

Self-study Problems #7: Early primates and Plio-pleistocene hominins

1. What does Potassium-Argon dating date?

the solidification of volcanic rocks, like ash or lava (basalt) flows

2. In what kind of climate and ecological setting did the first primates evolve?

hot, wet, tropical forest

3. Describe the important features of an angiosperm.

Angiosperms have flowers, so they depend on insects for pollination

Angiosperms bear seeds enclosed in fruits, to encourage animals to disperse the seeds

Angiosperms have wide leaves, rather than needles

Angiosperms have a complex branching structure that creates an interlocking forest canopy

4. Briefly describe the first primates of the Eocene. What modern primates did they resemble?

They were similar to modern lemurs and tarsiers. They had the full suite of primate characteristics, including opposable thumbs/toes, nails rather than claws, hindlimb-dominated locomotion, forward-facing eyes with overlapping fields of view, post-orbital bar, reduced snout and sense of smell, larger brain relative to body size, etc.

5. Explain Cartmill's visual predation hypothesis of the origin of primates.

Stereo vision, grasping hands/feet, and relatively larger brains were adaptations to catching insect prey in the forest canopy.

6. Explain why our recently improved information about plesiadapiforms casts doubt on the visual predation hypothesis.

Plesiadapiforms had developed grasping hands and feet without stereo vision, and their flattish molars suggest that they ate fruit, not insects. So grasping hands and feet must have provided some other sort of benefit to the ancestors of Plesiadapiforms.

7. Explain the "two-step" hypothesis of the origin of primates.

First, grasping hands with flat nails on the opposable thumbs/toes were beneficial to animals that were shifting to a diet of fruits and flowers, because grasping hands/feet would improve the animals' access to those foods, which tend to be near the ends of thin branches. Once this adaptation was established, the pre-primates may have developed stereo vision and shifted from smell to vision as the more important sense because these changes better suited them to hunt the insects found near their flowers and fruit they were already exploiting.

8. What evidence from the fossil record fits well with the the "two-step" hypothesis?

Plesiadapiformes had grasping hands/feet without stereo vision, which only appeared later. This suggests that these features evolved separately, and in the order proposed by the two-step hypothesis.

9. Describe some important features of hominoid locomotion and anatomy that may have originated in the late Oligocene and were clearly well developed in the second half of the Miocene.

More upright posture, wider torso, scapulae on the back rather than the side, long arms and short legs; long, curved finger bones. In short, evidence of a modern ape-like arboreal suspensory form of locomotion, possibly including brachiation and quadrumanual locomotion.

10. What happened to many species of Miocene apes around the end of the Miocene and the beginning of the Pliocene, and how might climate and ecology have been involved?

Many species of apes went extinct. May have been due to cooling climate, breaking up tropical forest into patches separated by grassland, and increasing seasonality. These would have trapped arboreal apes in smaller patches of forest, and reduced the availability and variety of food in them, especially during the dry or cold seasons.

11. What is an ape, and what is a hominin?

An ape is a tailless, generally larger and less quadrupedal primate. A hominin is a bipedal ape.

12. Explain a characteristic of the crania of some Late Miocene and early Pliocene apes that suggests the development of bipedalism.

Several fossil species have the foramen magnum (the hole through which the spinal cord attaches to the brain) located more underneath the brain, rather than behind it. This allows the cranium to balance on top of the vertebral column when the spine is roughly vertical, which is a typical position for a habitually bipedal animal.

13. Explain some features of the earliest known australopithecine, *Australopithecus anamensis*, that suggest that it may have been becoming more bipedal.

Its knee joint suggests bipedalism because it has large joint surfaces suited to frequently bearing the body's weight.

Both its knee and ankle joints had ranges of motion limited to the front-to-back swinging of a biped's leg and foot.

Its elbow joints do not lock in an extended position (as chimps' elbows do), suggesting that they did not regularly support their weight on their forelimbs.

14. What general characteristics did most or all australopithecines have in common?

Adaptations to heavy grinding on the back teeth: big molars and premolars, small canines, and massive jaw muscles as indicated by heavy, flaring zygomatic arches.

Chimp-sized brains and bodies; bipedalism

15. What have we learned from fossils of *Australopithecus afarensis* about the behavior and locomotion of early australopithecines? Mention the evidence that supports each claim.

Behavior: They lived in at least medium-sized social groups. Evidence: the "first family" of 13 individuals found together

Behavior: There was a lot of male-male competition, maybe male dominance hierarchies. Evidence: strong sexual dimorphism

Locomotion: They were bipedal. Evidence: angled knees, wide flaring pelvis, reduced flexibility of foot, foramen magnum underneath cranium.

Locomotion: They still spent a fair amount of time in the trees, with suspensory locomotion like modern apes. Evidence: Still had opposable big toe, long and curving finger bones, shoulder joint (scapula) that suggests hanging by the arms.

16. Why are the three species of paranthropines lumped into a separate genus from australopithecines (that is, what is different about them)?

They are even more extreme chewers and back-teeth grinders than the australopithecines.

17. Briefly discuss seven possible advantages of bipedalism that might have increased the reproductive success of individuals with features that made them better bipeds.

1. *Bipedalism may have been the most efficient terrestrial locomotion for suspensory apes, because they were unsuited to efficient quadrupedalism. So among early hominins, better bipeds would have wasted less energy and traveled perhaps more rapidly on the ground.*
2. *Bipedalism may have reduced overheating because a vertical body exposes less surface to the sun.*
3. *Bipedalism may have reduced overheating because more of the body is held up, out of the hot air near the ground.*
4. *Bipedalism may have reduced overheating because more of the body is up in the more rapidly moving breeze further from the ground, improving cooling*
5. *Bipedalism may have improved the ability to carry things, since the arms and hands are free.*
6. *Bipedalism may have made it more efficient to pick food from higher up in bushes or trees.*
7. *Bipeds may have had a better view of predators because their heads were elevated and above the grass.*

18. How does the newly-discovered species *Kenyanthropus platyops* complicate our understanding of australopithecines and our own ancestry?

Kenyanthropus platyops has some human-like features, especially its relatively small molars for a Plio-pleistocene hominin. Where we used to assume that some australopithecines were our ancestors, maybe Kenyanthropus was. This would eliminate the need to think that the back-teeth grinding adaptation arose in our lineage, then went away again, a seemingly unnecessary complexity. But other features of Kenyanthropus are less human-like than those of the australopithecines, and we have no fossils of later descendents that might have led to us.

19. What are zygomatic arches, and what can we learn about hominins by looking at them?

The bones that run from below the eyes to in front of the ears, arching over the temporal muscle and creating an attachment area for the masseter muscles, both of which close the mandible (lower jaw). The amount of space between the zygomatic arch and the side of the cranium shows the size of the temporal muscle that passed through that space. The heaviness of the zygomatic arch indicates how strong the attached masseter muscles were. So both of these features indicate the amount of muscle used to close the lower jaw, and thus the degree of emphasis on back-teeth grinding.

20. What was found with the fossils of the Plio-pleistocene australopithecine *Australopithecus garhi*, and why was this surprising?

*Animal bones with cutmarks made by stone tools. This was surprising because the date (2.5 mya) is well before the genus *Homo*, and neither *A. garhi* nor any of the other hominins known from this time had a particularly large brain. So what species could have made the implied tools?*

21. What were some probable features of our Plio-pleistocene hominin ancestor, even though we don't know which species it was?

*It was bipedal and terrestrial, but still spent some time in the trees. It had reduced canines and probably had large, grinding molars, suited for a wide range of foods. It was quite sexually dimorphic, implying life in groups with a lot of male-male competition. It had a brain similar in size to a chimp's (with one exception in *A. rudolfensis*). It had a short, rapid period of juvenile development, like a chimp's. It made simple stone tools and probably some simple tools from other materials. It may have hunted and/or scavenged more meat than other non-human primates do.*