Overview

- Following the extinction of the dinosaurs 65.5 million years ago, early mammal forms dispersed to new environments.
  - Unlike this cartoon, the dinosaurs were long gone before humans (dating to 200 kya).
  - Modern primates did not appear instantaneously 65 million years ago.
  - There were no monkeys, apes, or humans at that time.
  - A group of mammals began adapting to life in the trees.
  - These changes provided a base for further evolution, leading ultimately to modern-day primates.
    - The farther back in time we go, the harder it is to distinguish between different forms of primates.
    - Primates and primate-like species exhibited amazing diversity.
    - The accumulated fossil record for primate evolution shows that it is not a simple matter to draw a family tree connecting ancient and modern forms of primates.

Early Primate Evolution

- Overview of early primate evolution
  - Suggestion: I urge you to make a copy of Table 9.1 or to type into an Excel file as part of your study guide.
  - It is useful to summarize some of the major events that took place.
    - An adaptive radiation of primate-like mammals led to ‘true primates’. Primate-like mammals showed evidence of initial adaptation to life in the trees.
      - Most of these species died out; some evolved into primitive prosimians, then underwent another adaptive radiation.
      - Many early prosimians became extinct; some survived to ultimately evolve into different lines of modern primates.
      - Some prosimians evolved into early anthropoids; a subsequent adaptive radiation led to separate groups of New World monkeys, Old World monkeys, and primitive apes.
  - Primate origins
    - Primates evolved during the Cenozoic era.
    - Primate origin should be thought of as a bush, rather than a tree.
      - Three major radiations should be noted:
        - Primate evolution began as an adaptive radiation of primate-like mammals into ‘true primates’.
          - Suggested that they were adapted to arboreal environment.
          - The few that survived evolved into early strepsirhines, fully arboreal
          - A second radiation of the strepsirhines became the ancestral haplorhines, including the anthropoids.
          - Third radiation evolved into the groups of NWM, OWM and primitive apes

Primate Origins 1

- Primate origins (continued)
  - Living primates are most closely related to a group of mammals known as colugos and the insect-eating tree shrews.
  - Continental drift and primate evolution
    - Most early primate fossil evidence is found in deposits over 55 million years ago in N. America and Europe.
      - These are the primate-like mammals.
      - That these regions, certainly non-tropical, are the locales of these species is due to continental drift
        - Understanding continental drift is critical to understanding primate evolution
        - The next slide shows the location of the continents at different times in geological history
  - The primate-like mammals (plesiadapiforms)
During the Paleocene epoch (65.5-56 mya) we find the evidence of what are primate-like mammals.

- There were no monkeys, apes, or humans at that time. But the plesiadapiforms were very diverse as they were the result of an adaptive radiation.
  - There were 120 species that have been discovered.
  - Usually the size of a cat or smaller (although there is great diversity in size); they were quadrupeds
    - Body size and dental specializations distinguished one group from another.
    - Some had large incisor that allows for heavy gnawing, some were slicers
    - Others were nectar and insect eaters

- Not true primates yet as they:
  - Eyes more to side of head
  - Front teeth separated from rest of teeth (diastema)
  - Lacks a post-orbital bar

Capolestes simpsoni

- Capolestes simpsoni is a very important fossil find
  - Found in Wyoming and it dates from 55-56 mya
  - It was a small, arboreal, fruit eater
  - Lacks many primate features such as stereoscopic vision, but it did have:
    - Food adapted for grasping
    - An opposable big toe
    - Nail and not claw on this big toe
  - It is thus an intermediate between more primitive primate-like mammals and true primates.

- Why is it so important?
  - It confirms the Fruit Diet Model of Primate Origins
  - It gives evidence for the nature of primate origins and settles a debate related to the timing of grasping and vision
    - Demonstrates that grasping ability preceded stereoscopic vision
    - Dental data also supports a fruit diet
    - All this suggests that the ability to grasp small branches as an anchor as one eats from the ends of branches was an adaptation that let them eat more efficiently.
  - Does not explain stereoscopic vision.

Other Models of Primate Origins

- At one time there were three competing models to explain the origins of primates. As we just discussed, the Fruit diet model is supported by Capolestes simpsoni
- Even so, it does not explain the advent of stereoscopic vision so here are the other two models that may contribute an explanation
  - Arboreal model
    - Adaptation to moving in the trees
    - Three dimensional orientation, depth perception to move in trees
    - Smell decreases
    - Body required to bend and twist midair
      - The generalized skeleton of the early insectivores was of use to the first primates
      - Retention of 5 digits
• Good hand/eye coordination
• Compared with other arboreal species (squirrels) which use claws, primates used the grasping digits

- Visual predation model
  • Insect hunting as push
  • Other researchers suggest same characteristics evolved to hunt insects
  • Suggested that early insectivores hunted on ground and small branches, so that the grasping hands helped to secure the branches.
  • Later, these adaptations allowed move to trees

Primate Origins 2
• The First Primates
  • Many of the modern mammals appeared during this time..
  • During the Eocene period (55.8-33.9 mya), the first primates appear into a warm, humid environment.
    • Eocene primate fossils found in both North America and in Europe.
      • The timing of the first true primates was 50-55 mya.
      • Over 200 different primate species have been discovered
    • Physical characteristics:
      • Had stereoscopic vision
      • Grasping hands
      • Reduced snout
      • Teeth closer together
      • Presence of post-orbital bar
      • Large eyes suggests still nocturnal
    • Two general groups of these prosimian-like primates
      • One group was diurnal, leaf and fruit eaters similar to modern lemurs and lorises
      • Other fruit and insect eaters was more like tarsiers
  • Many of these species are now extinct, others evolved into present-day strepsirhines.
    • The farther back in time we go, the harder it is to distinguish between different forms of primates. Primates and primate-like species exhibited amazing diversity.
    • The accumulated fossil record for primate evolution shows that it is not a simple matter to draw a family tree connecting ancient and modern forms of primates.

Anthropoid Origins 1
• Identification of the first anthropoids and their relationship to other fossil primates is unclear.
  • Recent fossil discoveries suggest that anthropoids first evolved 50 million years ago.
  • Whether they first appeared in Africa or Asia is a hot debate.
  • They may have evolved from a third line (not lemur-loris group and not the tarsier group).
• Old world anthropoids
  • They date back to the Oligocene epoch (34-23 million years ago).
  • Fossils show continued radiation in both he Old World and New World
    • The climate was cooler
    • More grasslands and forests.
  • The climate seems to have promoted a southern movement of the primates and we see few primates in N. America and Europe by this time
  • This radiation shows primates with these physical characteristics:
    • Reduced snouts indicate greater reliance on vision.
    • They have both the postorbital bar, but fully enclosed eye sockets
    • They were small, arboreal quadrupeds who ate fruit supplemented with insects and leaves
• They were diurnal as suggested by their smaller eye sockets.
  • This means changes in behaviors
  • Also changes in their interactions with the environment.

**Anthropoid Origins 2**

• **New World monkeys**
  • Evolution of the New World Monkeys date back to 25 million years
  • Most of the evidence is fragmentary dental evidence which resemble living New World monkeys.
  • At one time it was thought that the OWM and NWM were an excellent example of parallel evolution from prosimians
  • This concept is based on the idea that species will evolve similar traits in similar environments.
  • Recent evidence indicates a single line with Old World monkeys of both groups, rather than parallel evolution
    (which I used to teach in the ‘old days’).

• **How did they get to the New World?**
  • By the time of the NWM, continental drift had separated the continents.
    • One suggestion is that ancestral forms may have floated on rafts to South America, either from North America
      or Africa
    • This is called rafting, but is based on floating on debris and such.
  • An African origin is supported for 3 reasons:
    • No early anthropoids have been found in N. America
    • There is evidence of rafting from Africa by rats
    • NW fossil evidence points to a close similarity to African anthropoids.

**Evolution of the Miocene Hominoids 1**

• The continued evolution of OW anthropoids led to 2 major branches; one branch are the OWM and the other the
  modern hominoids
• The oldest evidence for fossil hominoids is during the Miocene epoch (23-5.3 mya)
  • Most fossils are fairly modern in form
  • Roughly half of all modern mammals were present during this time
  • For part of the Miocene, Eurasia and Africa were joined.
    • Prior to 16 mya the environment was dense tropics, especially in Africa
    • After 16 mya the climate became drier and more open grasslands and mixed environments were found
• **The diversity of Miocene hominoids**
  • Today, there are more genera and species of monkeys than apes. Monkeys are more diverse.
  • The reverse was true in the past when dozens of species were found.
    • Why are there more monkeys today than apes?
      • Perhaps it is the slower reproduction among apes, with their greater period of gestation and parental care
      • The environment may have also contributed
    • This diversity creates a problem.
      • It becomes more difficult to find the ancestors of modern apes.
      • Many Miocene hominoids were dead-ends.

**Evolution of the Miocene Hominoids 2**

• **The fossil evidence**
  • Identification of Miocene hominid fossil forms is based on dental and cranial features.
  • Much less is known about the postcranial skeleton.
  • Miocene hominoids appear to be more generalized than modern apes.
  • **Proconsul** (see next slide)
    • **Proconsul** lived in Africa between 21 million and 14 million years ago.
• Genus shows considerable variation.
• They had no tail, and limbs but hands appear to be more monkey-like.
• Shoulders, elbows, and some dental features are more like those of apes.
• Arboreal and likely fruit-eater
• The skull is large to body size, a hominoid trait and the form of teeth also are hominoid
  • Lower premolar is molar is Y-5
  • Also a diastema
• Today seen as a transitional form

• Other Miocene hominoids
  • Most Miocene hominoid species discovered to date are not related to living apes.
  • Sivapithecus lived in Asia between 12.5 million and 7 million years ago.
  • Skull and teeth are similar to modern-day orangutans. The eye orbit is oval shaped and eyes close together
  • Arm bones are different from modern orangs, though
  • They may have been close ancestors, but not direct ancestors of orangs.

Reconstruction of Proconsul

Evolution of the Miocene Hominoids 3
• Other Miocene hominoids (continued)
  • Ouranopithecus and Dryopithecus lived in Europe in the Middle and Late Miocene (12-10 mya).
    • Both have been suggested as ancestors of apes and humans.
    • They share cranial features with living African apes and early hominoids.
  • Pierolapithecus is one of the possible ancestors of modern apes and humans.
    • Found in Spain and dates to 13 mya
    • Fossil is a cranium and partial skeleton
    • Postcranial mix of ape and monkey traits
      • Suggests it both climbed and walked on branches (and not hanged from the branches)
      • Some suggest ancestral to all apes, others suggest to African apes and humans only.
    • Really no one yet knows this answer.

Box 9.1 The Giant Ape
• Gigantopithecus is one of the most interesting of the Miocene apes
  • The genus name means giant ape
  • This explains the interest
  • Found in China, India and Vietnam at about 9 mya up to 500 kya (some researchers suggest more recently to 100 kya!).
    • The date for discovery way 1935 when anthropologist Ralph von Koeningswald found ‘dragon teeth’ in an apothecary.
    • What he found was teeth and other teeth have been found since.
  • Has huge molar and premolar sets with relatively smaller canines and thick enamel on the molar teeth
Humans have these same dental traits.
Adapted to a hard-to-chew diet
Likely not our line but is more similar to *Sivapithecus*

**Box 9.2: The Genetic Evidence**
- Molecular dating uses the methods of genetic analysis to estimate the sequence and timing or divergent evolutionary lines.
  - The more genetically similar the closer the two species are to each other.
  - This measure is called genetic distance.
    - The estimates depend on the type and number of genes that are included in the analysis.
    - Differences in statistical estimations can affect the estimates.
    - Also making a difference is which calibration points from the fossil record are used.
  - The genetics agree with the fossil record
    - The first evolutionary split was the line leading to orangutans (roughly 13 million years ago).
    - The gorilla line split at roughly 7 million years ago.
    - The hominin and chimpanzee-bonobo split occurred at roughly 6 million years ago.
    - Bonobos split from chimps about 2.5 mya