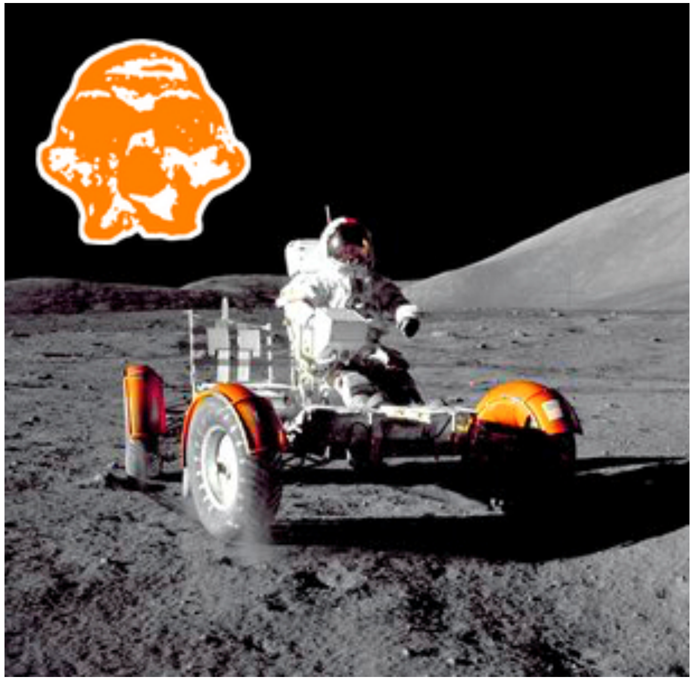


From Apemen to Spacemen: the story of human evolution

Part 2.3: The first hominins and bipedalism

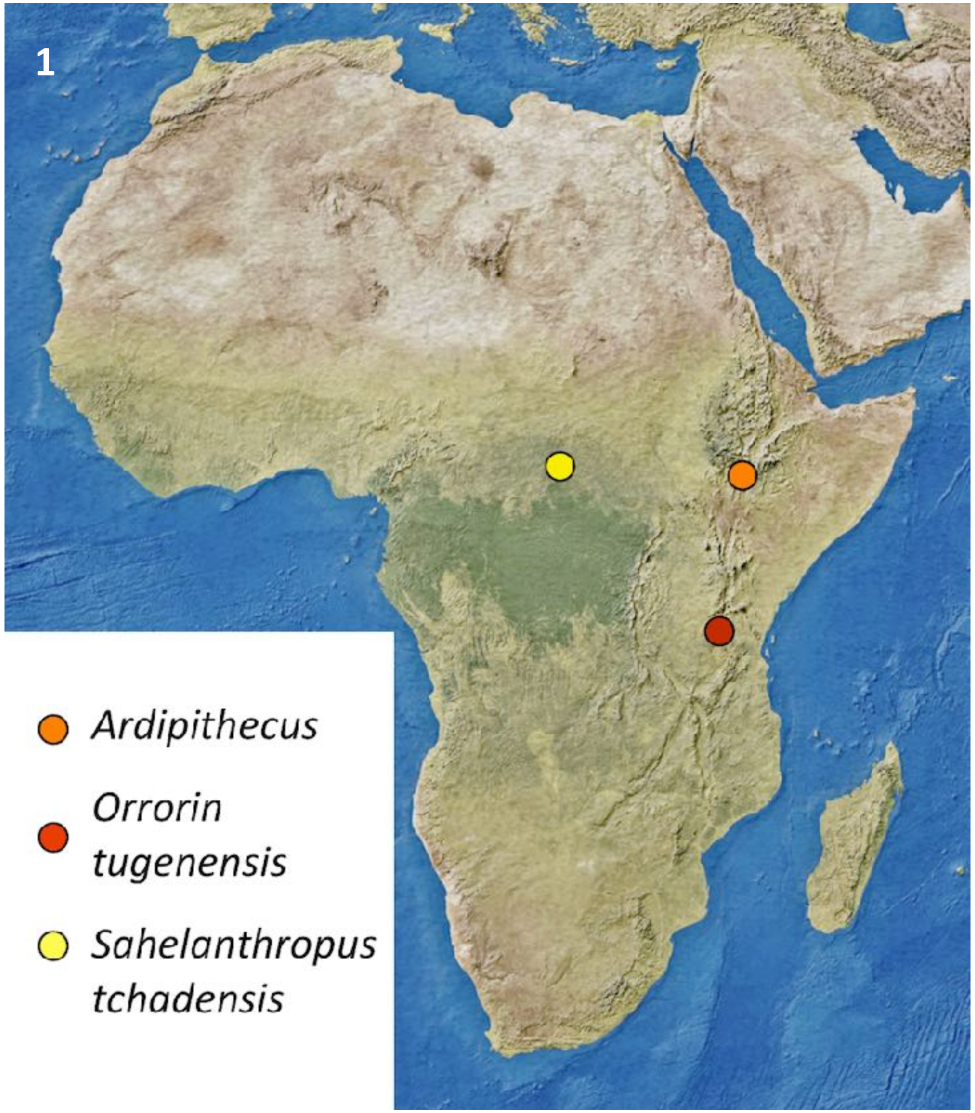
PART 2.3: THE FIRST HOMININS AND BIPEDALISM

In parts 2.1 and 2.3 we looked at the anatomical and environmental background to early hominin evolution.

In part 2.3 you will learn about:

- The first hominins
  - *Sahelanthropus*
  - *Orrorin*
  - *Ardipithecus*
- The origins of bipedalism, walking on two legs

SAHELANTHROPUS TCHADENSIS



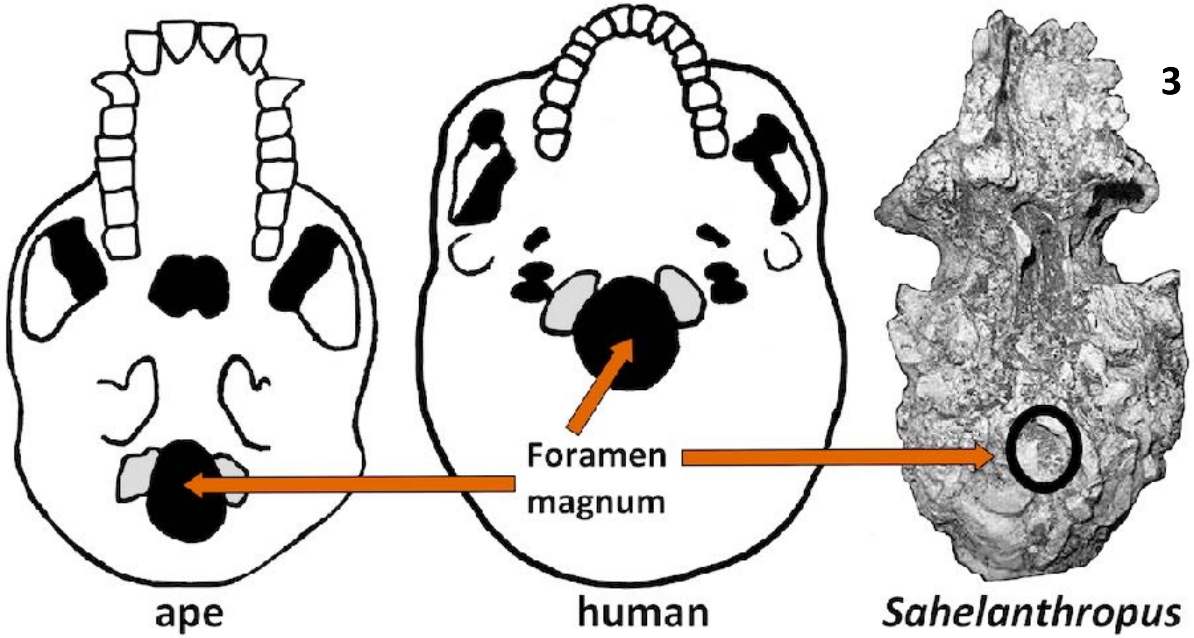
A partial skull was found in 2002 and dated to about 7 ma, so close in time to the current estimates for the divergence of humans and chimpanzees. Also known as Toumaï, which means 'hope of life' in the local Goran language.

The skull was found in the Djurab Desert of Chad, over 2000 km away from the East African Rift Valley where most of the other early hominins have been found. Therefore, Toumaï showed that the earliest hominins were far more widely distributed than was previously thought.

The fossils represent at least six individuals, including a nearly complete but badly deformed skull, which was reconstructed using computer software (fig. 2). Fragments of a lower jaw and several loose teeth were also found.

The skull has some hominin features. The brain size was relatively small at 360-370 cc, so slightly below the average for both chimpanzees and early hominins. The hole allowing the entry of the spinal column into the skull (the *foramen magnum*) is located more under the base of the skull rather than towards the back of the skull as in apes (fig. 3). This suggests that the head was held erect on top of the spine, which indicates that it walked in an upright bipedal fashion. However, no postcranial remains (i.e., bones below the skull) have been found, so bipedalism cannot be confirmed.

The canines are quite small, unlike chimpanzees. Also more hominin-like is that the face does not project forward much under the nose and the large browridge that is continuous above both eye sockets. However, the relatively short snout and browridges are actually features shared with much later hominins of the genus *Homo* and not the hominins immediately



preceding *Sahelanthropus*, the genus *Australopithecus*, who we will meet in part 3 of the course. The australopithecines (or at least one of them) are thought to be ancestral to later hominins, including *Homo*. It would be odd for *Homo*-like features to evolve in *Sahelanthropus* then to disappear in *Australopithecus* and finally to reappear in *Homo* - somewhat convoluted! Therefore, the facial similarities between *Sahelanthropus* and *Homo* are not directly related and do not represent an ancestor-descendant relationship.

The teeth of *Sahelanthropus* indicate that it ate mainly fruit, but probably also included leaves, nuts, seeds, and roots. At the time that it lived the area would have been forested with plenty of water around. More open habitats were also nearby.

No new *Sahelanthropus* fossils have been found since 2002, though scientists working in the laboratory have identified a possible hominin femur (thigh bone) that was part of the original finds - this has yet to be published.

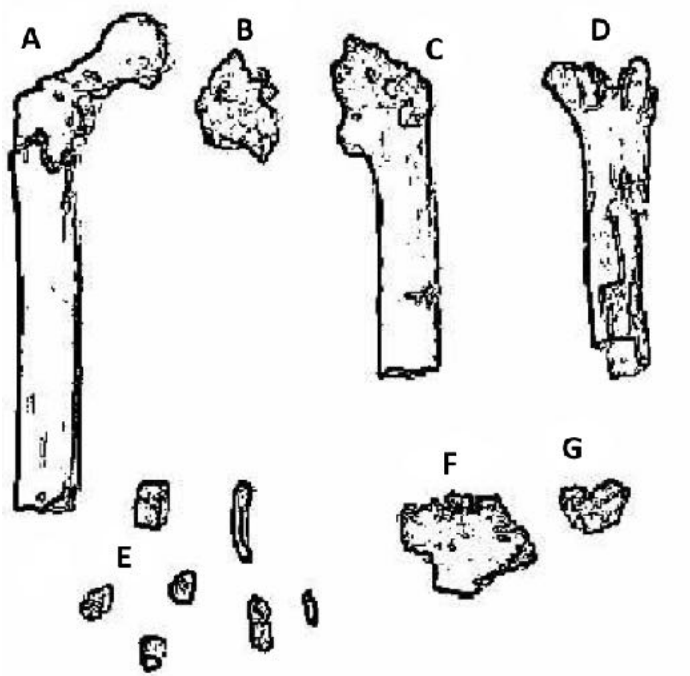
Even if *Sahelanthropus* turns out not to be a hominin, given the lack of ape fossils from this time it would still be an important find. Overall thought, Toumaï does appear to have been a hominin.

ORRORIN TUGENENSIS

Found in the Tugen Hills, Kenya, in 2000 and dated to 5.7-6 ma. *Orrorin* means 'original man' in the language of the Tugen Hills.

20 specimens have been found, including part of the jaw, several teeth, parts of the femur (thighbone), upper arm (humerus), and part of a thumb (fig. 5).

The thigh bones are broken just where the morphology would be crucial for establishing a bipedal gait. However, one of the thighbones does preserve the upper part that is connected to the hip. The hip joint of bipeds is quite distinctive, and the *Orrorin* femur indicates bipedalism. In particular, there are marks on the femur left by the ligament that connects the femur to the pelvis, in a way that is found only in humans. The arm bones indicate a tree-living lifestyle. So we seem to have a biped that was also a good climber.



A: left femur; B: fragmentary right femur; C: left femur; D: right humerus; E: teeth; F: left mandible fragment; G: right mandible fragments.

5

The teeth are apelike in their form, but have thick enamel, which is typical of most hominins and not apes. *Orrorin* seems to have lived in a forested area fringed by streams with open woodland nearby.

ARDIPITHECUS

First found in 1994 in Aramis, Ethiopia. Its name means 'ground ape'. Ardipithecus is far better known that *Sahelanthropus* and *Orrorin*. There are two species recognised. *Ardipithecus kadabba*, dated to 5.6 ma, is known only from fragmentary teeth and skeletal remains (fig. 6).

6

7

Ardipithecus ramidus, dated to 4.4 ma, is known from fossil remains nicknamed 'Ardi'. Ardi comprises most of the skull and teeth, arm and leg bones, pelvis, hands, and feet. The remains were so crumbly that it took over ten years to put the skeleton back together.

It had a small chimpanzee-sized brain and a very apelike skull (fig. 7). However, the canines are smaller than in the earlier *Ardipithecus kadabba* and so are more hominin-like. The teeth are not very specialised and so indicate a varied, perhaps omnivorous diet, though fruit would have been an important component.

The wrist and hand bones show no evidence of knuckle-walking, the distinctive form of quadrupedal locomotion used by chimpanzees and gorillas. This in intriguing. DNA shows that humans are more closely related to chimpanzees than they are to gorillas. But if both chimpanzees and gorillas use knuckle-walking then the chimpanzee-human common ancestor ought also to have been a knuckle-walker. Therefore, we would expect to find some signs of knuckle-walking in the hand and wrist bones of an early hominin such as Ardi. That we do not is a puzzle. Did knuckle-walking actually evolve independently in chimpanzees and gorillas? Is Ardi not actually a hominin?

The pelvis looks hominin-like overall. The upper pelvis is shorter and broader than that of living apes and would have prevented Ardi from swaying from side to side while walking. But the lower part of the pelvis is quite ape-like and the powerful leg muscles for climbing would have been attached here. So the pelvis could just as well be an adaption to an upright posture in the trees than to walking bipedally on the ground.

The big toe does not project forward inline with the the other toes like in humans. Rather, the foot is long and curved with a divergent big toe well suited for grasping branches. The arm and hand bones demonstrate good climbing ability. Quite how Ardi locomoted is a mystery. An upright posture is a given but it seem ill-suited for a life on the ground but rather large to be moving around upright on the tops of branches.

Ardi lived in a closed wooded environment, more wooded than where *Sahelanthropus* and *Orrorin* lived.

THE ORIGIN OF BIPEDALISM

The hominins we have looked at so far show that bipedalism, walking on two legs, goes back as far as 7 million years, almost to the beginning of the hominin story. We have also found evidence of hominin footprints at Laetoli in Tanzania, which date to 3.7 ma (fig. 9).

Many of the ways in we have seen that humans differ from apes are due to adaptations to bipedalism:

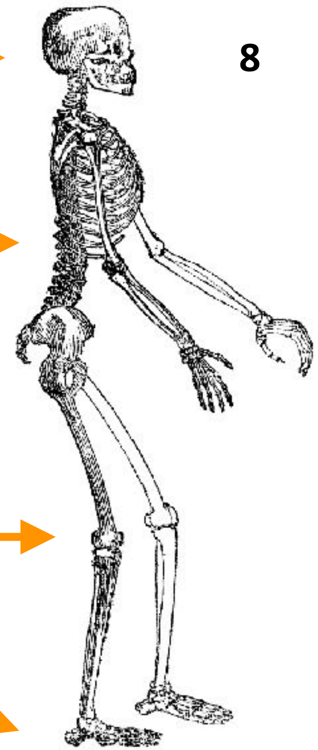
The skull must be balanced on the spine, so the hole for the spine (foramen magnum) is located under the skull.

The vertebral column (spine) has an S-shaped form, bending forwards in the lumbar region - making it easier for us to stand upright and walk.

The hip joints are larger as they have to support more body weight. The pelvis has become short and squat.

Long legs that angle inwards so that the knees are located directly under the body. The knee joints are large and stable to take the body weight.

Feet have enlarged heels and have an arch, which helps to transmit our weight while walking.



8

9

Hominin footprints from Laetoli, Tanzania, 3.7 million years ago

Leaving the relative safety of the trees for even a partly terrestrial life was no small thing for the earliest hominins. In a forest habitat an adept tree-climber (especially a relatively large one) would have had few predators. It would also have had a fairly reliable food supply that would have varied in a seasonal yet predictable way. In contrast, on the forest edge, woodland and grassland there would have been an abundance of fearsome predators, such as lions and saber-toothed cats. Furthermore, a new foraging strategy would have been required to obtain food in these new habitats.

So why did bipedalism evolve? There must have numerous benefits to compensate for the disadvantages outlined above. Well, there are many theories regarding the evolution of bipedalism in hominins.

Some believe bipedalism evolved to free the hands for **carrying**, perhaps for tools. Carrying is more likely a useful by-product rather than the sole reason for the evolution of bipedalism.

Gathering food would perhaps have been easier and hominins could have carried surplus food for storing.

Seeing over grass in the savannah is another idea. However, some monkeys stand tall to see over grass but are not bipedal. Plus, the earliest hominins actually lived in wooded environments.

Human bipedalism is **more energy efficient** than chimpanzee locomotion though early hominin walking was perhaps not so efficient as their gait was not quite the same as modern humans. It is clear that modern humans are more efficient walkers than runner, for early hominins more so. One problem with this theory is that the earliest bipedal hominins seem not to have lived in open habitats.

Another theory centres on **thermoregulation**. An upright posture means a bipedal hominin would create a smaller shadow than an ape and so have less direct exposure to sunlight which in turn would help them to keep cool - and remain more active - in open country during the height of the day, a time when many other animals are rather inactive. Additionally, an upright posture means that the bulk of the body is raised from the ground, thus benefitting from the cooling effects of the wind. This probably did not lead to the evolution of bipedalism in the first place because the earliest hominins didn’t live in open country, but it could have been a contributing factor to the subsequent success of the hominins.

A **seed-eating** hypothesis was also proposed, whereby having permanently free hands would increase feeding speed. An upright posture could also aid feeding on tall bushes and small trees. However, other primates feed in such ways and have not evolved bipedalism.

In his excellent 2003 book ‘Lowly Origin’, Jonathon Kingdon proposed a hypothesis whereby a forest-living **squatting ground ape** would have had the need for a flexible waist which could have led to a shortened human-like pelvis rather than a long apelike pelvis. With a shorter, squatter pelvis the changes required to adapt the pelvis for true bipedal locomotion would have required far fewer changes.

Many believe that the origins of bipedalism lie **in the trees** and not on the ground, as has been the traditional view. An upright posture could have developed from walking upright in trees whilst using hands for support. Because an upright posture would have been the norm for such a species when it came to the ground bipedalism was the most natural form of locomotion. This seems very plausible and it also takes into account that the earliest hominins still lived in wooded environments and that their anatomy still retained adaptations to climbing.

It is difficult to say which, if any, of these theories is correct. It is possible that many of them may have played their part, and there is no reason why there should have been only one cause. Ultimately though, standing upright must have been a natural posture for the earliest bipedal hominins for the reason that they would have already been posturally upright, probably from an **upright life in the trees**. For early hominins, moving on all fours on the ground must have been awkward due to the posture they held in the trees. Overtime, their bipedal locomotion on the ground would have become more refined. All the other benefits of bipedalism, such as carrying objects, food gathering, seeing over tall grass, thermoregulatory advantages and so on, would have only come into play once the first bipedal steps had already been taken. But the numerous benefits of bipedalism outlined above can perhaps explain the ultimate success of the hominins.

SUMMARY OF PART 2

In part 1 we looked at the closest living relatives of humans, the apes. The chimpanzee is our closest living relative. We share over 98% of out DNA and share a common ancestor which would have lived around 7-8 million years ago.

In part 2 we have looked at those apes on the human side of chimpanzee-human divide, the hominins, of which we are the last surviving members.

We saw that climate around the time of common ancestor was changing, becoming cooler and drier which led to forests becoming more fragmented. The East African Rift Valley formed at this time too, and all of these factors may have led to the ancestral chimpanzee and human populations becoming separated.

Then we looked at the earliest hominins, who lived between 7 and 5 million years ago. They were *Sahelanthropus* from Chad, *Orrorin* from Kenya, and *Ardipithecus* from Ethiopia.

We know from these earliest hominins that the first distinctive hominin feature to evolve was bipedalism, walking on two legs. We ended by looking at some of the reasons why bipedalism may have originated.

Picture credits

1. Adam Newton: own work
2. Didier Descouens: CC BY-SA 4.0
3. Sapiens Ergsap CC BY-SA 2.0
4. Tim Evanson: CC BY-SA 2.0
5. Lucius: CC BY-SA 3.0
6. Lucius: CC BY-SA 3.0
7. T. Michael Keesey: CC BY 2.0
8. Modified from: Huxley - Mans Place in Nature:
   Public Domain.
9. Tim Evanson: CC BY-SA 2.0