

Chapter 12

Human Evolution

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12.1 Learning objectives

1. Understand the evolutionary relationships among primates.
2. Describe the evolutionary relationships between chimps, humans and gorillas.
3. Classify different groupings of hominins as monophyletic, paraphyletic, or polyphyletic.
4. Differentiate between the different phylogenetic hypotheses about the relationship between *Homo sapiens* and *Homo neanderthalensis*.

12.2 Laboratory exercises

All humans share a hominin common ancestor. We also share a common ancestor with all hominoids, a group that includes humans, and the rest of the apes. Hominoids share a common ancestor with all primates, both living and extinct (Figure 12.1). Living primates can be placed in three groups.

1. Lemurs (Figs. 12.2 and 12.3) , lorises and pottos.
2. Tarsiers (Fig. 12.4)
3. Anthropoids, a group that includes New World monkeys, Old World monkeys, and hominoids (humans and apes).

12.2.1 Primates

The oldest known primate fossil is *Archicebus*.(Fig. 12.5) It is about 55 million years old, and was discovered in China in 2013. Fossils in the Fayum deposits of Egypt, about 45 million years old, show that by this time anthropoids were already a diverse group and that most species were well adapted to climbing trees.

Primates generally have hands and feet adapted for grasping, and flat nails. They also have skin ridges on their fingertips (fingerprints in humans), large brains, and forward-looking eyes. These traits probably evolved as adaptations to life in the trees (arboreal adaptations), including visual predation on insects and other small animals. Primates also exhibit very intensive and long-lasting parental care and social behavior.



Figure 12.1: Phylogenetic tree of the Primates.



Figure 12.2: The sifaka (*Propithecus*), a Lemur from Madagascar.



Figure 12.3: Variety of lemurs, from top to bottom and left to right: Ring-tailed lemur (*Lemur catta*) Diademed Sifaka (*Propithecus diadema*) Aye-aye (*Daubentonia madagascariensis*) Giant sloth lemur (*Archaeoindris fontoynonti*) Gray mouse lemur (*Microcebus murinus*) Red-tailed sportive lemur (*Lepilemur ruficaudatus*) Red-fronted brown lemur (*Eulemur rufifrons*) Black-and-white ruffed lemur (*Varecia variegata*). From Wikipedia <https://en.wikipedia.org/wiki/Lemur#/media/File:Lemuroidea.jpg>



Figure 12.4: The Philippine tarsier, *Carlito syrichta*. <https://en.wikipedia.org/wiki/Tarsier#/media/File:Tarsier-GG.jpg>



Figure 12.5: *Archicebus*.

What is the technical term, as we discussed in class, used to describe *shared derived traits*, such as the characters discussed in the paragraph above?

Look at the phylogeny in Figure 12.1. Are anthropoids more closely related to tarsiers or to lemurs?

Does the phylogeny in Figure 12.1 say that “humans came from chimps”? If not, then how would you characterize the relationship between humans, gorillas, and chimps, based on this phylogeny?

12.2.1.1 Comparison of skulls

Examine the skulls and teeth of modern apes such the chimpanzee (*Pan*), gorilla (*Gorilla*), or orangutan (*Pongo*). Compare these with the hominins *Australopithecus* and *Homo*, and answer the following questions:

- Count the number of incisor teeth, canines, premolars, and molars; these four numbers constitute a dental formula. Is the dental formula the same in apes and humans?
- How do the canines compare in size to between apes and humans?

- Are the tooth rows parallel or curved? How do they differ among these species?
- How many cusps are on each molar tooth? Do you find differences among species?
- How large is the brain of each species? How large are the jaw muscles? Is there a sagittal crest?
- Are brow ridges (supraorbital tori) present in some species? Which ones?
- Locate the opening (foramen magnum) in the back of the skull through which the spinal cord exits from the brain. Is it in the same position in humans and the rest of the apes? Position the skull facing to your right, and examine the position of the foramen magnum in a lateral view. If you imagine a clock face on the side of the skull, is the foramen magnum near 6 o'clock, 9 o'clock, or some other position?
- Are fossil hominids comparable to modern humans in all of the above traits?

- Are any traits in fossil hominids more similar to those of modern humans, or to those of the rest of the apes?

12.2.2 Hominins

Paleoanthropologists have discovered over 20 species of hominins (Fig. 12.6).

Looking at Figure 12.6, can you tell if the species appeared in a step-wise fashion, that is, one superseded the other, one at a time, or where some species contemporaries?

Australopiths are a paraphyletic assemblage of hominins living between 4 and 2 million years ago. Some species, such as *Australopithecus afarensis* walked fully erect, but had small brains and are not considered as modern humans. Monkeys and apes have opposable thumbs. “Robust” australopiths had sturdy skulls and powerful jaws. “Gracile” australopiths were more slender and had lighter jaws.

What do we mean when we say that Australopiths are a paraphyletic group?

12.2.3 The genus *Homo*

Modern humans belong to the genus *Homo*. The earliest well-dated fossils belonging to *Homo* are those of *Homo habilis* from the Olduvai Gorge in East Africa. These range in age from about 2.4 to 1.6 million years. The name *Homo habilis* translates as "handy man," a reference to the hand axes and other stone tools found with some of the fossil specimens. Foot bones found in *Homo habilis* also show that this species walked fully erect.

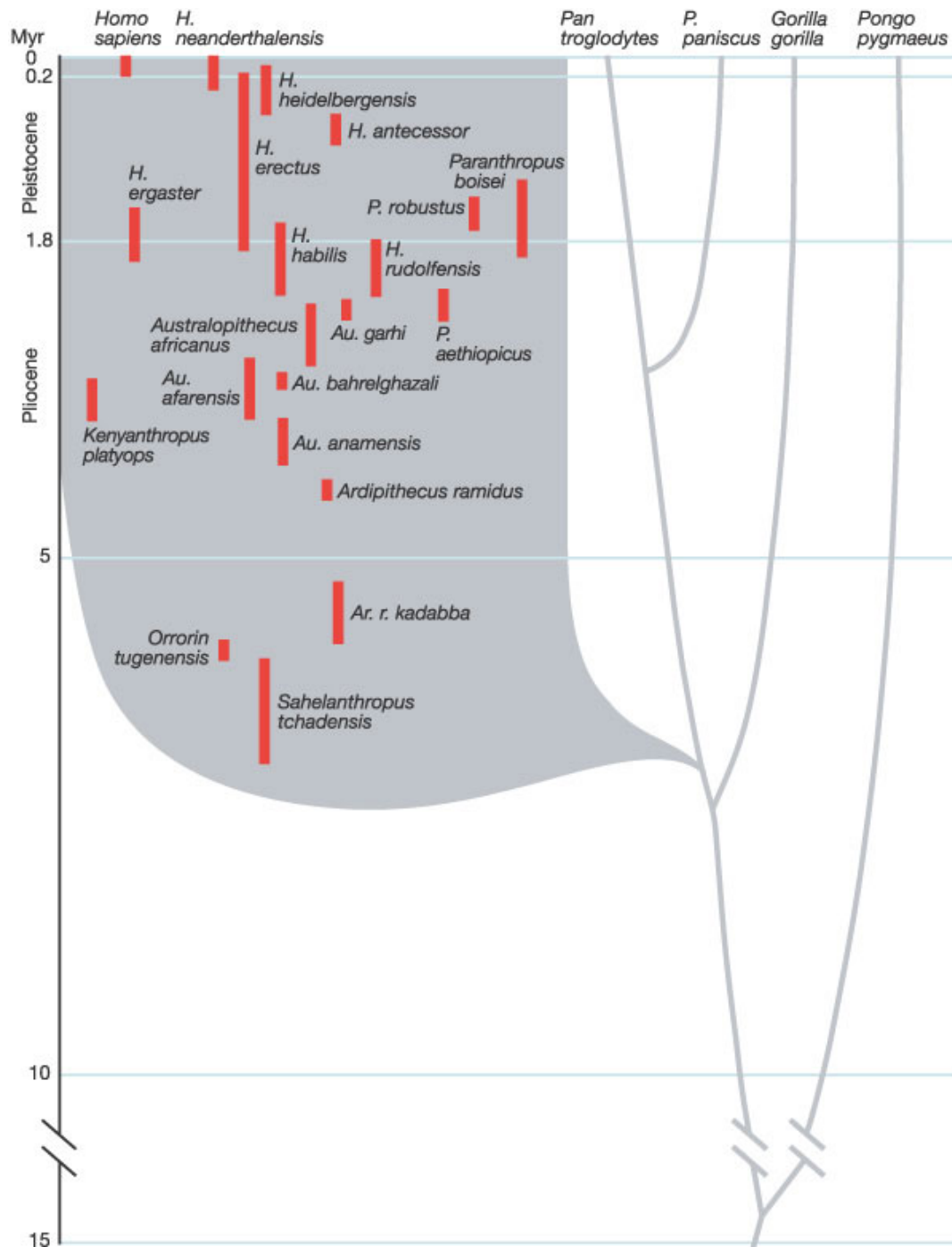


Figure 12.6: Phylogeny of the hominins. From Nature 422, 849-857 (24 April 2003).

Homo erectus (12.7), originated in Africa about 1.9 million years ago. This species was the first hominid to spread throughout Africa, from South Africa to Morocco, and across Europe and Asia – from Germany to eastern China. Compared with earlier hominids, *Homo erectus* had a larger brain and a reduced sexual dimorphism (size difference between the sexes). The early populations of *Homo erectus* are sometimes considered a distinct species called *Homo ergaster*, but fossils from Dmanisi, Republic of Georgia, show considerable similarity between *Homo erectus* and *Homo ergaster*, strengthening the view that they should be treated as a single species. Extensive fossils in and around the Zhoukoudian Cave in China have also shown that *Homo erectus* used campfires and large, yurt-like tents.

In 2004, fossils of a species of small stature, and about 18,000 years old, were found in Indonesia and given the name *Homo floresiensis* (Fig. 12.8). Some experts believe that *H. floresiensis* was a late-surviving offshoot of *Homo erectus*.

Examine the available skulls of *Homo erectus* and compare them to both earlier and later species. How does the width of the braincase compare to *Australopithecus* and to *Homo sapiens*? How does the length (front to back) compare? How does the height of the braincase compare?

In 2015, a new species named *Homo naledi* (Figure 12.9), was discovered in a cave in South Africa. Hundreds of fossil specimens were found. The date, not yet determined, may show these fossils to be even older than any previously known species of *Homo*. Throughout history, scientists have long been amazed at discoveries made in Africa:

"Ex Africa semper aliquid novi" (Out of Africa there is always something new) –
Pliny the Elder

12.2.4 Neanderthals

Neanderthals, *Homo neanderthalensis*, lived in Europe and the Middle East from about 350,000 to 28,000 years ago. They were thick-boned and had large brains. They made hunting tools and hunted animals as large as woolly rhinoceros and possibly even mammoth. They buried their dead and decorated the graves with flowers. Considerable debate centers around the extent to which Neanderthals and modern *Homo sapiens* exchanged genes.

Look at the two competing hypothesis on the phylogenies in Figure 12.10. What is the difference between the two hypotheses, in terms of the relationship between modern humans and neanderthals? The data supports the tree to the right (b). According to this phylogenetic hypothesis (b), are modern humans monophyletic, paraphyletic, or polyphyletic?

12.2.5 *Homo sapiens*

Fossil evidence shows that our species, *Homo sapiens*, originated in Africa and spread elsewhere from there. Fossils about 115,000 years old are known from the Middle East (Kafzeh, Tabun, Skhul), but fossils even older than these (as old as 120,000 years by some estimates) have recently been found in Daoxian, China. Humans first arrived in the Americas around 15,000 years ago or perhaps earlier.



Figure 12.7: *Homo erectus*. https://en.wikipedia.org/wiki/Homo_erectus#/media/File:Homme_de_Tautavel_01-08.jpg



Figure 12.8: *Homo floresiensis*. https://en.wikipedia.org/wiki/Homo_floresiensis#/media/File:Homo_floresiensis.jp



Figure 12.9: Skull of *Homo naledi*.

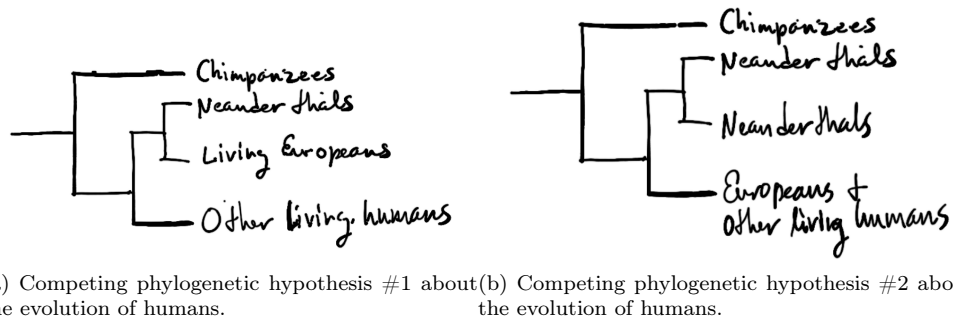


Figure 12.10
Competing phylogenetic hypotheses about the evolution of humans.

Homo sapiens was the first species to show evidence of symbolic and sophisticated thought (Fig. 12.11). Palaeolithic cave paintings from Europe show bison hunting, deer hunting, animal mating rituals, and human cultural activities including dance.

12.3 Homework

Answers the questions on this handout.

12.4 Vocabulary

1. Fossil
2. Hominin
3. Australopithecine
4. Neanderthal



Figure 12.11: The Ochre Horse. This original fragment of a rib bone contains the oldest known carving of its type in Britain. The horse was carved approximately 12,500 years ago and was on temporary display at the small museum at Creswell Crags to November 2009 (although a replica of the ochre horse is always on display). It was found on the 29th June in 1876 at the back of the western chamber in the 'Robin Hood Cave' in Creswell Crags. https://commons.wikimedia.org/wiki/File:Ochre_Horse.jpg