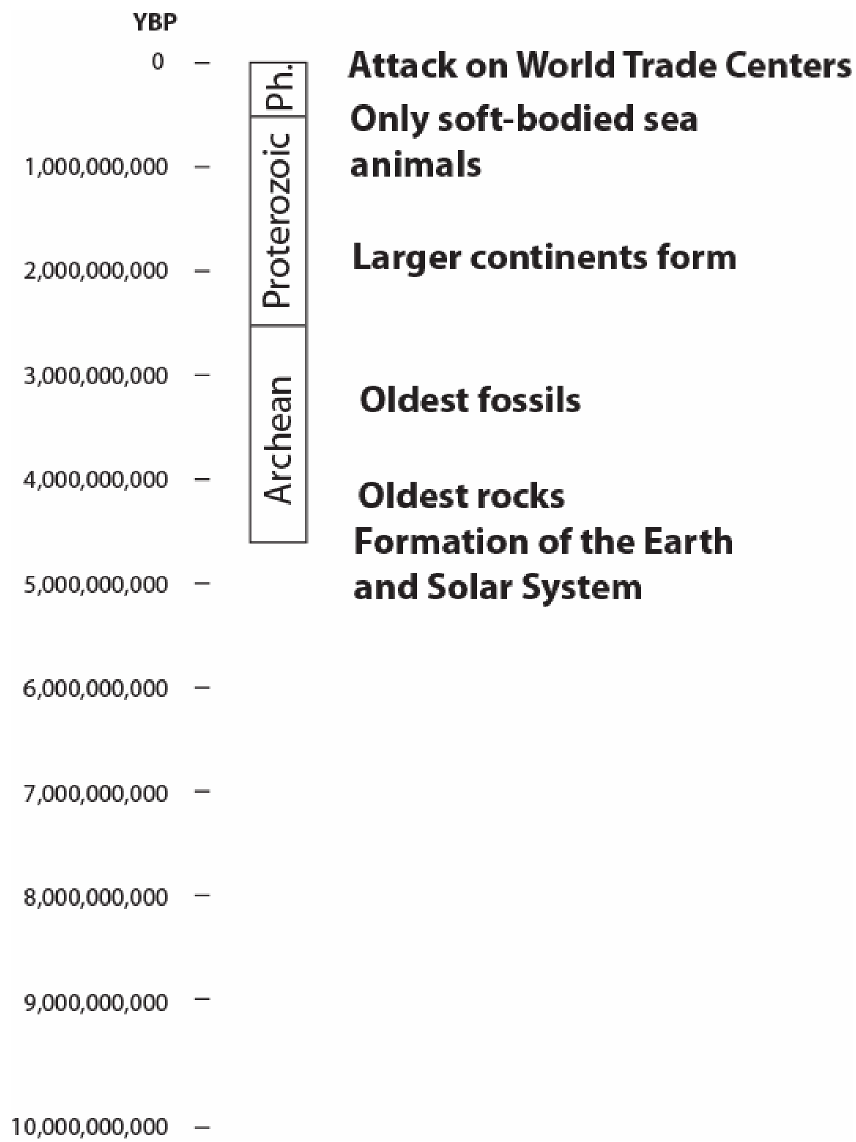
The last mammoths



(Stuart *et al.*, 2004. *Nature*, 431: 684-689)

9

Ninth level of magnification



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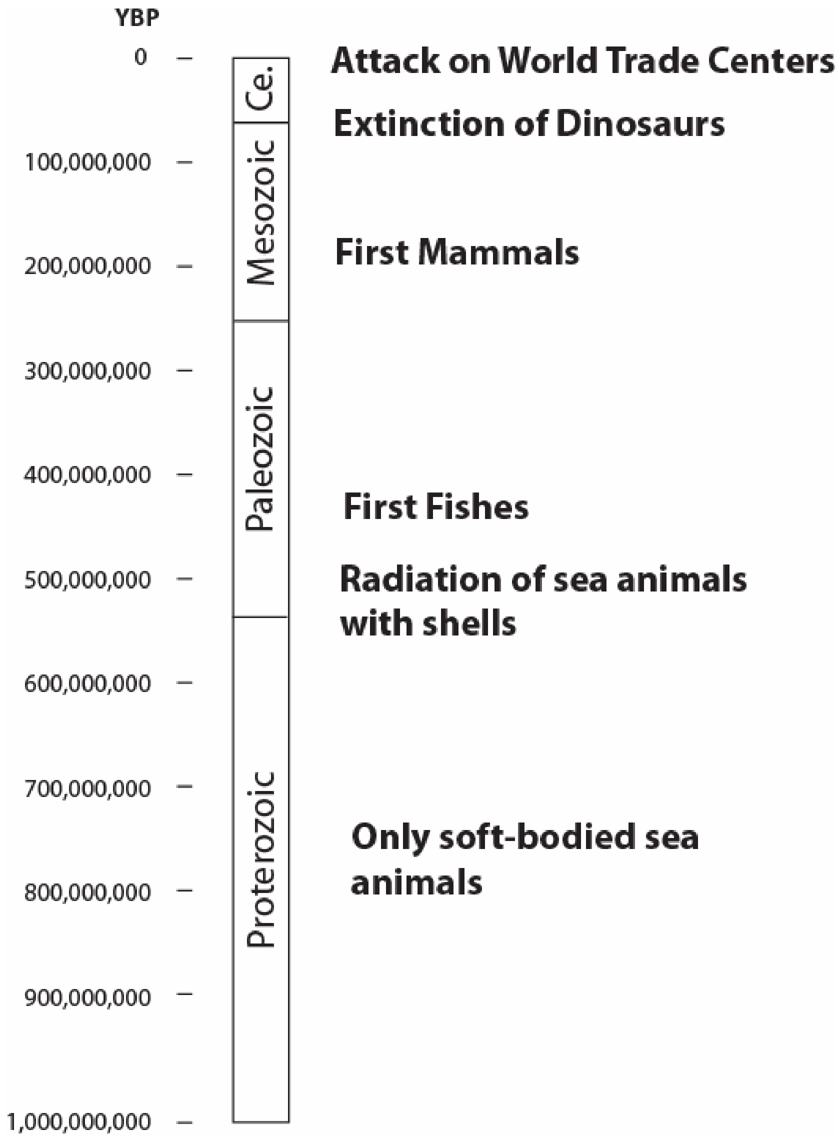
Eigth level of magnification



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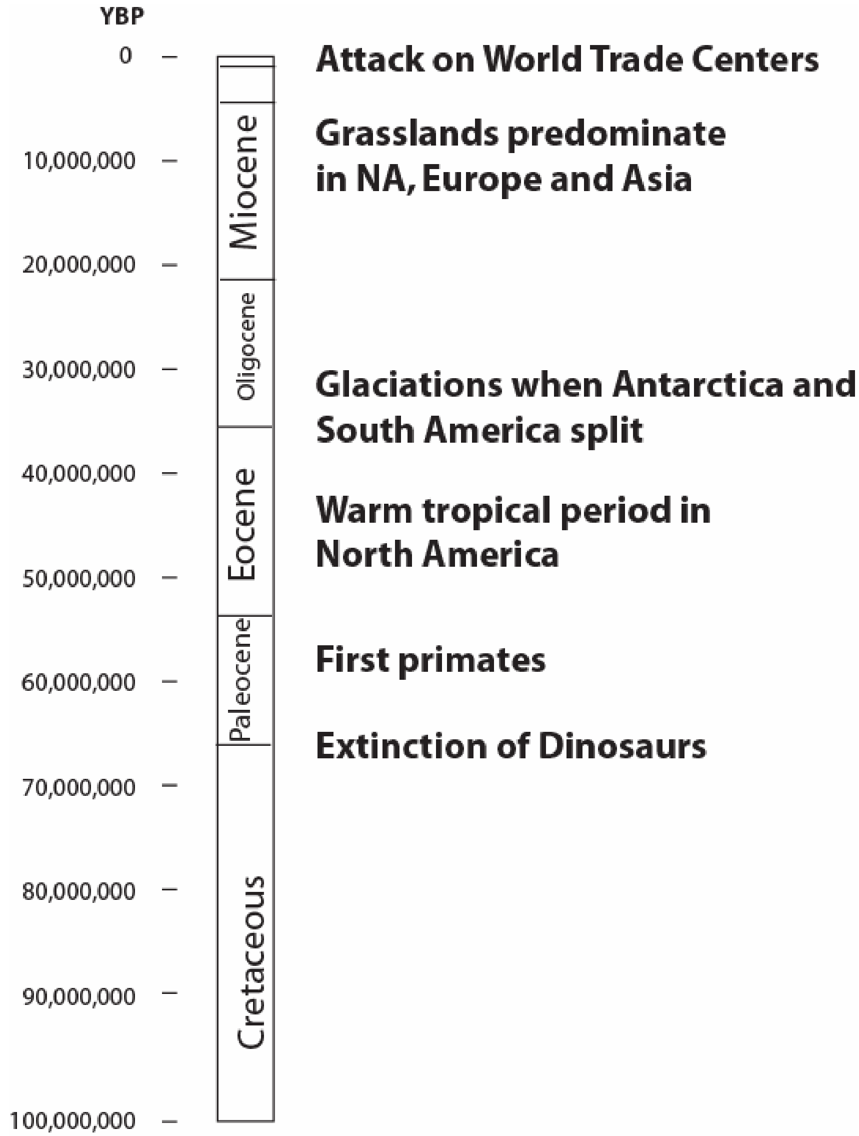
7

Seventh level of magnification



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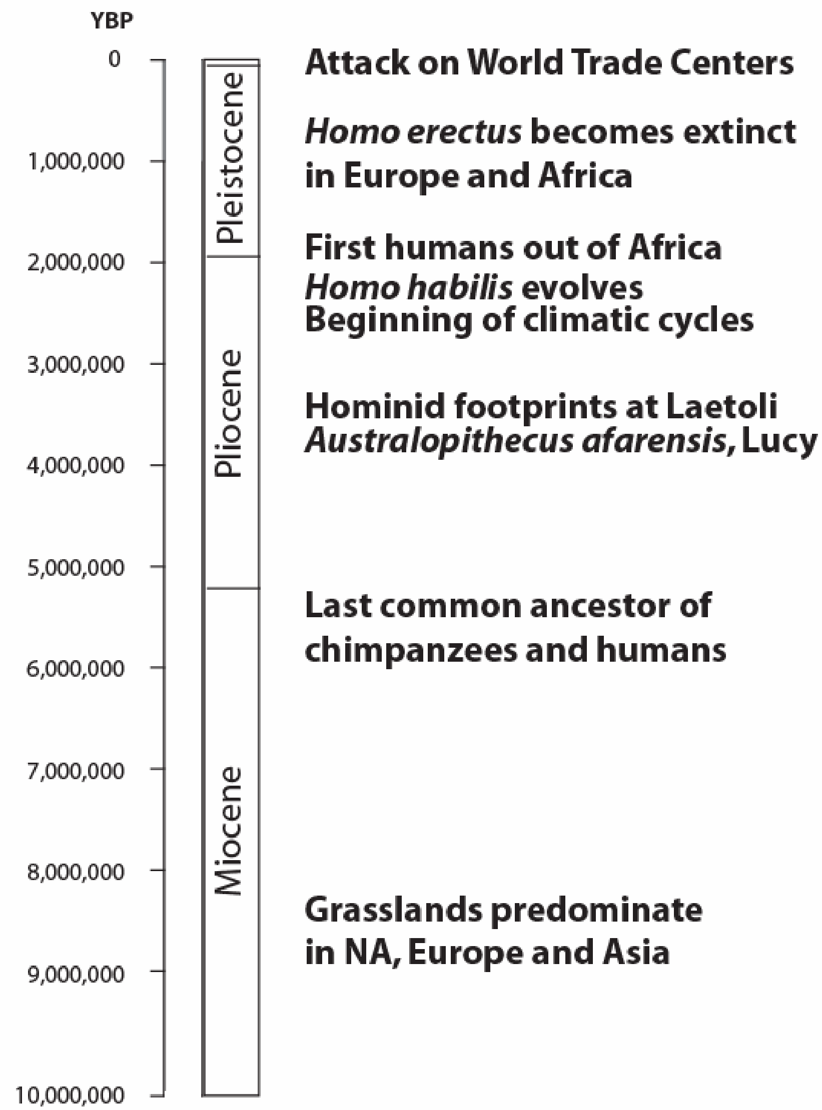
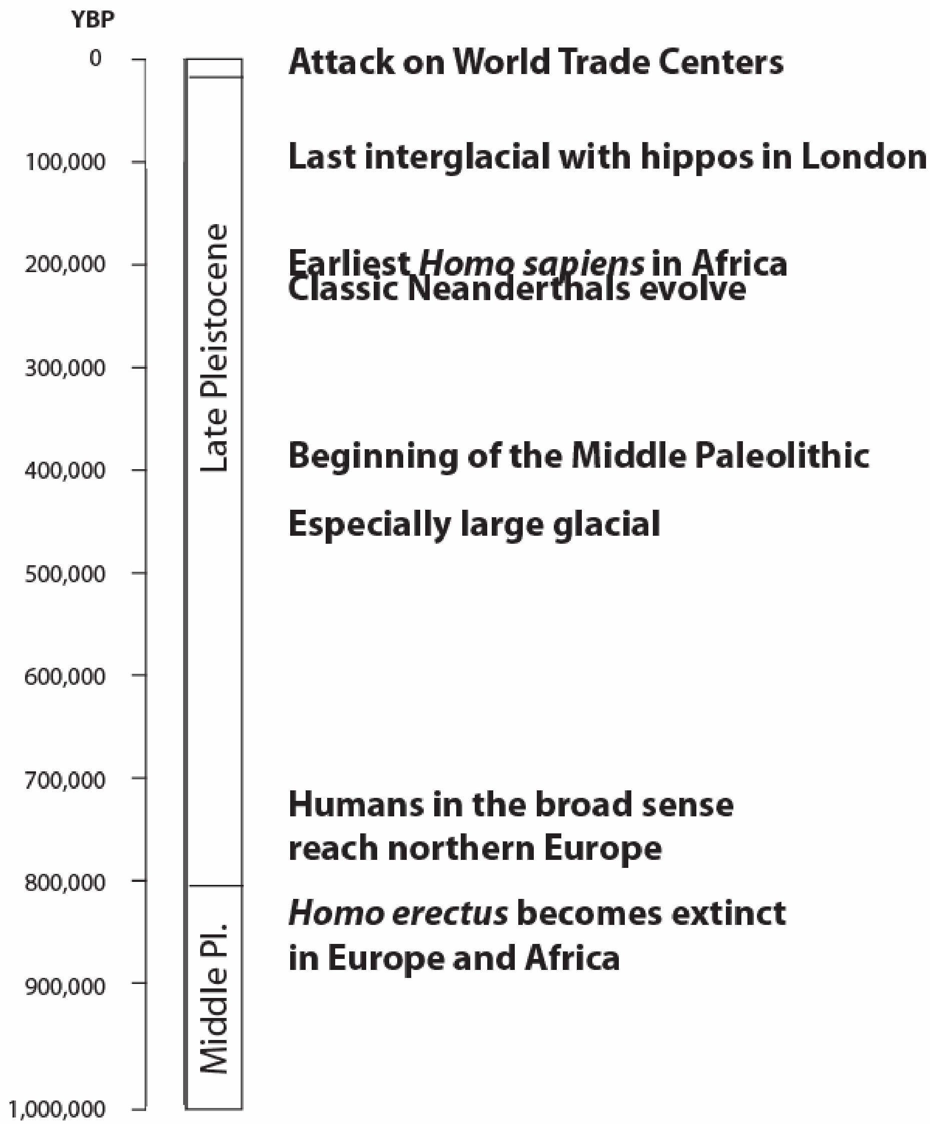
Sixth level of magnification



5

Fifth level of magnification



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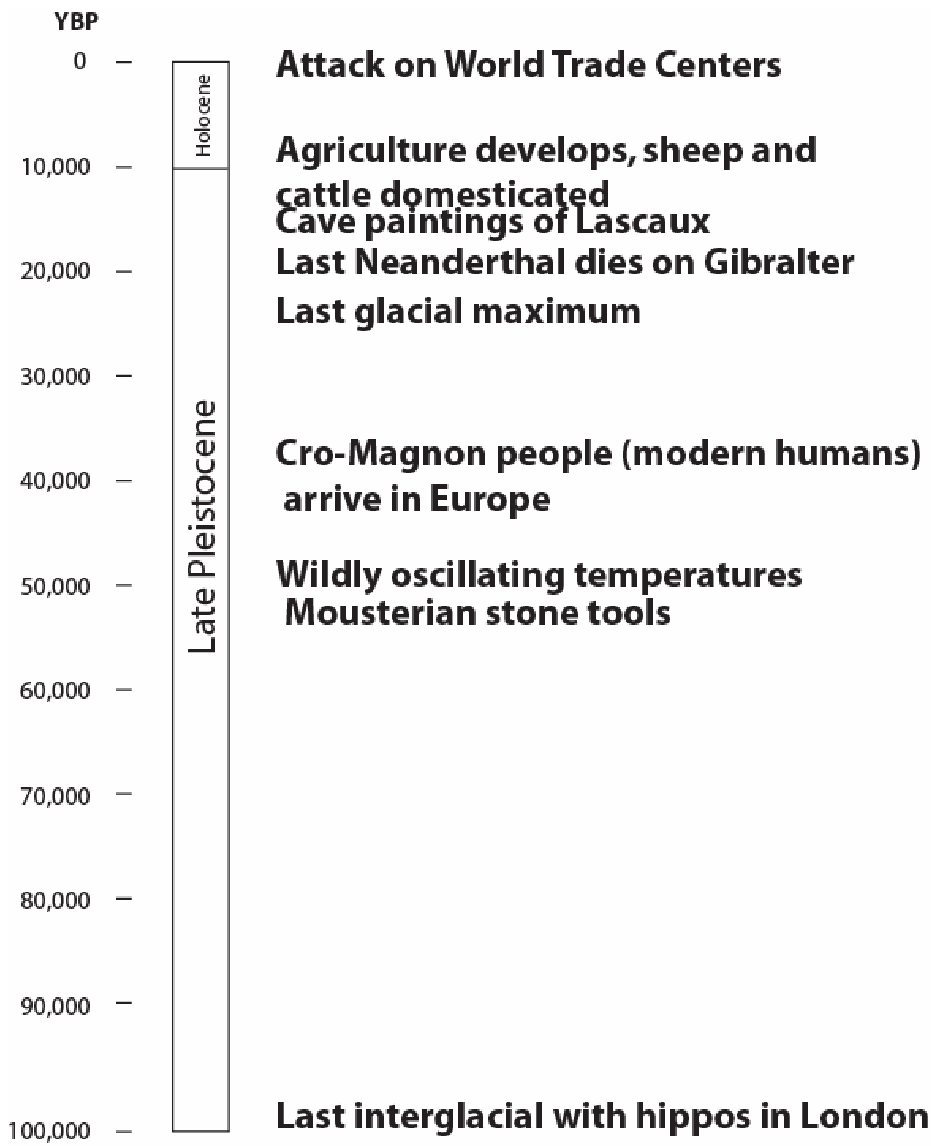
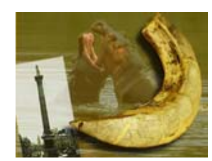
4

Fourth level of magnification





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3

Third level of magnification

YBP		
0	AD 2006	Attack on World Trade Centers
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2000	AD 6	Julius Caeser assassinated Darius rules Persia
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4000	BC 2006	Empire of Ur
5000	BC 3006	Bricks first used in Egypt
6000	BC 4006	Rice farming culture in China
7000	BC 5006	
8000	BC 6006	
9000	BC 7006	Walled settlement at Jericho
10,000	BC 8006	Agriculture develops, sheep and cattle domesticated

The last mammoth dies in Siberia

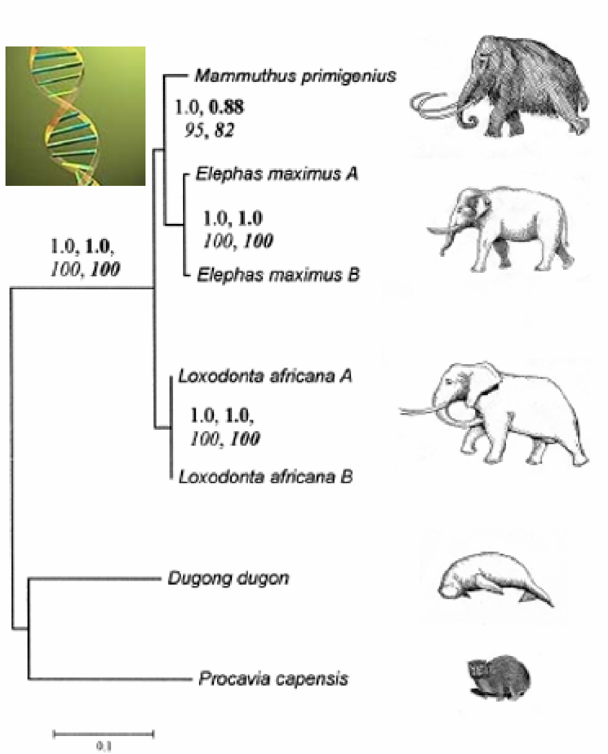


Figure 4. Paenungulata Tree and Phylogenic Relationship of the Woolly Mammoth

The analysis of complete mtDNA sequences places *M. primigenius* with *E. maximus* on the tree. The Sirenia *(D. dugon)* and Hyracoidea *(P. capensis)*, most closely related species among extant taxa to Elephantinae, were taken as outgroups. Bootstrap values and posterior probabilities were calculated using a Bayesian approach [29,31] assuming a gamma distribution of the rates of evolution across sites with a General Time Reversible model (normal font), HKY model (bold), with a parsimony approach (italic), and by neighbor joining (italic and bold) [28]. The scale is 0.1 substitutions per site. The mitochondrial genomes of *M. primigenius, E. maximus A, E. maximus B, L. africana A, L. africana B, D. dugon*, and *P. capensis* were used in the analysis.
DOI: 10.1371/journal.pbio.0040073.g004

(Rogaev *et al.*, 2006. Complete mitochondrial genome and phylogeny of Pleistocene mammoth *Mammuthus primigenius*. *PLOS Biology*, **4:** 403-410.)

Analysis of Mammoth DNA

Mammoth from cave painting at Peche Merle, France

Frozen mammoth in Siberia

Historical Processes (5 weeks)
- Rocks, their origin, and their history
- Plate tectonics (movements of continents)
- Fossils and the rocks they come from
- Geochemical cycles and learning about the environmental conditions of the past
- Midterm I

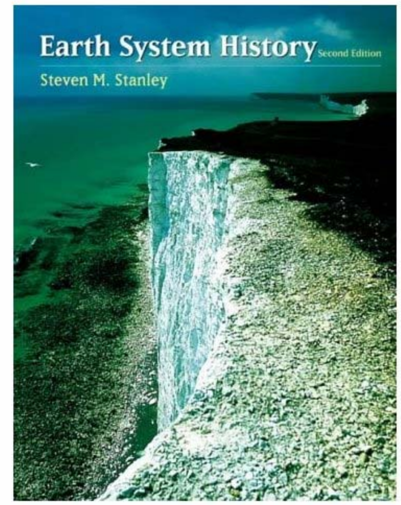
Biological Diversity, Evolution, and Geological Time (4 weeks)
- Geological time and determining the age of rocks
- Diversity of life
- Evolution, how it works, and what we know from fossils
- Reconstructing past life and environment
- Midterm II

Earth History (6 weeks)
- Blow-by-blow account of the history of the earth including:
- Origin of the earth
- Oldest life
- Life in the age of dinosaurs
- Life in the age of mammals
- Human evolution
- Global climate change
- Indiana geology

Textbook

Earth System History, 2nd Edition
Steven M. Stanley, 2005
W.H. Freeman and Company: New York

The course is not organized to fit the book and I will suggest reading to go with each week's lectures. There will be a lot of material in lectures and labs that is not in the text.



Grades

lab work	(25%)
a take-home report	(30%)
two mid-term examinations	(20%)
a final examination	(25%)