ANTH 42: Primates in Nature

Lecture 2:
Primate evolution

http://weber.ucsd.edu/~jmoore/courses/anth42web/

Rules to a story

- **What?**
- **When?**
- **Where?**
- **Why?**

… but today, not in that order:

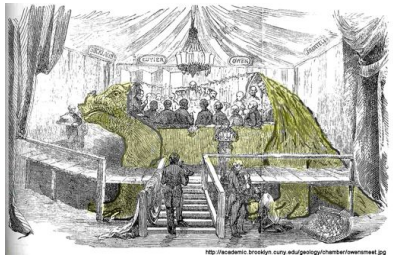
When? Dating methods and deep time

Where? How do fossils form - taphonomy

What? The primate fossil record

Why? Evolution and its mechanisms (including natural selection) [*later lecture*!]

WHEN: Dating methods



1854: Dinner in the *Iguanodon*

***Bishop James Ussher*: 1650 calculated from Bible that Creation occurred 4004 BC**

Mary Ann Mantell: 1820 discovered "Iguanodon" tooth (Sussex, UK)*

***Richard Owen*: 1842 coined word "Dinosaur"**

Was hard to reconcile 6,000 years with creatures SO different and so clearly extinct.

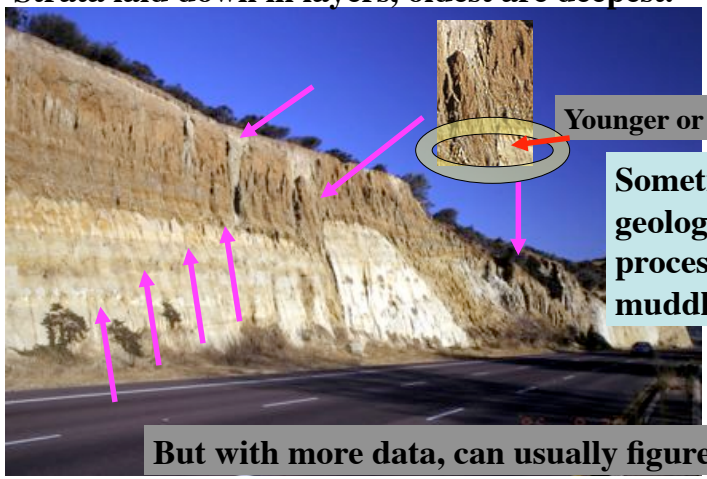
Uniformitarianism violated.

*** Other giant bones known, but this specimen first to kick off 'modern' interest**

WHEN: Dating methods

Uniformitarianism & the earth

Strata laid down in layers, oldest are deepest.



Sometimes, geological processes can muddle that up.

But with more data, can usually figure it out.

WHEN: Dating methods

≈ 100 years trying to date fossils. Recognized fossil 'stages' - rocks with no crinoids or coral overlaid by rocks with crinoids and coral, but no dinosaurs, so could talk about "age of crinoids" and "age of dinosaurs". Knew the order taxa showed up (relative dating), but argue about when in years (absolute dating).

WHEN: Dating methods

Absolute.

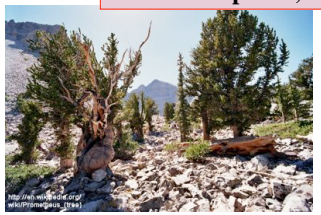
Dendrochronology

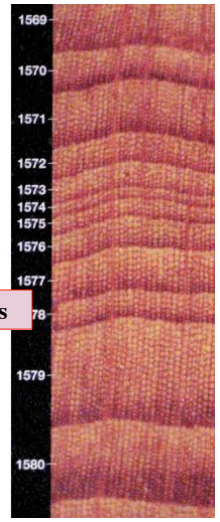
(tree rings)

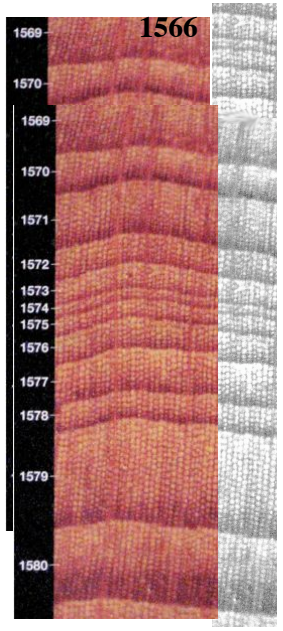
Growth depends on rainfall; annual rings.

Count inward from outermost ring, get age of tree.

Bristlecone pine 5,000 yrs







Buried log

WHEN: Dating methods

Absolute.

Dendrochronology

(tree rings)

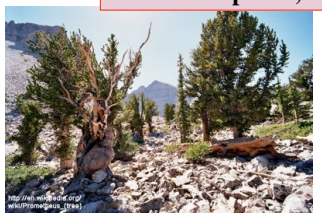
Growth depends on rainfall; annual rings.

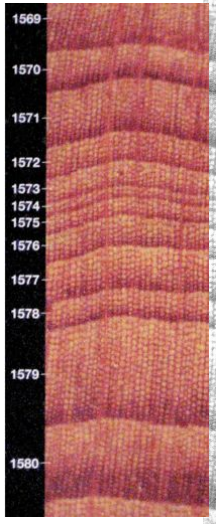
Count inward from outermost ring, get age of tree.

River oaks, S. Germany: > 10,000 yrs

Bristlecone Pines, SW USA: 8,500

Bristlecone pine 5,000 yrs





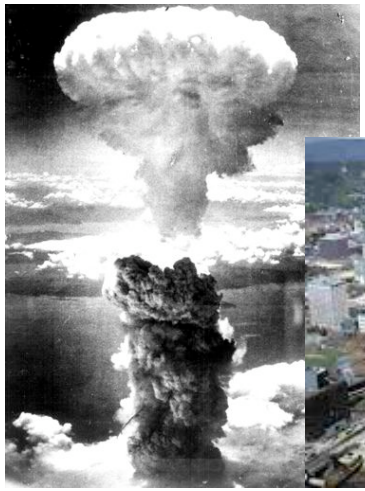
1566

Buried log

WHEN: Dating methods

Absolute. Dendrochronology

Radiometric



Isotopic decay - measurable rates

Buried log

WHEN: Dating methods

Absolute. Dendrochronology

Radiometric

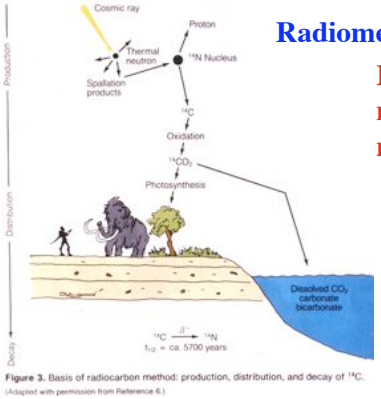
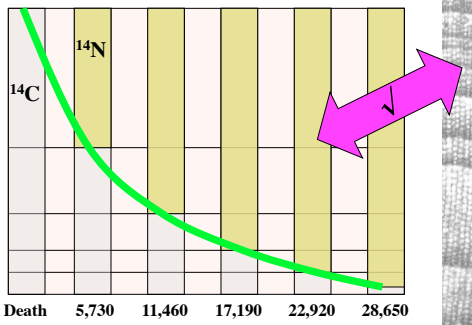


Figure 3. Basis of radiocarbon method: production, distribution, and decay of ^{14}C.
(Adapted with permission from Reference 6.)

Radioactive decay of unstable isotopes - half-life

Isotopic decay measurable rates

- **total amount of carbon**
- **amount of ^{14}C**
- **^{14}C/^{12}C at death (atmospheric)**



TIME

WHEN: Dating methods

Absolute. Dendrochronology

Radiometric

Uranium - Lead (U/Pb)

^{235}U -> ^{207}Pb: 700my

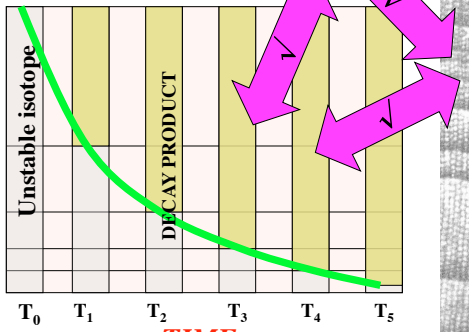
^{238}U -> ^{206}Pb: 4,500my

Potassium - Argon (K/Ar)

^{40}K -> ^{40}Ar: 1,300my

Radioactive decay of unstable isotopes - half-life

Isotopic decay - measurable rates



TIME

WHEN: Dating methods

Absolute. Dendrochronology

Radiometric

NOW:

"DEEP TIME"

Uranium - Lead (U/Pb)

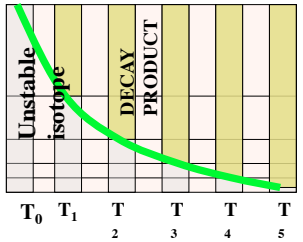
^{235}U -> ^{207}Pb: 700my

^{238}U -> ^{206}Pb: 4,500my

Potassium - Argon (K/Ar)

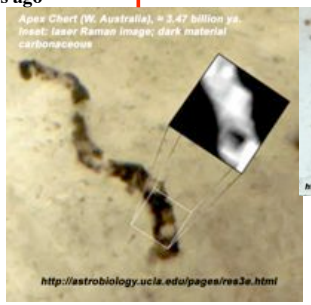
^{40}K -> ^{40}Ar: 1,300my

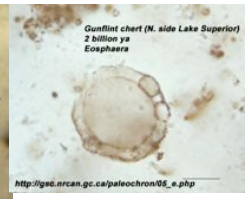
Radioactive decay of unstable isotopes - half-life

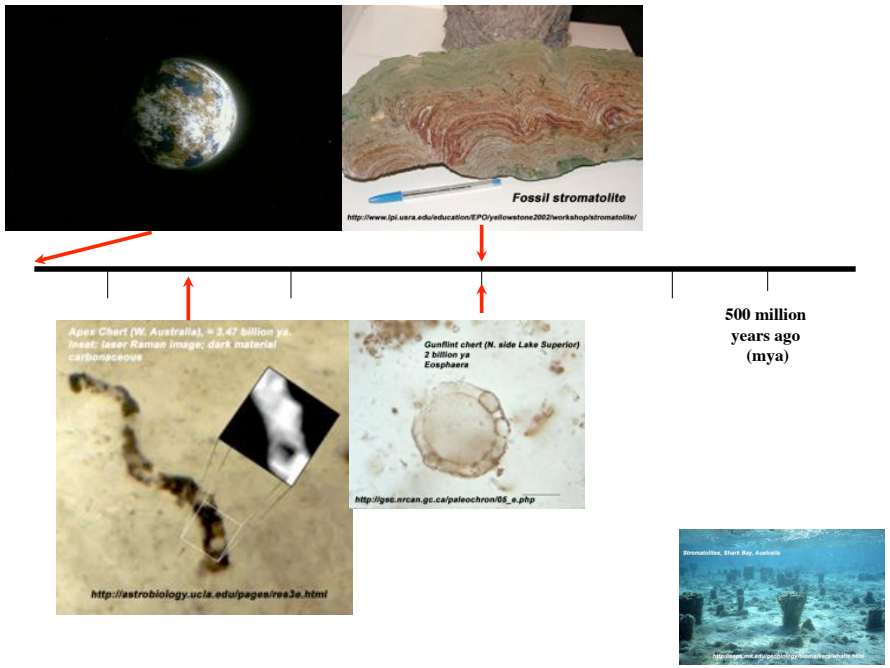


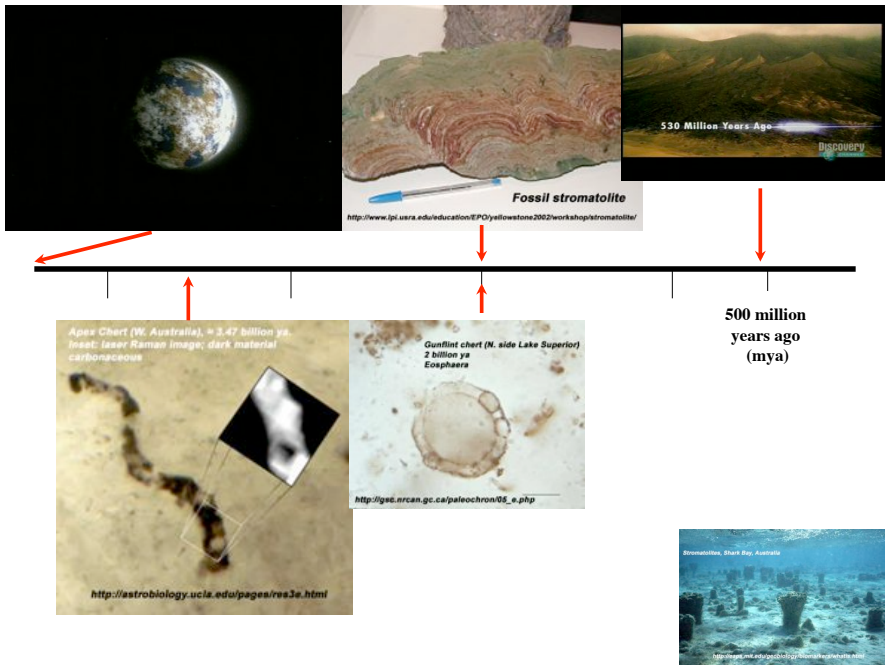
4.4 billion years ago

500 million years ago (mya)






Fossil stromatolite
http://www.lpi.usra.edu/education/EPO/yellowstone2002/workshop/stromatolite/
500 million
years ago
(mya)
Apex Chert (W. Australia), ≈ 3.47 billion ya.
Inset: laser Raman image; dark material
carbonaceous
http://astrobiology.ucla.edu/pages/res3e.html
Gunflint chert (N. side Lake Superior)
2 billion ya
Eosphaera
http://igse.nrcan.gc.ca/paleochron/05_e.php
Stromatolites, Shark Bay, Australia


530 Million Years Ago
Discovery
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(mya)
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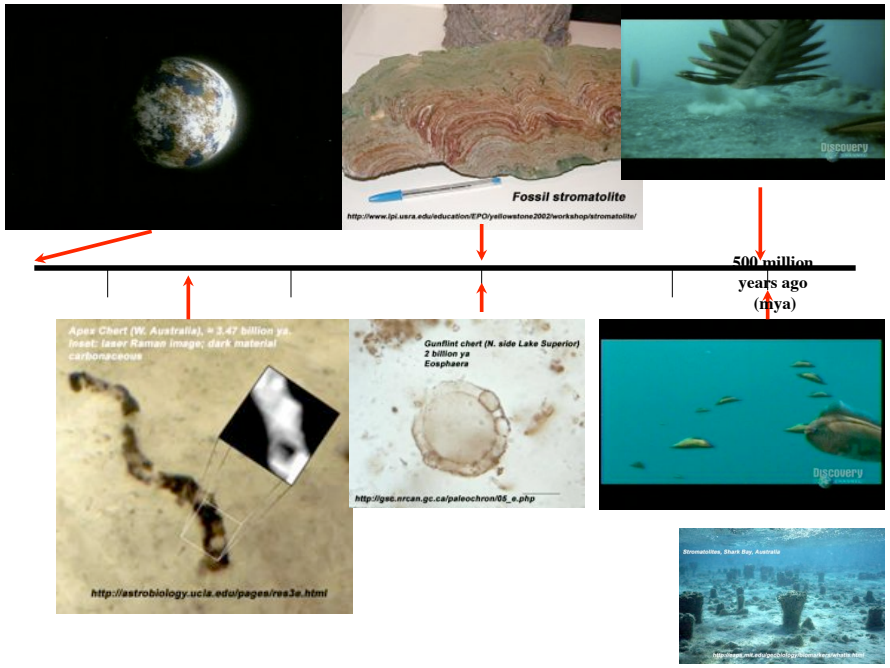
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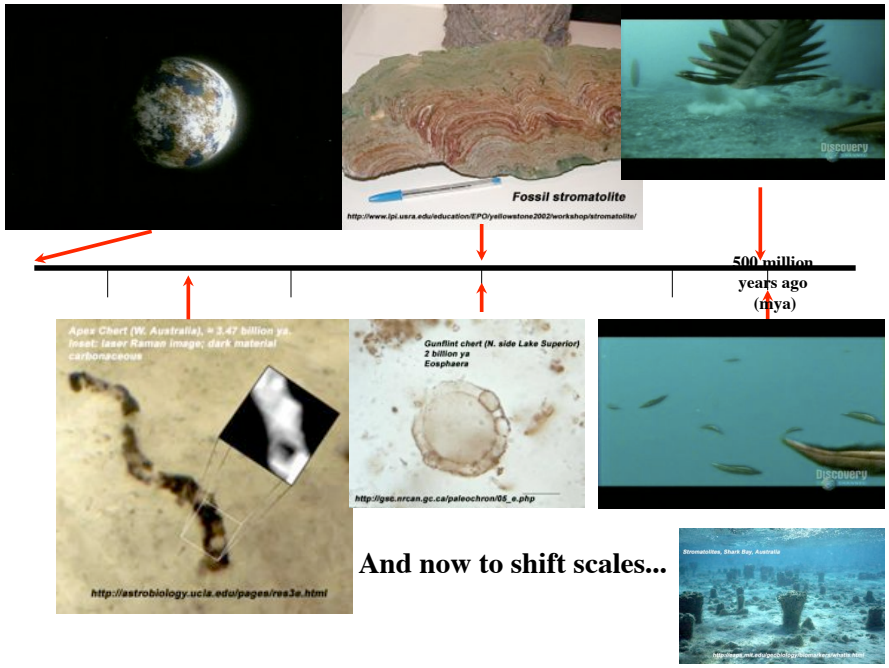
Discovery
Stromatolites, Shark Bay, Australia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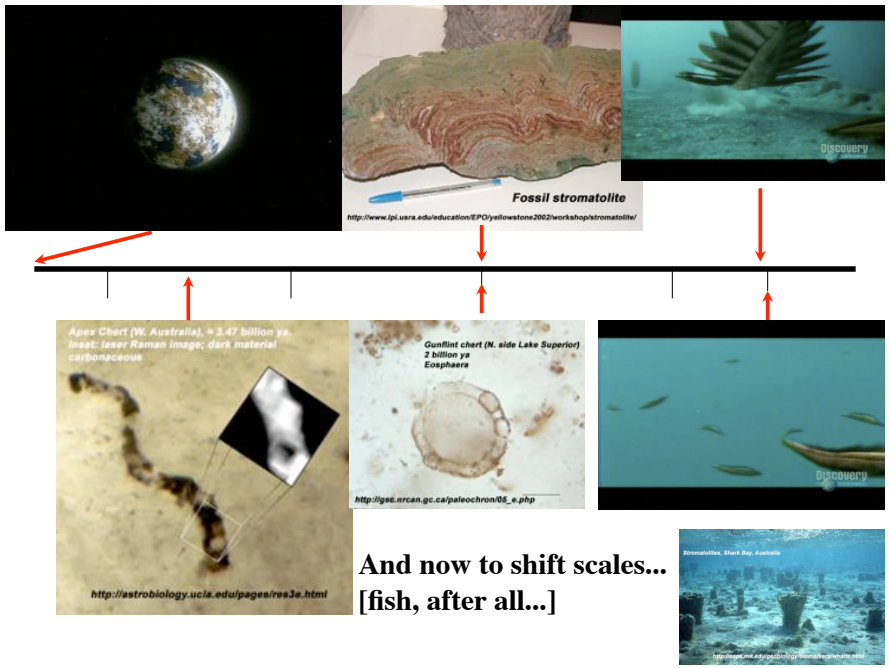
Discovery
And now to shift scales...
Stromatolites, Shark Bay, Australia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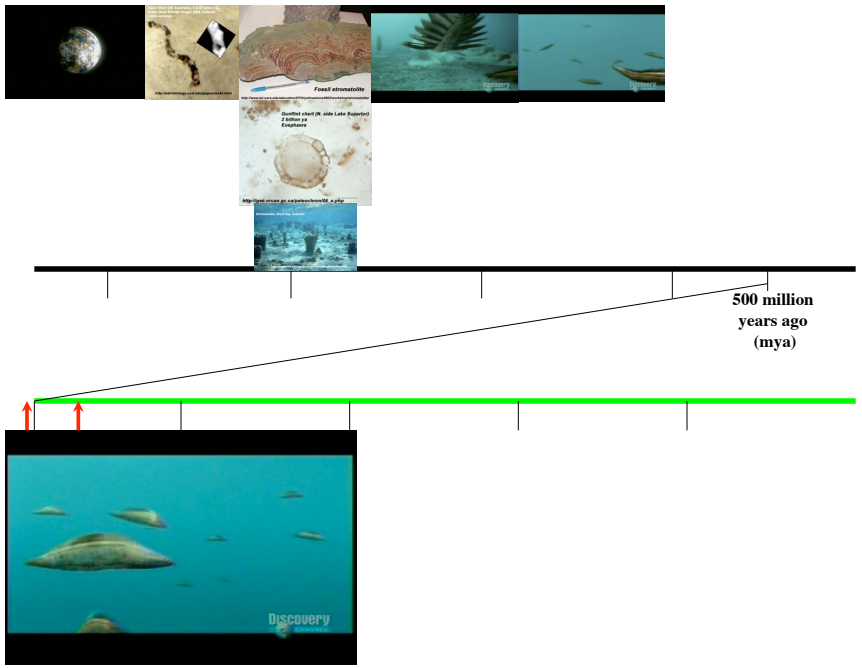
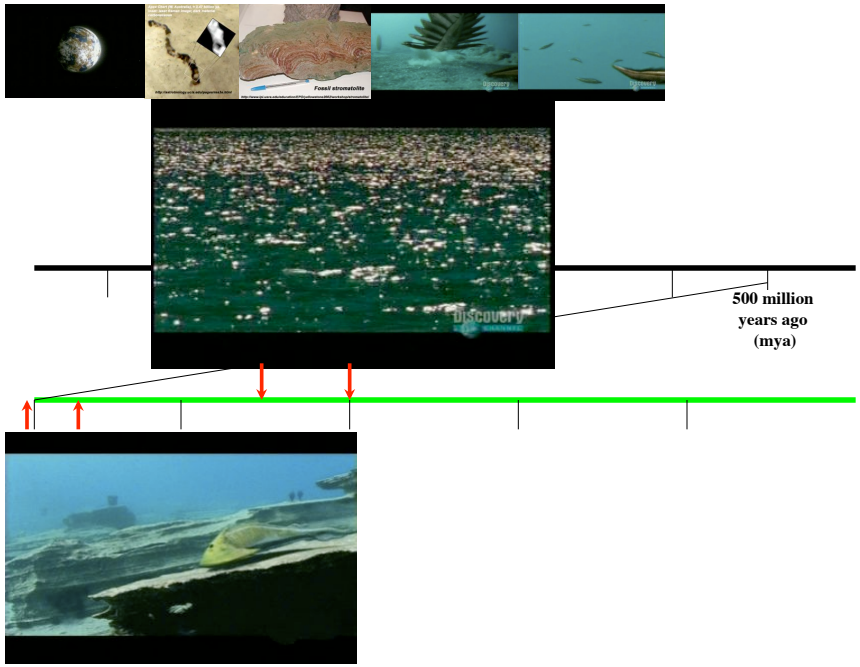
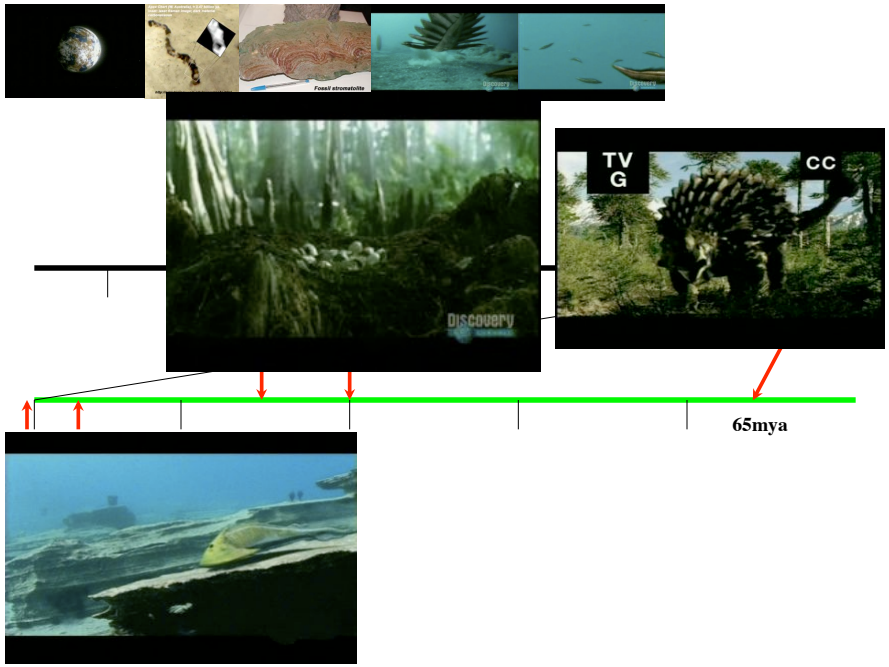
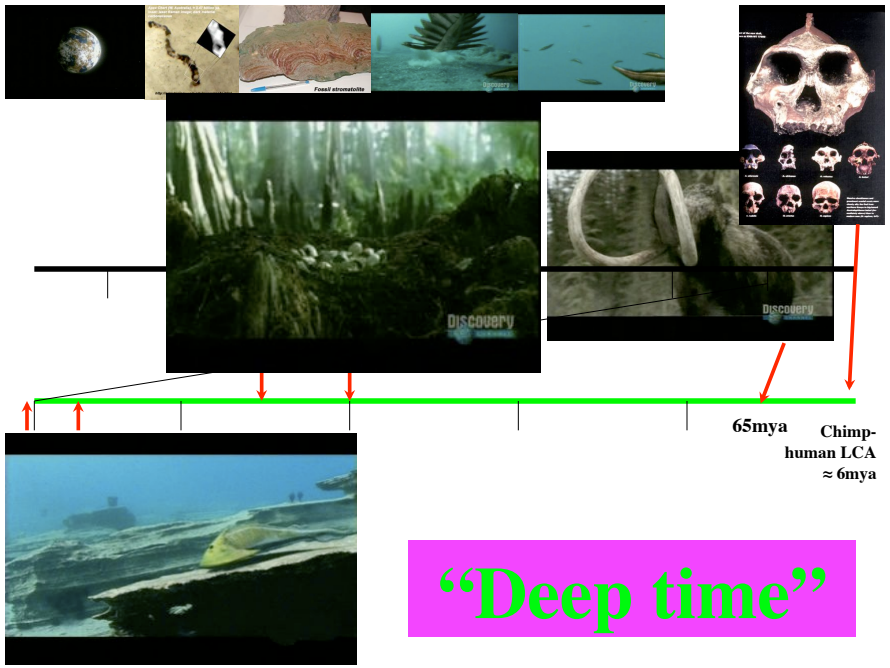
http://gsc.nrcan.gc.ca/paleochron/05_e.php
Stromatolites, Shark Bay, Australia
And now to shift scales...
[fish, after all...]


500 million
years ago
(mya)


500 million
years ago
(mya)


TV
G
CC
65mya

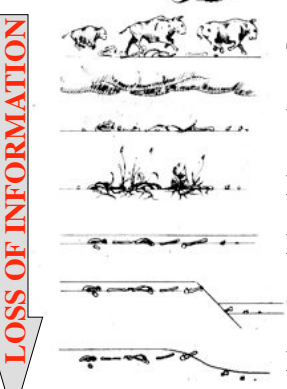


"Deep time"

WHERE: Taphonomy

***Taphonomy*: the study of burial and decay; creation of fossils.**

LOSS OF INFORMATION



Chewed up, pulled apart

Trampled, dispersed

Weathered

Plant roots

Buried

Geological deformation

Exposed (partially?)

***Gain* of information (?): What happened to this horse?**

WHERE: Taphonomy - one consequence

Living species *Same color = closely related.*

- **Because VAST MAJORITY of individual organisms that have ever lived do NOT become fossils (let alone recognizable ones),**
- **And of the ones that do, only a TINY MINORITY then become exposed and available for study,**
- **We *expect* gaps in the fossil record….**

LOSS OF INFORMATION

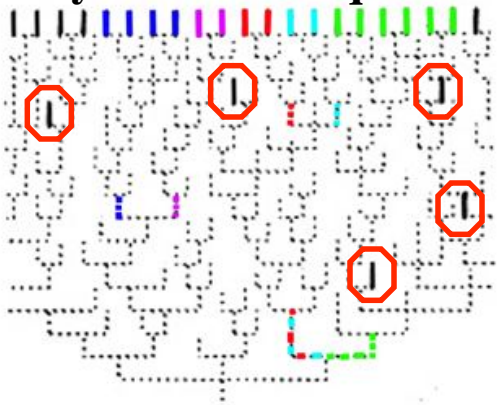
Morphological similarity

WHERE: Taphonomy - one consequence

Living species *Same color = closely related.*

LOSS OF INFORMATION

Time



Morphological similarity

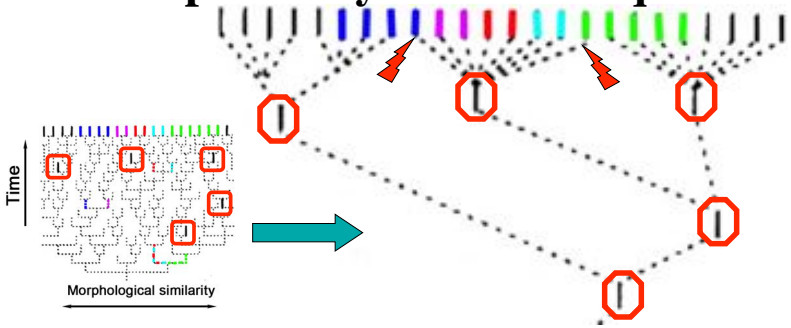
Fossils

***Count* species in modern habitat, *compare* with fossil species in similar "fossil habitat", *estimate* # missing species. Guess?**

≈ 90%

(Uniformitariansim)

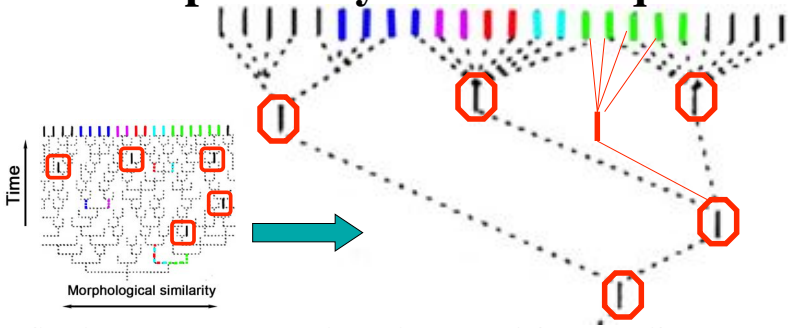
WHERE: Taphonomy - one consequence



LOSS OF INFORMATION

- **Cheating to connect branches with species we haven't found, even if know they *must* have existed.**
- **So connect up available species.**
- **Make mistakes.**

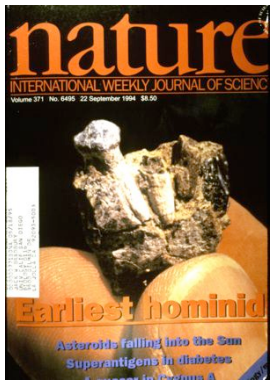
WHERE: Taphonomy - one consequence



LOSS OF INFORMATION

- Cheating to connect branches with species we haven't found, even if we know they *must* have existed.
- So connect up available species.
- Make mistakes.
- **Find new fossil, revise understanding (and get closer to reality)**

WHERE: Taphonomy - another consequence



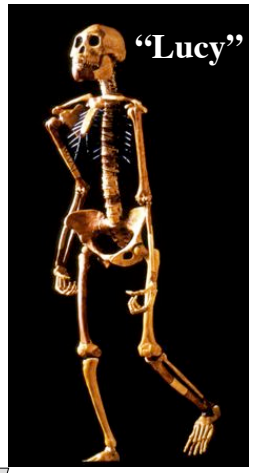
Jaws and especially *teeth* are HARD

What *PARTS* get left?

Faces aren't easy to chew and don't have much meat (medium-size animals).

LOSS OF INFORMATION

WHERE: Taphonomy - another consequence



Aegyptopithecus **(jaw and skull found separately)**

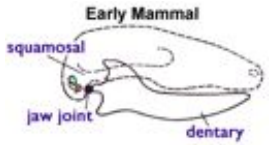
Dinosaur National Monument (UT)

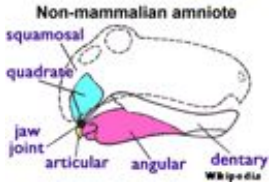
How do we put them together??

LOSS OF INFORMATION

WHAT: The record.

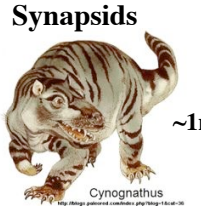
- What does a mammal look like when it's a bone?
- What's the difference between a primate and a possum?

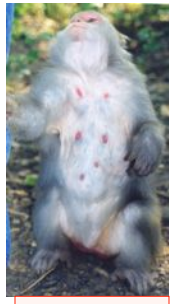




Bony definition of mammal

Origin of mammals, primates





Mammae don't fossilize

Reptile --> mammal

Jurassic

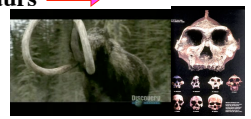
Primates

Fish

Reptiles

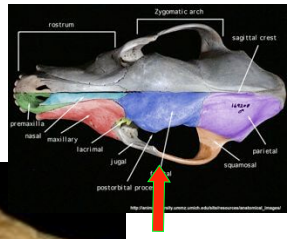
Dinosaurs

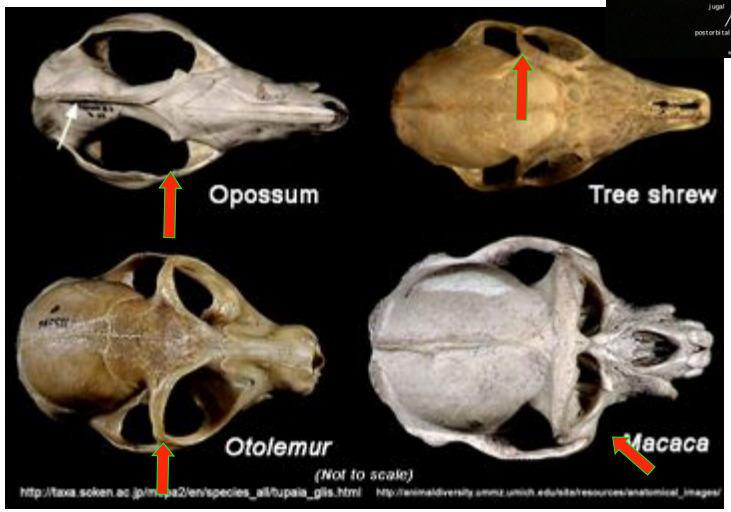
500 million years - 1st fish to present



Primates v. other mammals

Postorbital bar --> bony orbit

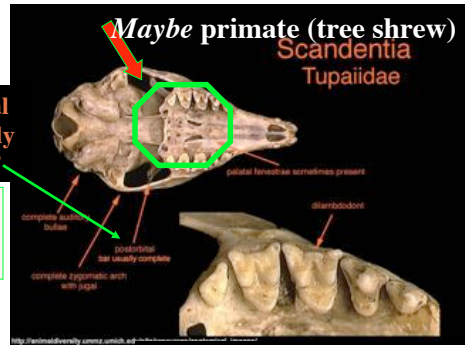


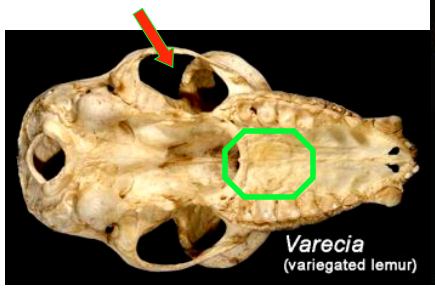


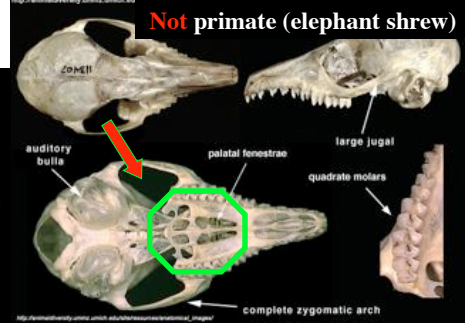
Primates v. other mammals

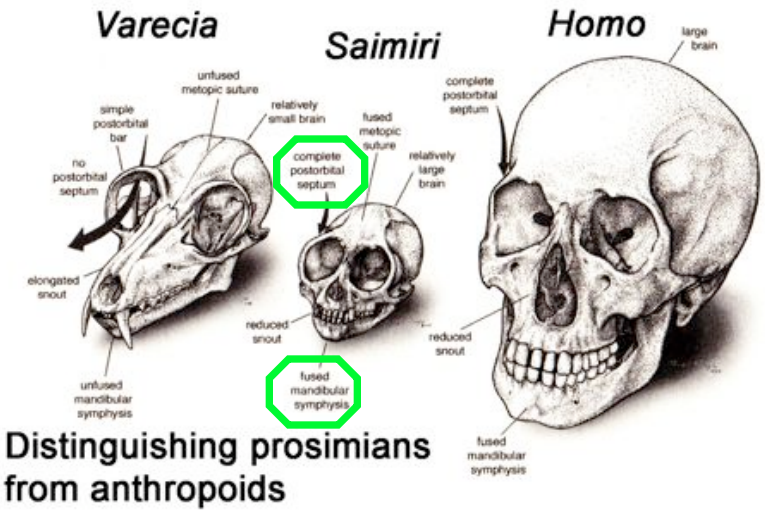
"Postorbital bar is usually complete"

But it's not real obvious, hence disagree over *Tupaia*



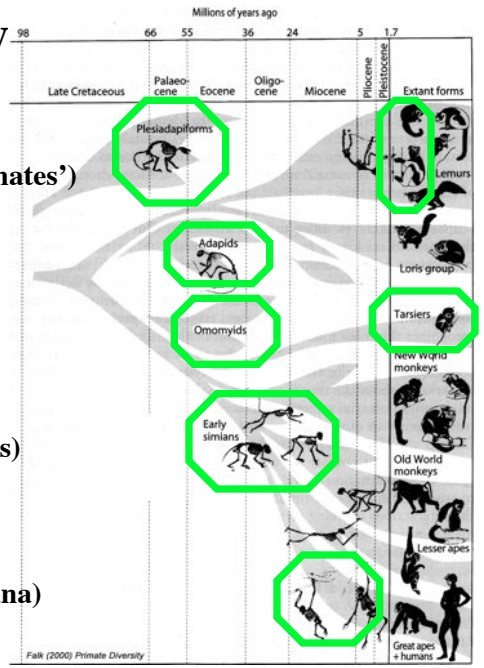






Prosimian vs. anthropoid skulls

Primate phylogeny (Falk)



Plesiadapiforms (‘proto-primates’)

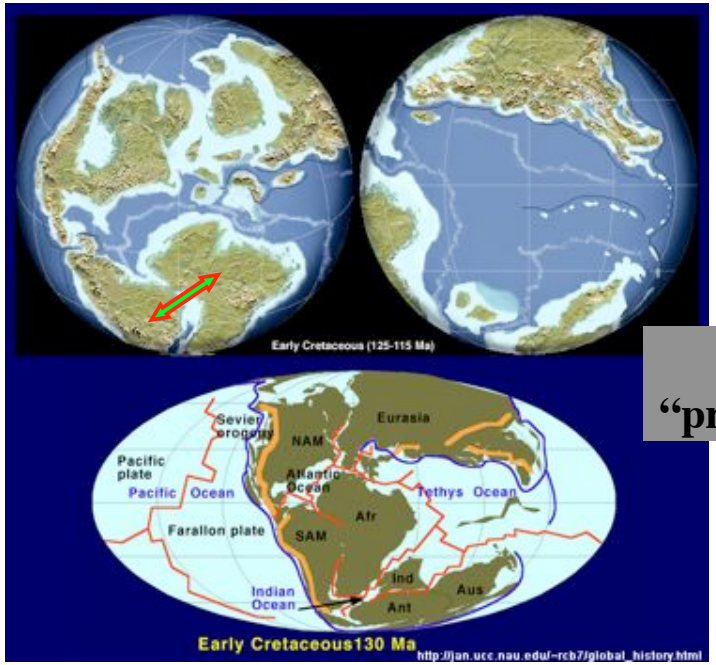
Adapiforms (prosimians)

Omomyiforms (tarsiers [?])

Late Oligocene (early simians)

Early Miocene (apes)

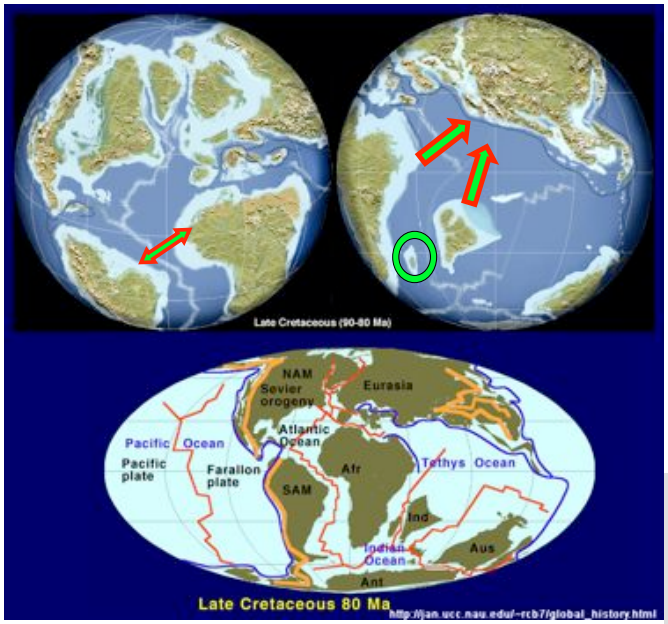
Madagascar (lemur megafauna)



130 mya, South America, Africa, India all connected

No “primates”

115 mya, drifting apart.



80 - 90mya

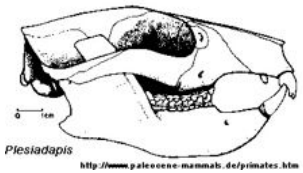
Conceivable ancestors of primates around, but continents separate.

Dinosaurs still dominant.

Madagascar off on own.

End Cretaceous - K/T boundary 65 mya - ‘primates’!

Plesiadapiforms

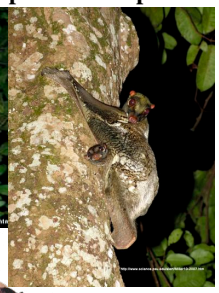


Eyes lateral

Purgatorius

~ rat size; ~ 65mya Purgatory, Montana. "primatomorph"

Prosimians - or "flying lemurs"?

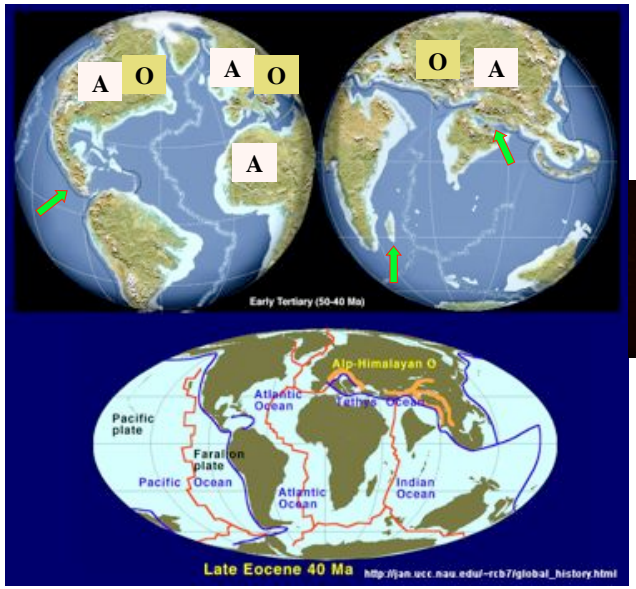


***Plesiadapis*: ~2 ´ (beaver-sized); North Dakota**

Plesiadapiforms

Weird jaw + grasping paws…

Nail, not claw

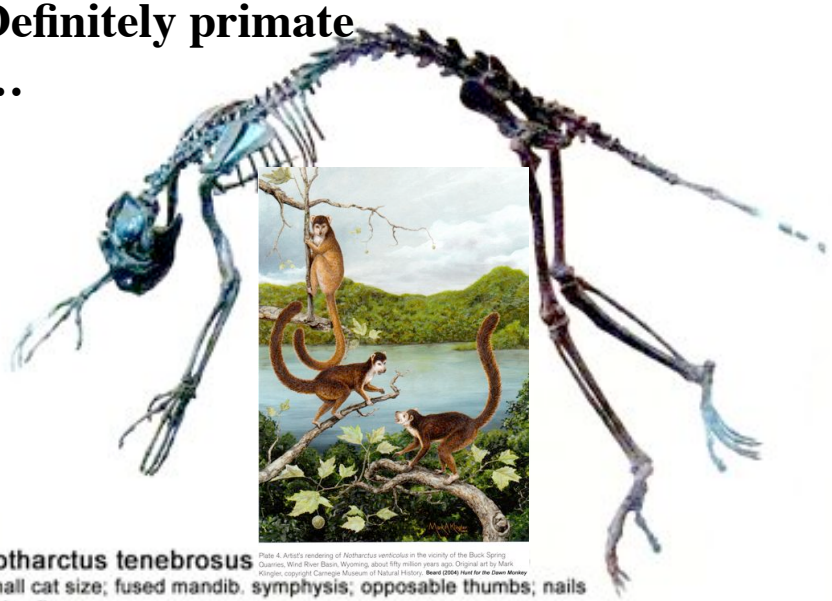


Eocene

Adapids

Omomyids

Definitely primate …



Notharctus tenebrosus
Small cat size; fused mandib. symphysis; opposable thumbs; nails
wikipedia

erences in size
nd is *Donrussellia*,
in this size range,
in the background
jaw structure of
nd copyright by

Adapis

Lots of specimens and # species

Note forward facing eyes, postorbital bar

Plate 2. A well-preserved skull of *Adapis parisiensis*, a leaf-eating adapiform primate once common in the Quercy region of southern France. Photograph by D. Serrette, courtesy of and copyright by Muséum National d'Histoire Naturelle, Paris. Beard (2004) *Hunt for the Dawn Monkey*

Omomyids

Shoshonius

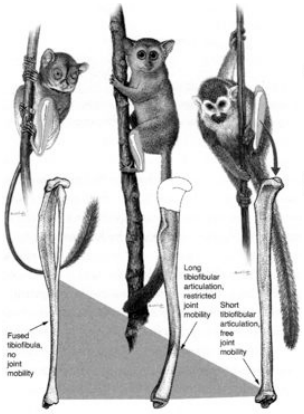


Figure 24. Variation in the anatomy of the tibiofibular joint reflects different adaptations for posture and locomotion in primates. In living tarsiers (left) the tibia and fibula are fused, stabilizing that joint as an adaptation for leaping. In living squirrel monkeys (right), the tibia and fibula remain unfused, allowing free joint mobility across the wide range of postures and modes of locomotion employed by these animals. An intermediate condition occurs in *Shoshonius*. Original art by Mark Klingler, copyright Carnegie Museum of Natural History. **Beard (2004) *Hunt for the Dawn Monkey***

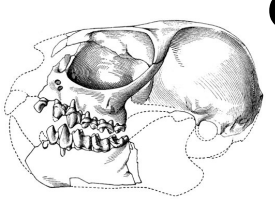


Figure 9. Jacob Wortman's skull of *Tetonius homunculus*, the first omomyid primate skull ever unearthed in North America. Reproduced from Matthew and Granger 1915. **Beard (2004) *Hunt for the Dawn Monkey***

Plate 1. A tarsier, the only living primate that consumes nothing but live animal prey. Photograph courtesy of and copyright by David Haring/Duke University Primate Center. Beard (2004) *Hunt for the Dawn Monkey*

Plate 7. A skull of *Shoshonius* compared with that of a living tarsier (right). **Beard (2004) *Hunt for the Dawn Monkey***

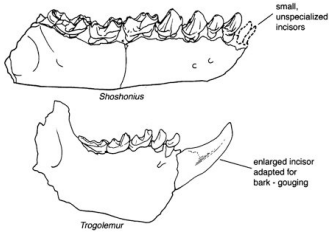


Figure 10. Divergent incisor morphology reflects the range of dietary specialization among North American omomyid primates. Enlarged and procumbent incisors like those found in *Trogolemur* suggest that certain omomyids were specialized gum-feeders who used their incisors to gouge the bark of trees to stimulate the flow of sap and gum. Based on the development of shearing crests on its cheek teeth, *Shoshonius* ate mainly insects and small vertebrates. Its incisors were small and relatively unspecialized. Original art by Mark Klingler, copyright Carnegie Museum of Natural History. **Beard (2004) *Hunt for the Dawn Monkey***