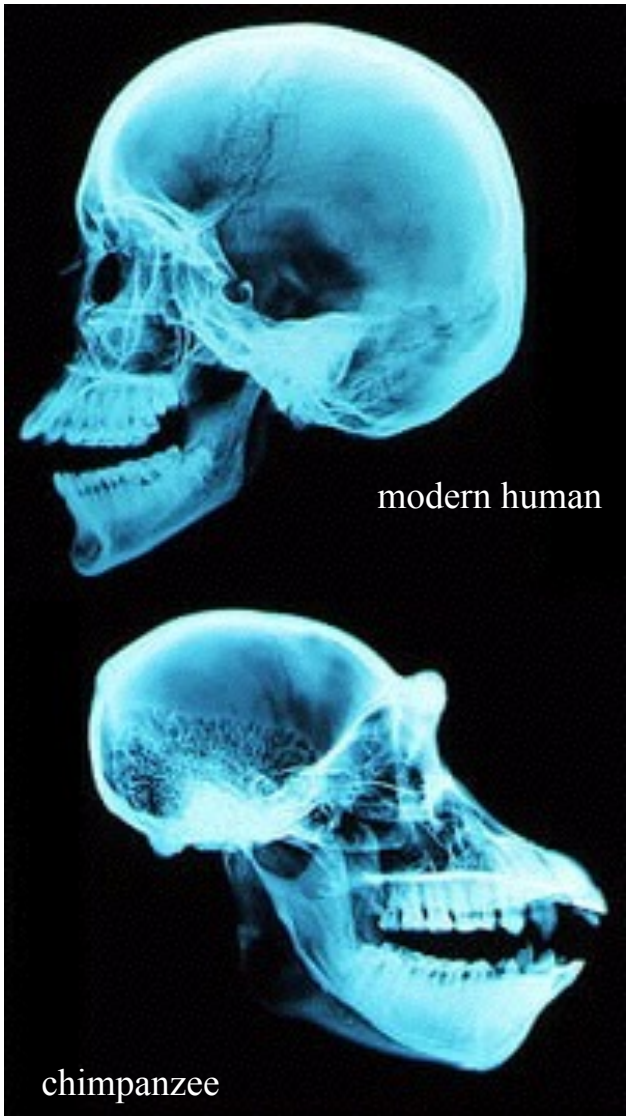
Anthro 101:
Human Biological Evolution

Lecture 12: The Fossil Record

Prof. Kenneth Feldmeier

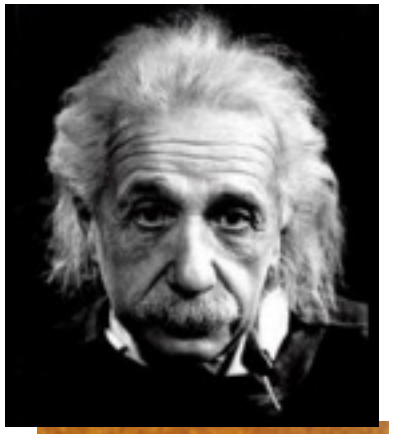
The Fossil Record

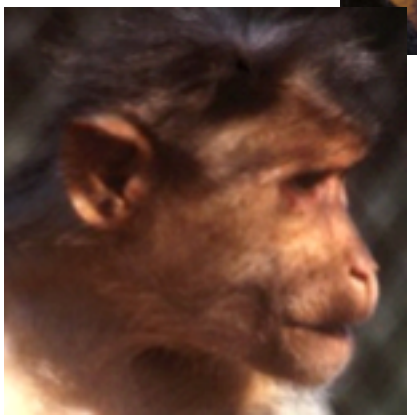
- The Geological Time Scale
- Dating Techniques
- The Fossil Record
- Early Primate Ancestors



Our goal is to trace our lineage back in time

- unbroken chain of ancestors back in time to
  - a creature much like a modern chimpanzee
  - a creature like an Old World monkey
  - a creature like one of the prosimians
  - a creature like a tree shrew





How do you define an extinct species?

- Can't see if fossil organisms reproduced
- Track phenotypic traits - skeletons

- **Paleospecies** - a group of similar fossils that vary from each other within the range of variation observed in a closely related living species

- Can be tricky to determine similarity
  - Age, sex
  - Intraspecific variation
  - Variation over time & location
  - Limited number of fossils to compare

- Typological viewpoint vs. Populationist viewpoint

Fossil evidence helps to trace our ancestry

- **Fossils**: any remains, impressions or traces of plants or animals from a previous geological age
  - Bones replaced by minerals

- **Paleoanthropology**: the study of fossil hominin species & related
  - Understand early primate-like & human-like creatures
  - Figure out the lives they led

The Fossil Record

- Knowing dates is only part of the story
- We are interested in evolutionary patterns
  - phylogenetic relationships
- Our ability to infer these is imperfect

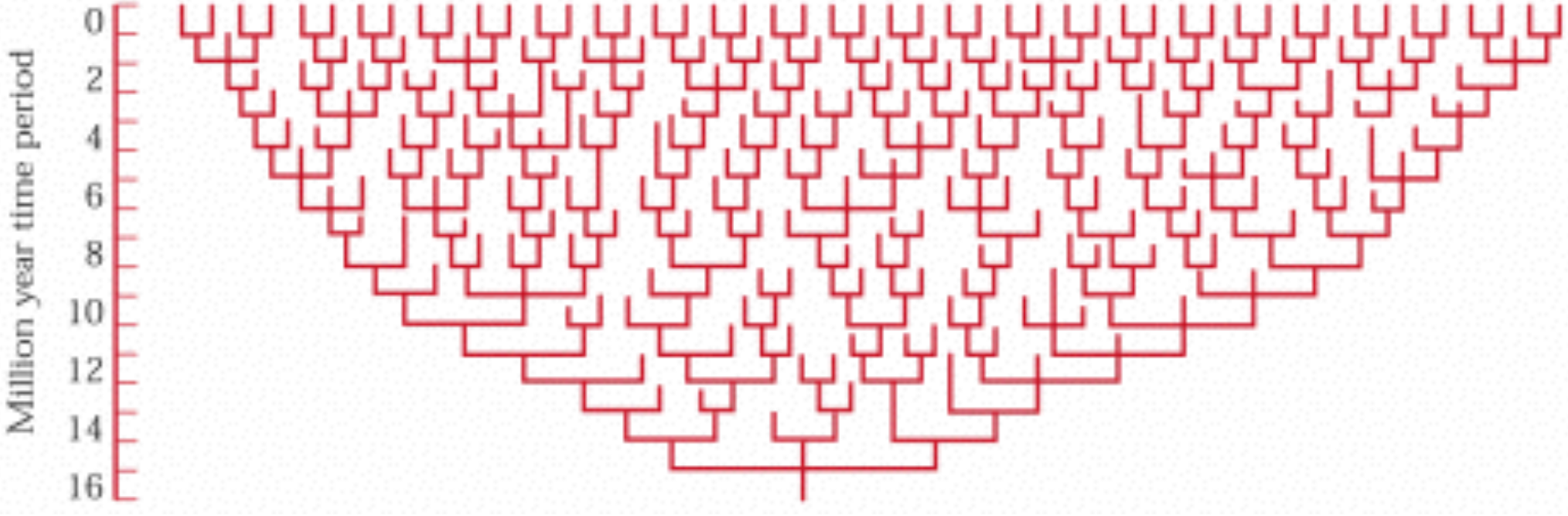
- Still lot of interesting questions
  - Selective pressures
  - Adaptation

Finding fossils is a playing the lottery

- Fossils are very, very old
- Africa and Asia are very, very large
- Ancient habitats & poor preservation
- Difficult conditions in modern habitats
- Surface materials easily destroyed
- Much material is buried

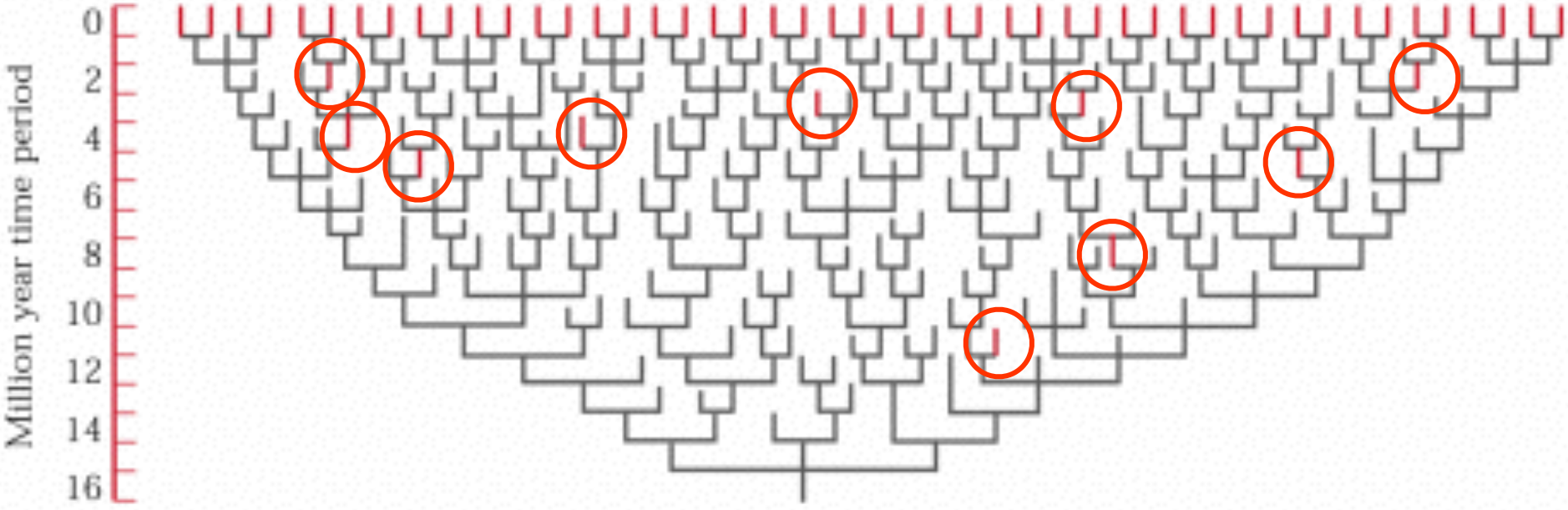
Reconstructing the phylogeny is prone to errors

- Imagine the “real” diversity of extinct species



Reconstructing the phylogeny is prone to errors

- Start with the "real" diversity of extinct species
- Suppose known fossils are randomly drawn from extinct species
  - Only about 3% of fossil species are likely ever found



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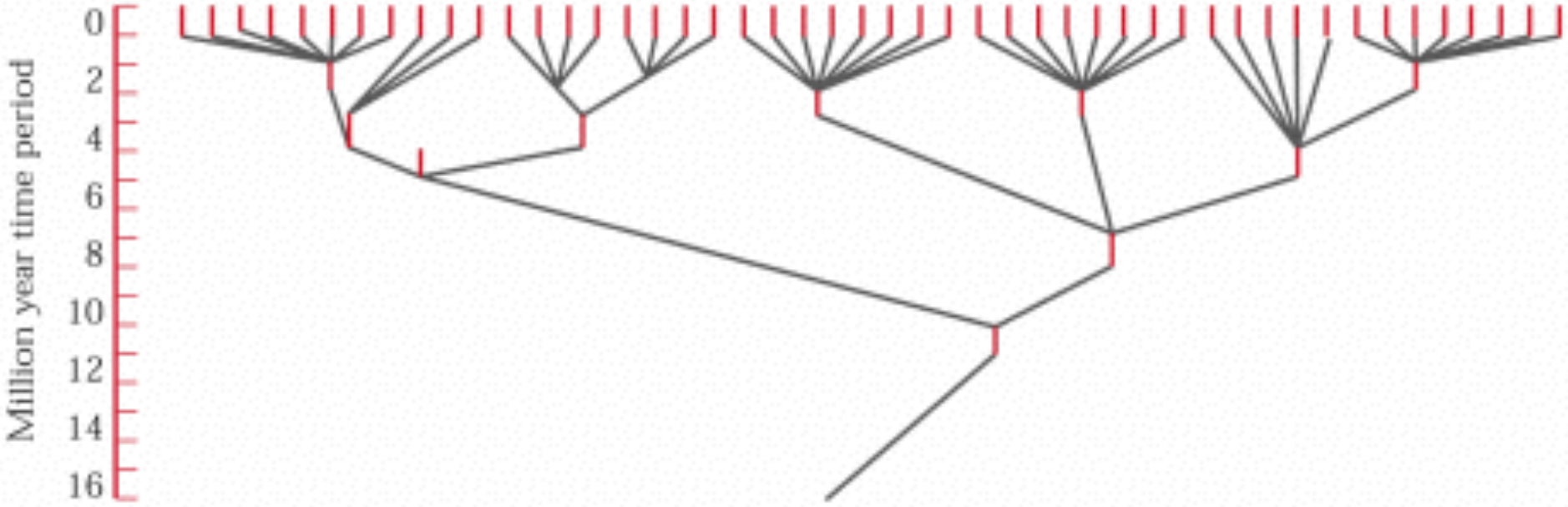
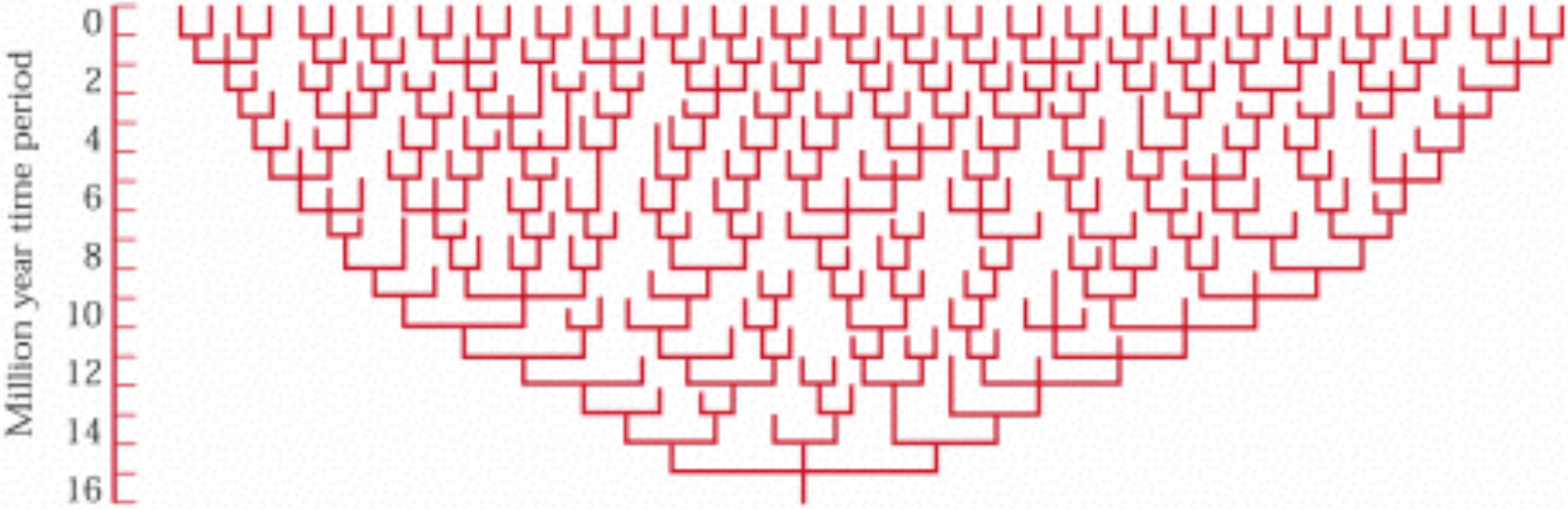


Reconstructing the phylogeny is prone to errors

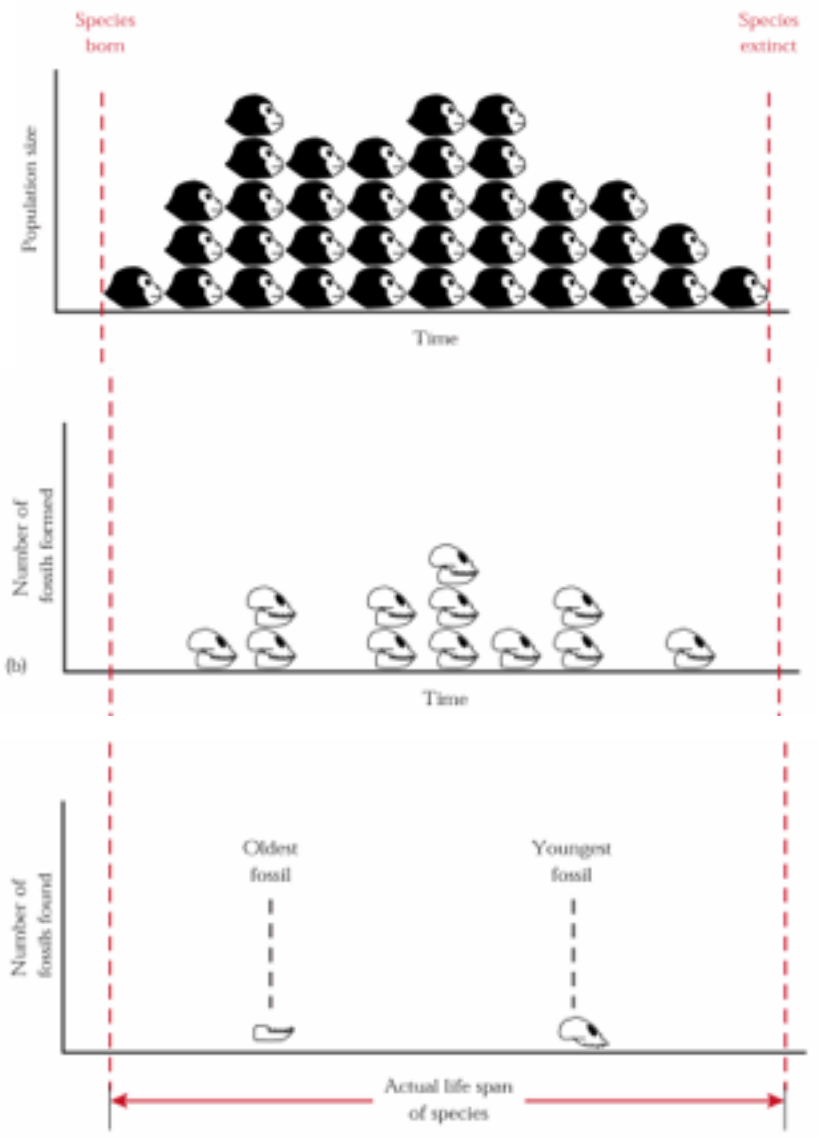
- Start with the "real" diversity of extinct species
- Suppose known fossils are randomly drawn from extinct species
  - Only about 3% of fossil species are likely ever found
- Draw phylogenetic tree from *known* fossils
- **Falsely simplifies actual phylogenetic relationships**



Missing data can also mislead us about the date of origin and the lifespan of a species

- Extinct species
  - Many individuals lived
  - Very few become fossils

- Small chance of finding very earliest or very latest fossils
  - **Under-estimate both age and lifespan of species**



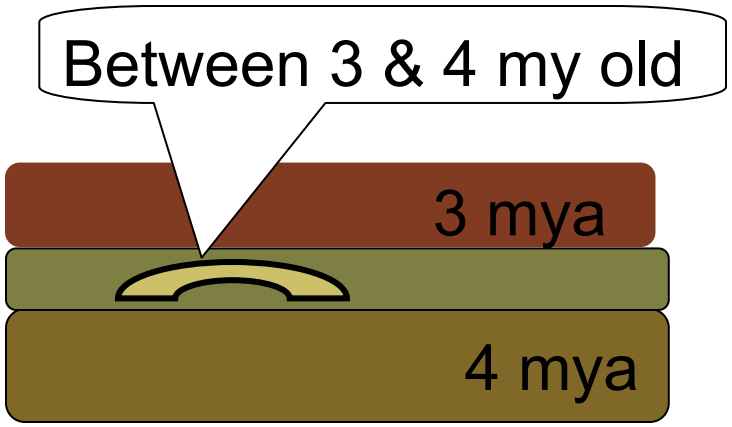
Determining the age of fossils pg 245 - 254

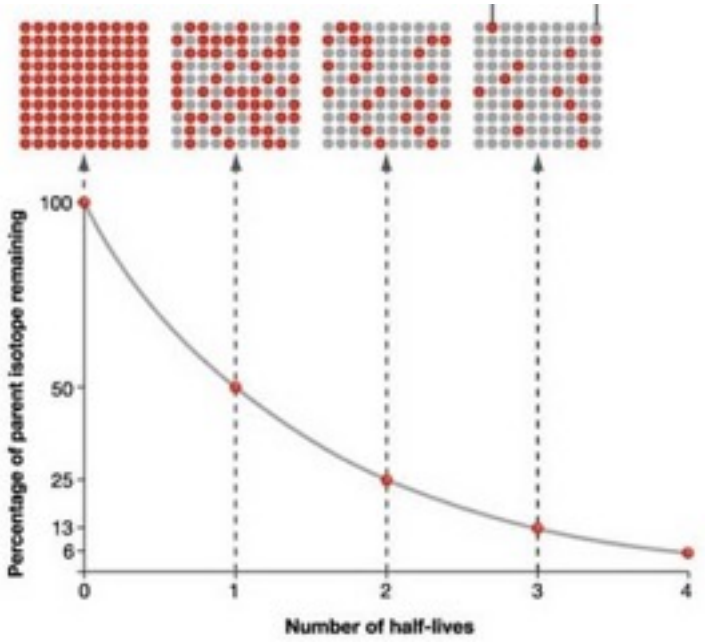
Relative Dating Techniques

- Stratigraphy
- Faunal Correlation
- Fluorine Dating
- Paleomagnetism

Chronometric Dating Techniques

- Radiometric Techniques
  - Carbon-14
  - Potassium-Argon

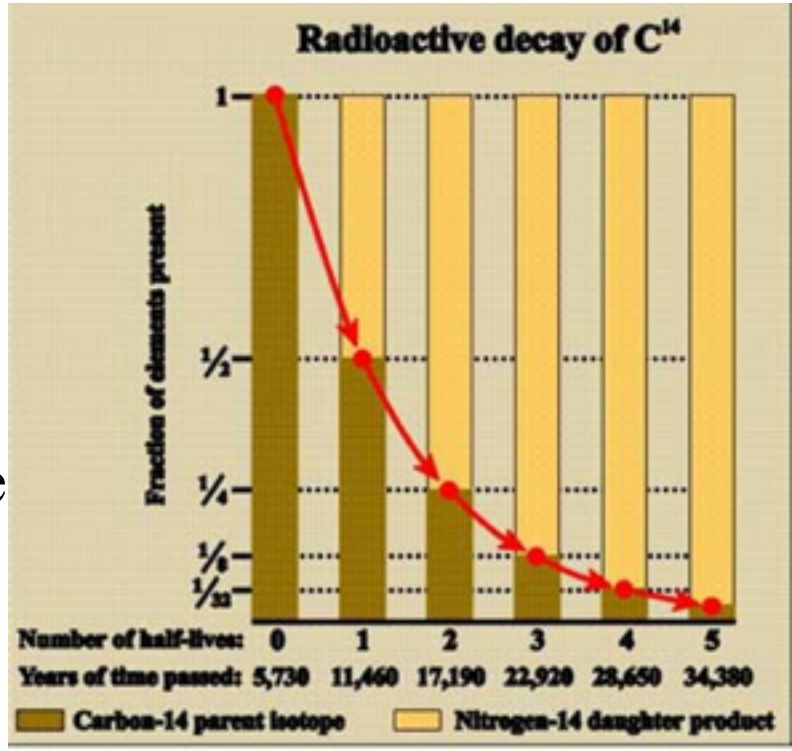




Radiometric Dating techniques

- Assign an absolute date to a layer of rock and fossils in it

- Radioactive isotopes are unstable
  - Isotope = variant of an element
- Decay into stable isotope
- Takes place at constant rate
- Measure decay rate by half-life
  - Amount of time it takes for half of remaining amount to decay
- Measure ratio of radioactive isotope to its decayed form = age



Radiometric Dating Techniques

potassium/argon (K/Ar) dating:

- Volcanic eruptions releases Ar gas
- Rock cools
- ^{40}K decays into ^{40}Ar
- ^{40}Ar is trapped in the rock
- half-life of 1.3 billon yrs
- ratio of K/Ar tells you how long ago the volcanic rock was formed
  - age of any fossils within that rock

Carbon-14

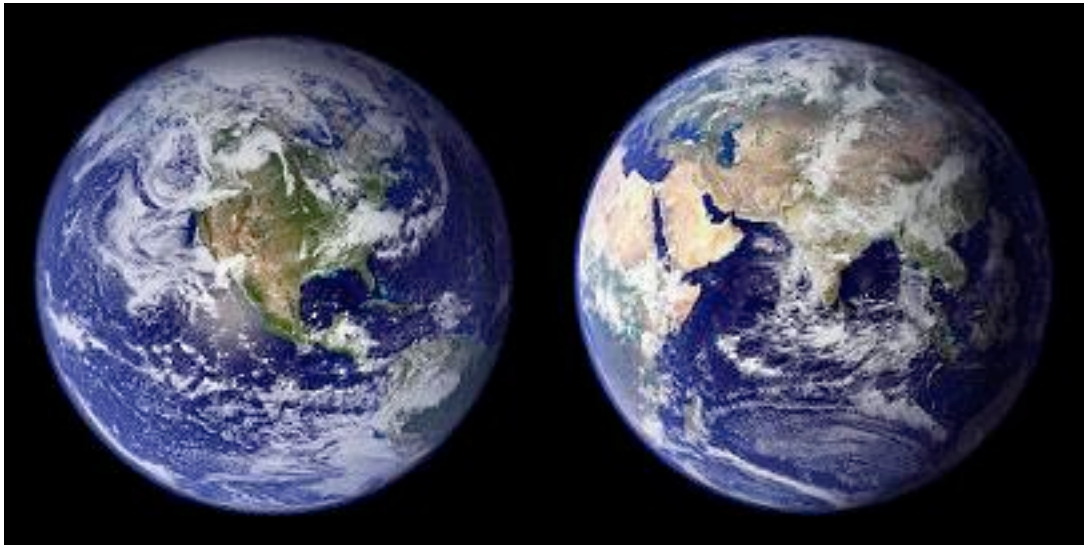
- Animals eat carbon 14 during lifetime
- Carbon 14 decays to carbon 12 when an animal dies
- Measure the ratio of carbon 14 to carbon 12 in bones or organic material
- **Best for fossils younger than 40,000**

Reminders

- Exam tomorrow
- 6 CLASSES LEFT
  - HOLY SH*%
  - Last quiz Monday
  - Final project handout today
  - Homework tonight watch video and answer questions
  - Lets finish strong!!!

Geologic Time Scale

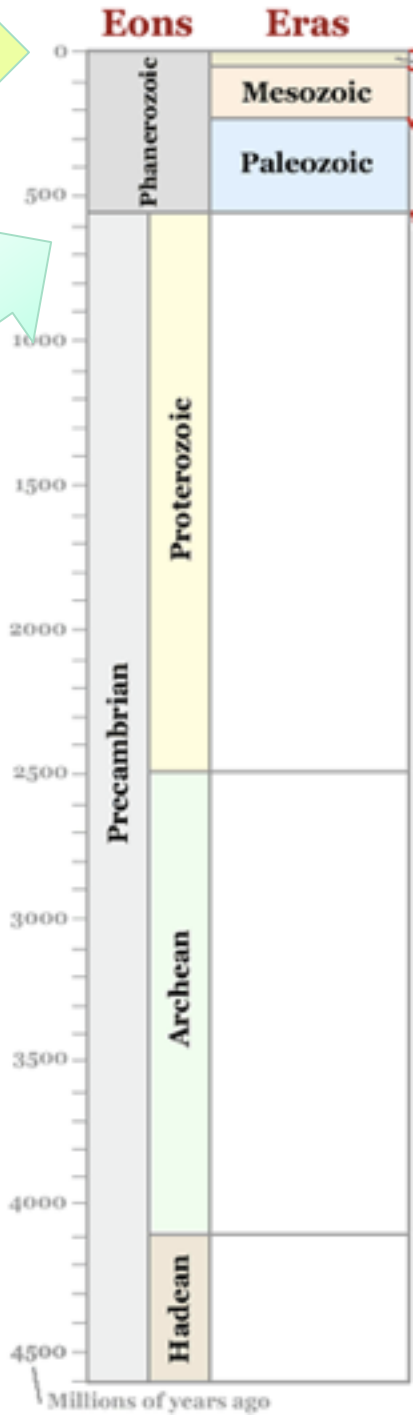
- Measures history of Earth – 4.5 billion years
- Organizes history of Earth into various units
- Eon > Era > Period > Epoch
- Important to understand the scale and pace of evolution



Cenozoic

Mesozoic

Paleozoic



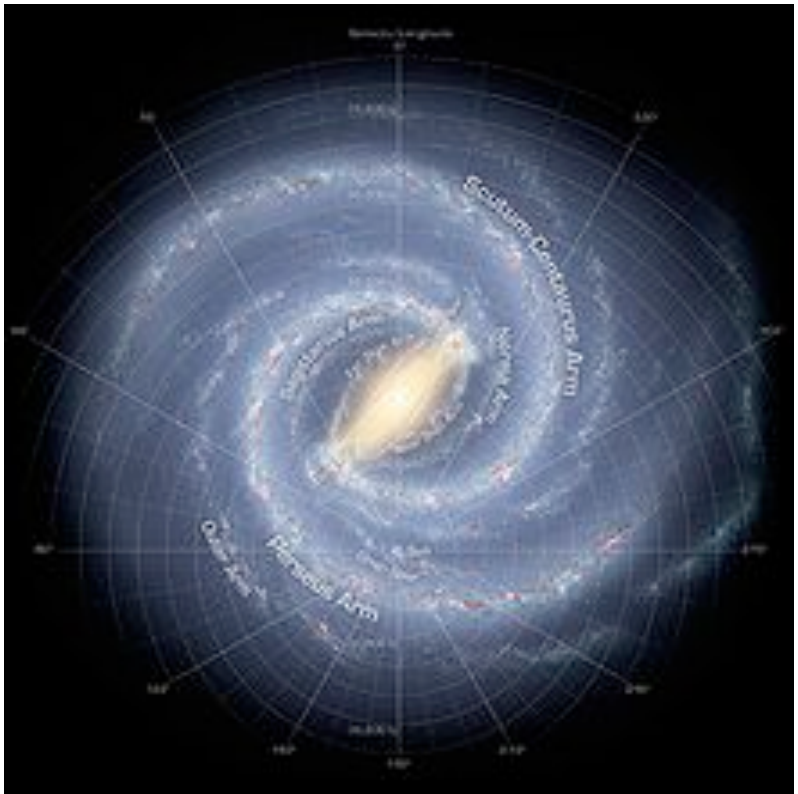
Phanerozoic Eon

Life appears on Earth

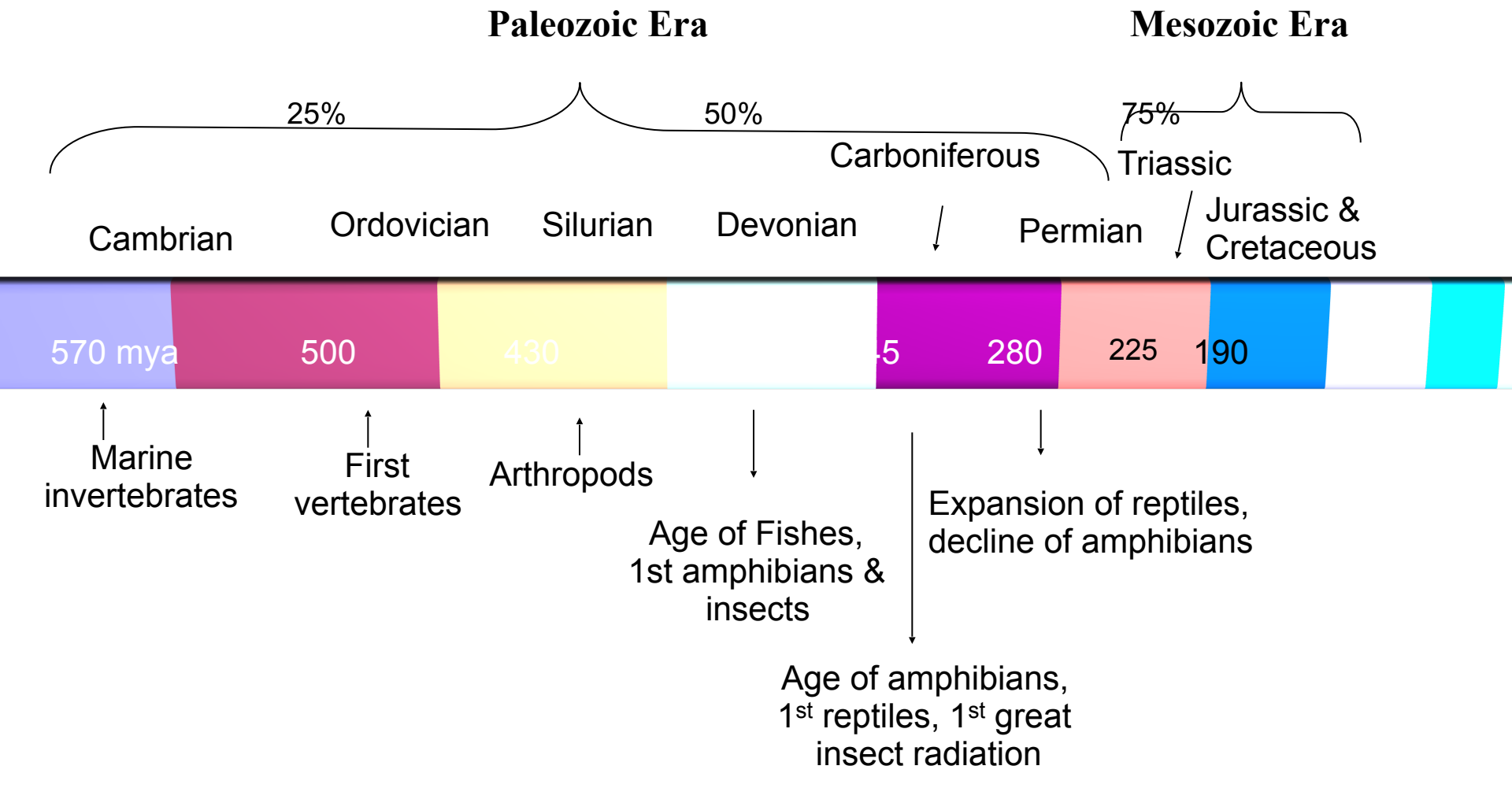
3.5 Billion YA

Earth forms

Solar System forms



Animal life diversifies starting in the Paleozoic



Recognizable fauna of the Mesozoic

Triassic Period

Jurassic Period

Cretacous Period

Cenozoic Era

0%

10

225

6

65

1st Mammals (Monotremes) & dinosaurs

Age of dinosaurs
1st birds

Mammals, birds, insects flourish

25%

Mesozoic Era

50%

1st flowering trees (**angiosperms**)
!st Marsupials, Placental mammals
Dinosaurs vanish @ 65mya
Continent(s) breaking apart

Starting in the Mesozoic the earth rearranged itself (200 mya – present)

A 225 mya

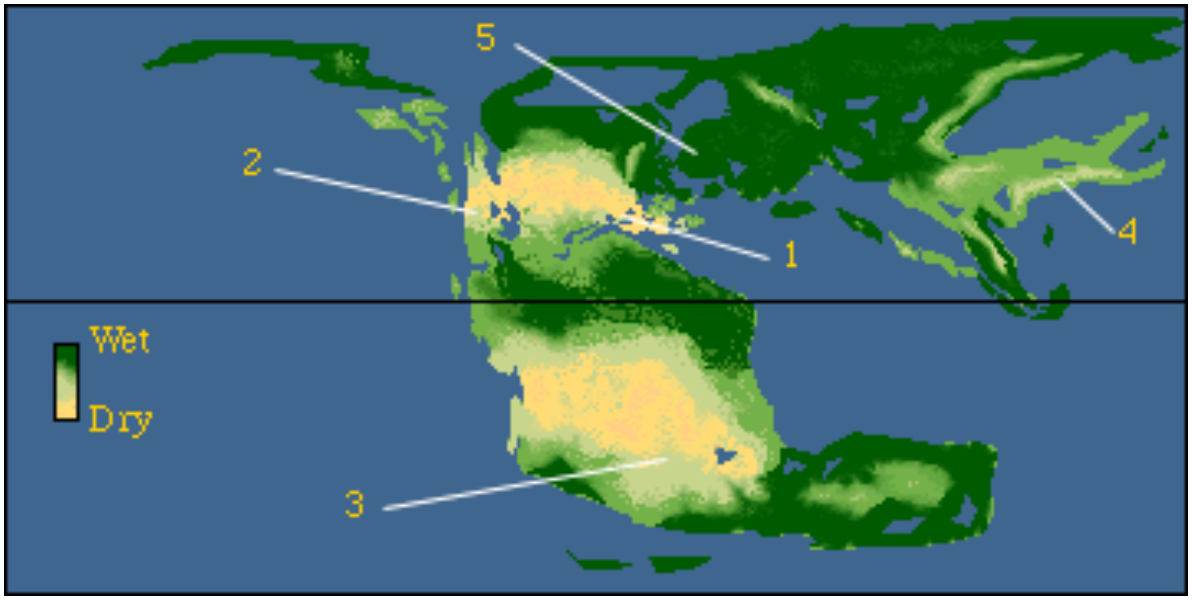
B 135 mya

C 65 mya

D Present

The Mesozoic: Triassic (225 mya)

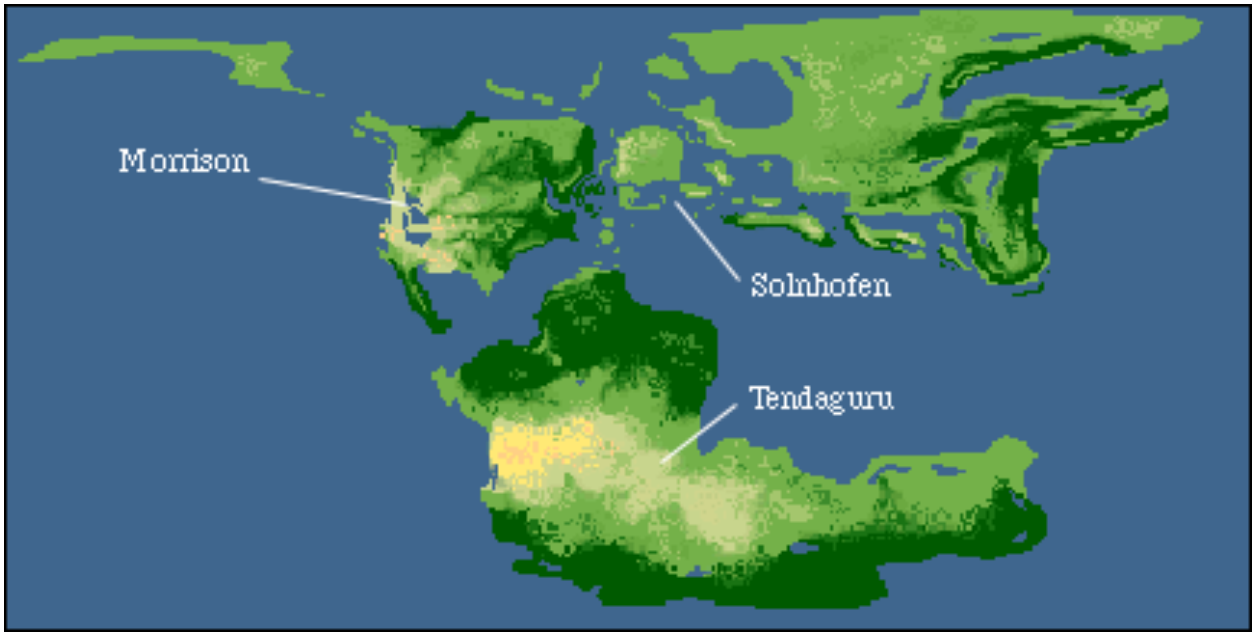
- Pangea was a single continent
- Dinosaurs & small mammals evolve
- Pangea HUGE land mass
  - Hot, arid, seasonal, some coastal areas more humid



Transition from Triassic to Jurassic

The Mesozoic: Jurassic (190 mya)

- 200 mya Pangea starts breaking up
  - Laurasia & Gondawana
- Oceans are barriers to gene flow = new species form
- World gets warmer, climate stable when continent splits
- Dinosaurs and mammals evolve in this warmer world



The Mesozoic: Cretaceous (136 mya)

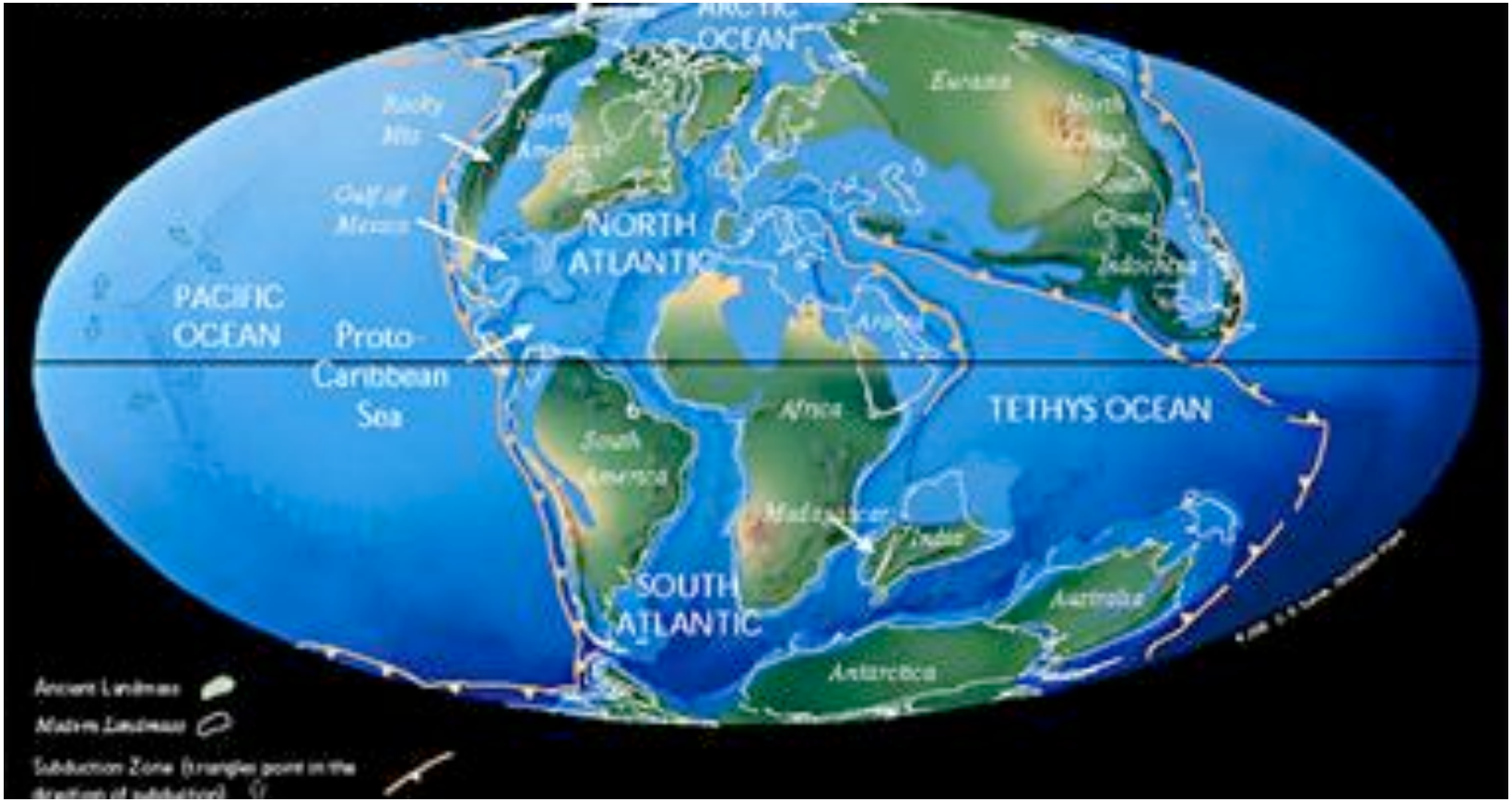
- Rise of **angiosperms** = fruits bearing trees = new foods
- Placental mammals evolve
- Adaptive Radiation

Gymnosperms

Angiosperms

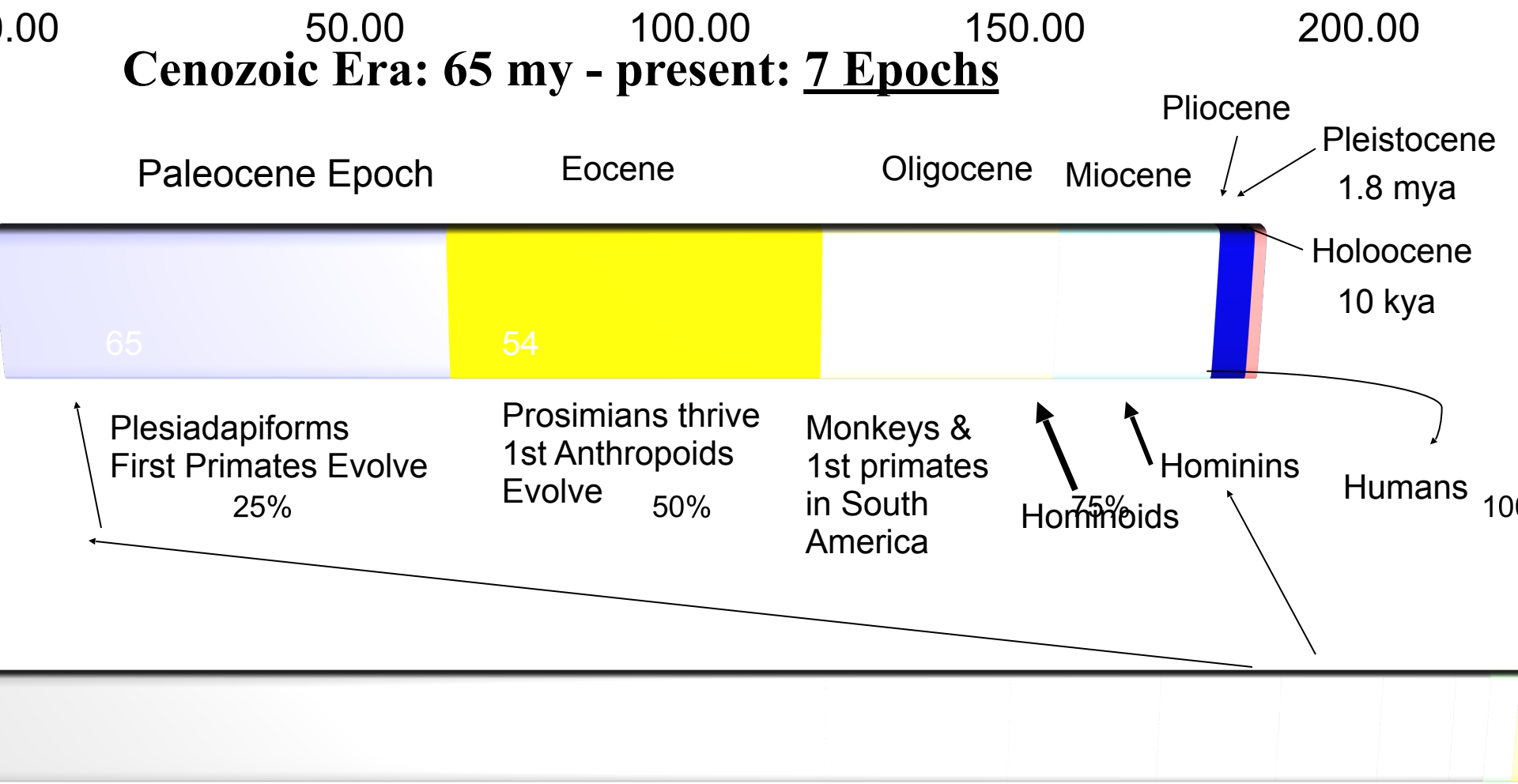
The Mesozoic: Cretaceous (136 mya)

Life's great until mass extinction of dinosaurs 65 mya



Continents & Climate @ 94 mya

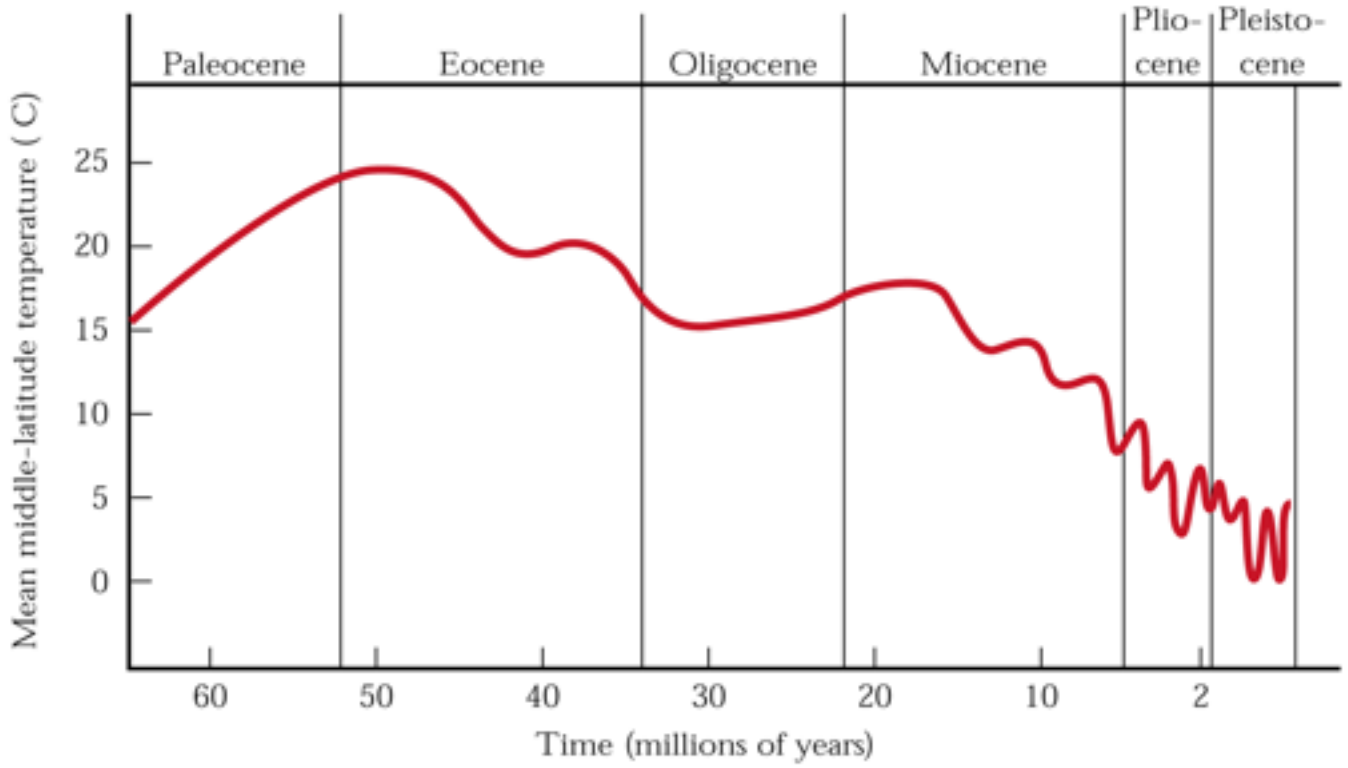
Primates finally start to enter the scene, 65 mya



Continental drift is important part of human history because it changed global climates

Temperatures have declined steeply from Eocene to present
Huge fluctuations in last 5 my

25C = 77° F
10C = 50° F



The Cenozoic: Paleocene

- **Paleocene** wet & warm
  - Radiation of mammal taxa with some primate-like traits
  - **Plesiadapiforms – not quite yet primates thrive**
    - Europe & North America
    - Primate-like molars
    - Ankles for climbing trees

Purgatorius

Dryomomys

The Cenozoic: Eocene

- **Eocene** ↑ wetter & warmer
  - Tropical forests
  - SA isolated from NA & Europe = new species
  - First true primates
  - Prosimian-like traits
  - Two families in North America & Europe
    - **Adapidae**
      - Lemur-like prosimians
    - **Omomyidae**
      - Tarsier-like prosimians
- Mass extinction at end of Eocene
- First Anthropoids evolve

Smilodectes

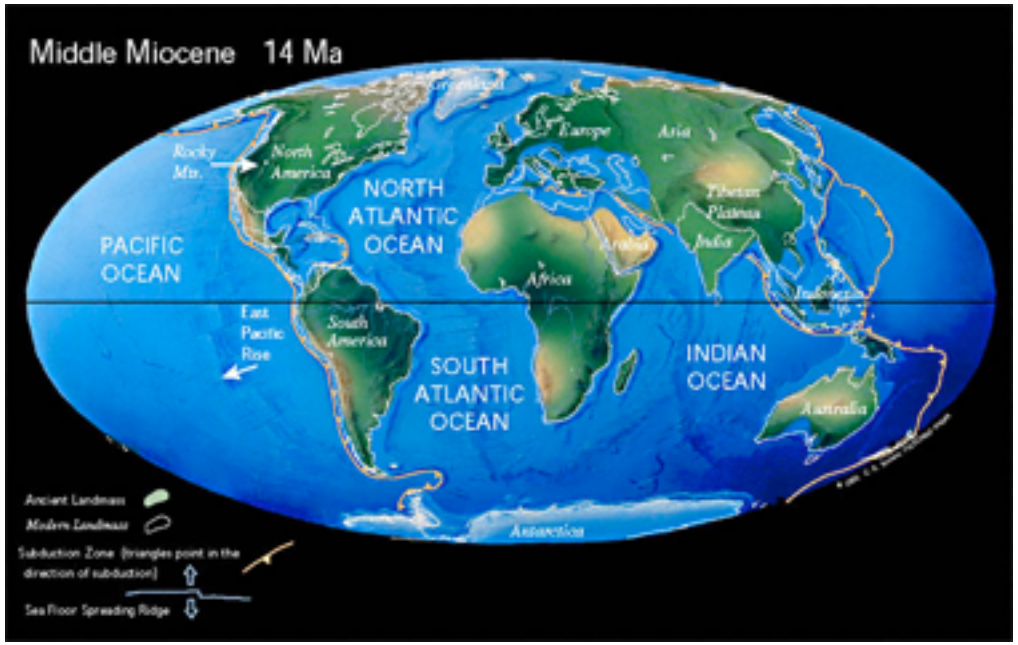
The Cenozoic: Oligocene

- **Oligocene** getting colder & drier
  - more seasonal variation
  - Mostly modern continent positions
    - South America still separate
  - Cold water currents cooling earth
    - Africa & SA tropical forests remain
    - Tropics receding in other areas
  - **Age of the Anthropoid (monkeys)**
    - **Parapithecidae (*Apidium*)**
    - **Proliopithecidae (*Aegypotopithecus*)**
  - First platyrrhines in South America!
  - **First Hominoids (apes) evolve**

Aegypotopithecus

The Cenozoic: Miocene

- **Miocene** warm & moist at beginning
  - Got colder & drier
  - Forests retreating = open woodland habitat
  - Himalayas form = block warm → cold air currents
  - Rift valley forms = rain shadow & dry savannah



The Cenozoic: Miocene

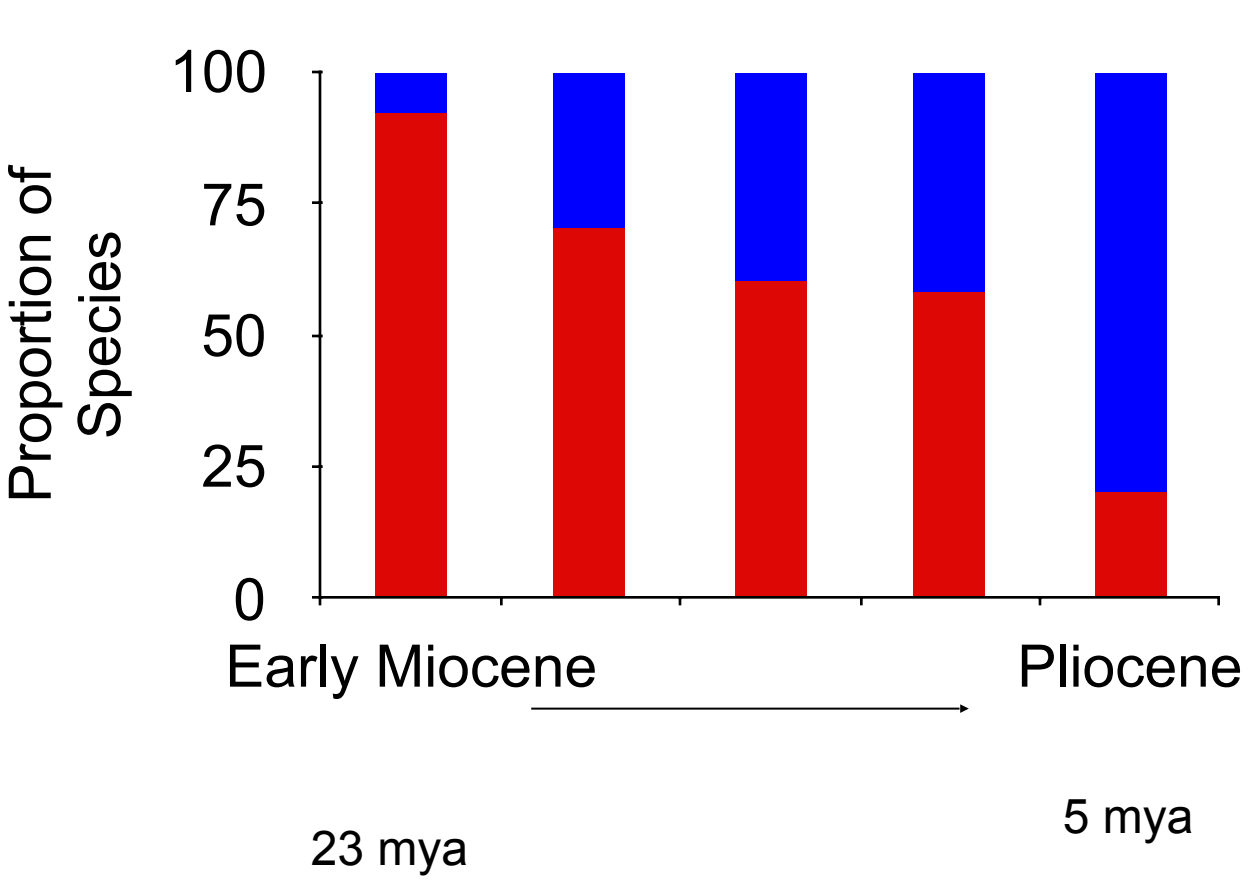
- **Miocene** warm & moist at beginning
  - **Golden age of the Hominoids (apes) (early Miocene)**
    - Great diversity of species
    - Fruit diet specialization
    - Some arboreal quadrupeds, some terrestrial quadrupeds, **suspensory adaptations later**

Proconsul

- **Late Miocene** getting drier & colder
  - Ape shift to knuckle-walking adaptations
  - Ape species retreat to remaining tropics
  - Mass extinction of apes at end of Miocene
  - **First hominins evolved (late Miocene)**

Ardipithecus

The distribution of primate species shifted during Miocene

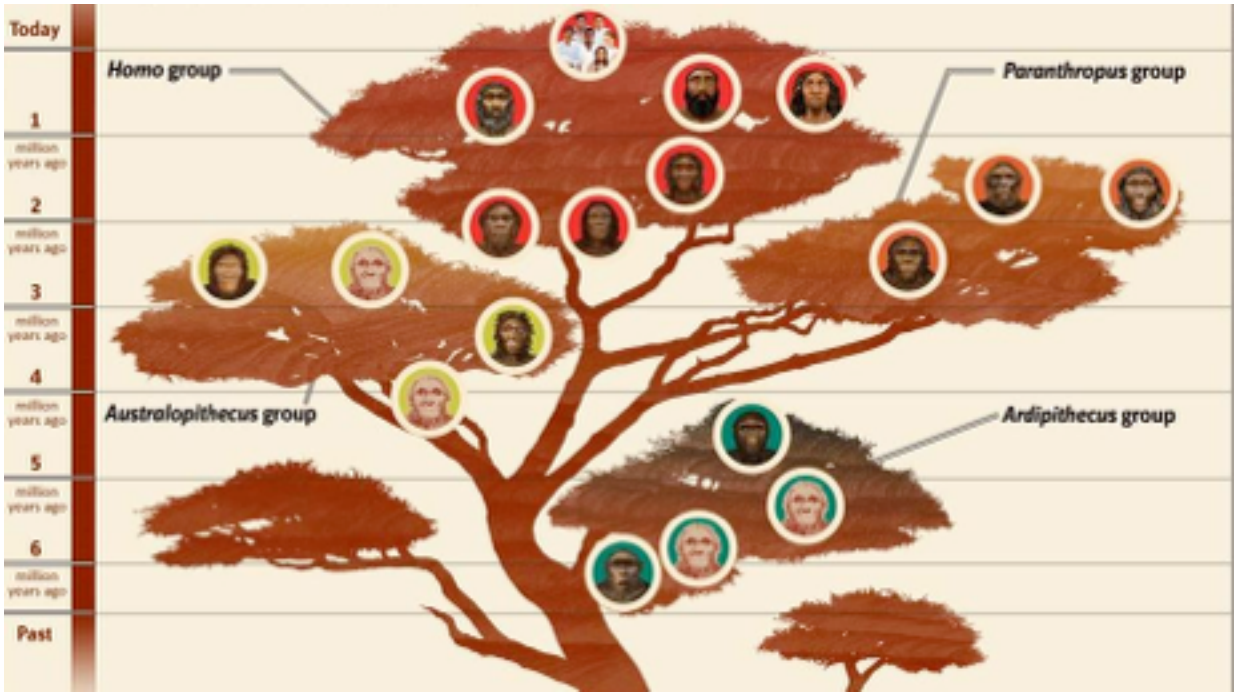


- Monkeys are more r-selected than apes
- reproduce faster
- respond quickly to environmental changes
- apes didn't adapt to changes, stayed in tropical forest niches

The Cenozoic: Age of the Hominins

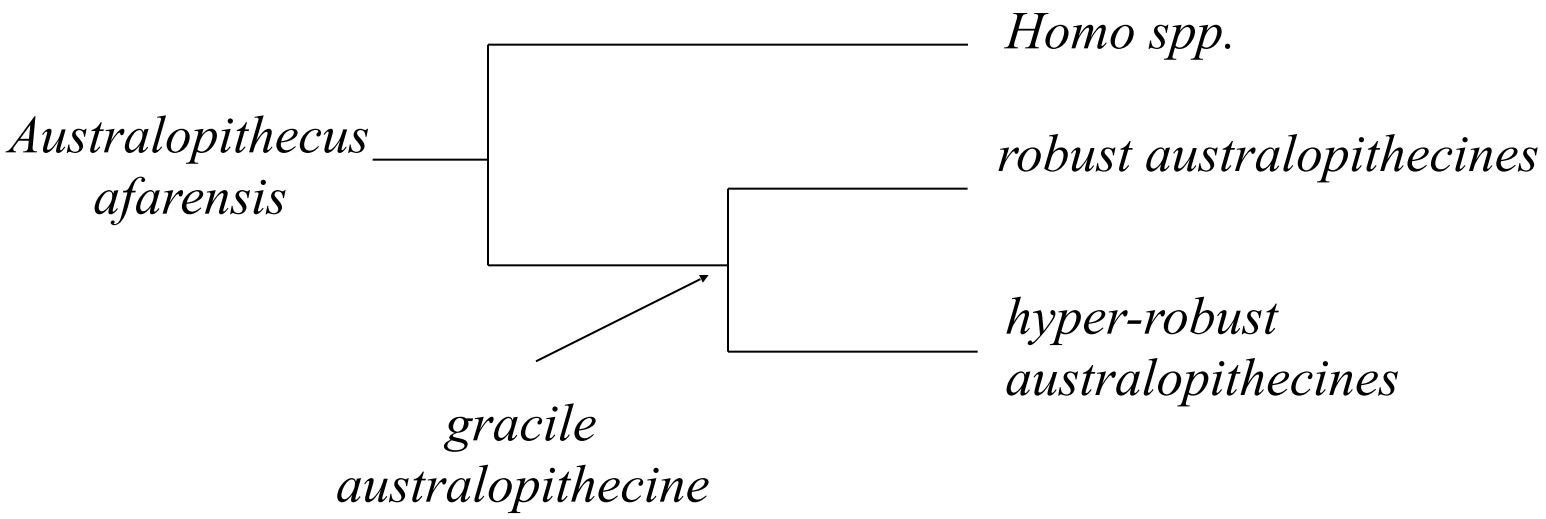
- **Pliocene** begins frequent temperature fluctuations
  - Hominins diversify
  - *Australopithecines* & *Paranthropines*

- **Pleistocene**: extreme temperature fluctuations
  - Genus *Homo* appears 1.8 mya

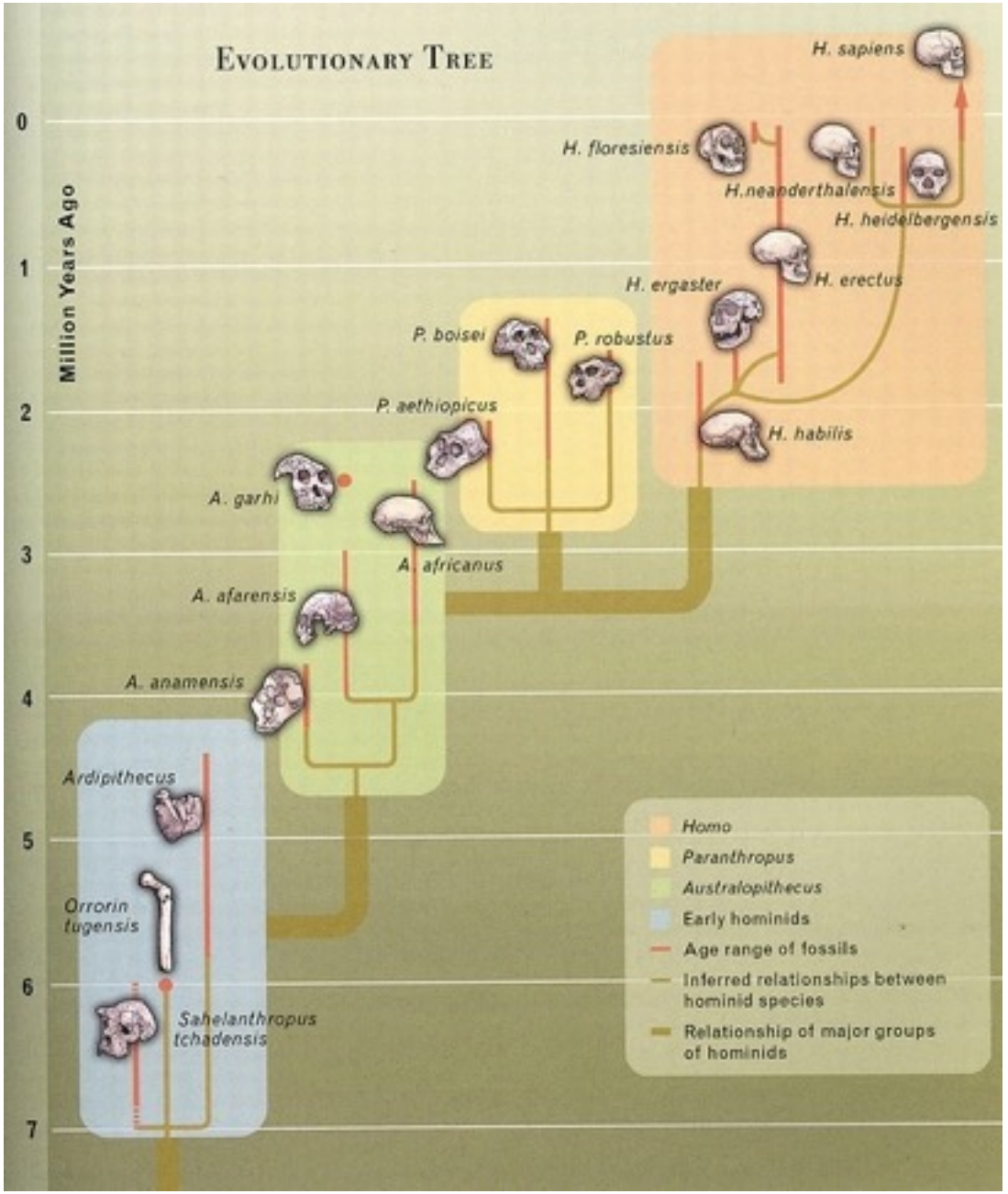


Paleoanthropology is full of controversies:

We used to believe that the hominid lineage was fairly simple



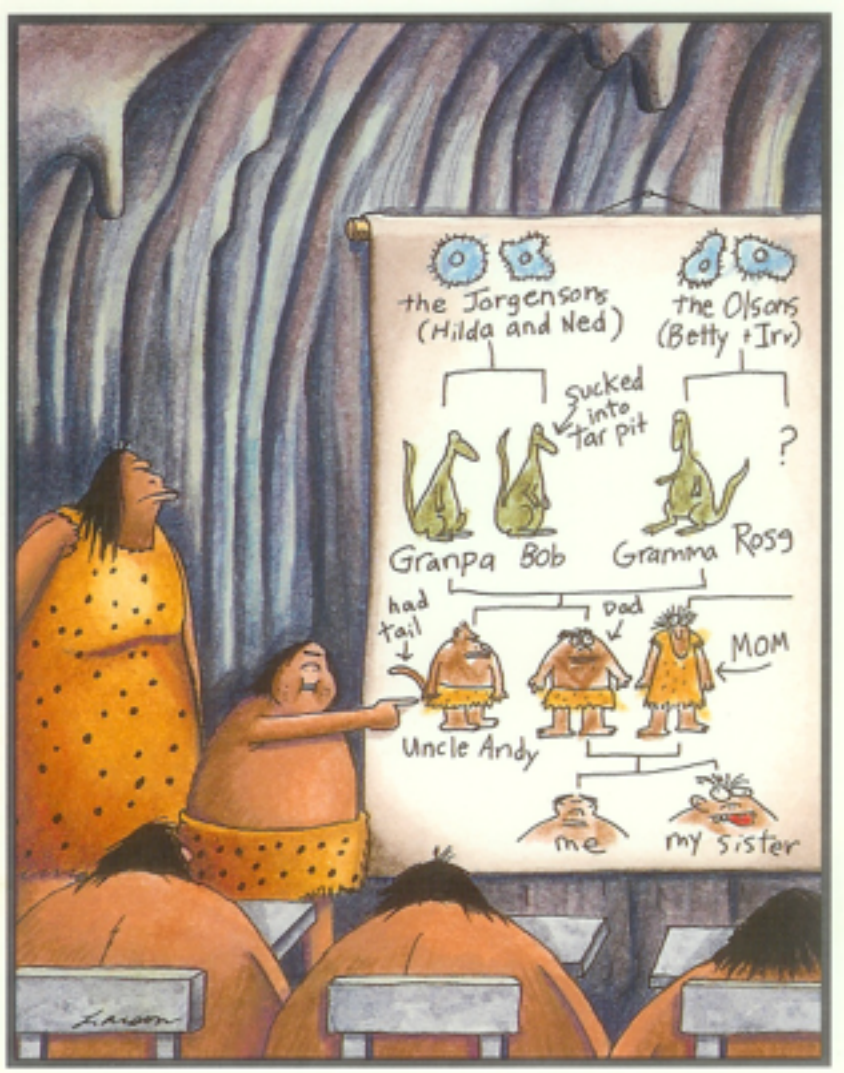
As new species are unearthed, the phylogeny is less certain



Don't be too worried about the phylogenetic relationships

- Know a lot about how life has evolved
  - Recognize our understanding changes
  - Recognize that *improving* ≠ *disproving*

- More interested in the selective pressures & adaptations that occur along the way



Dirk brings his family tree to class.