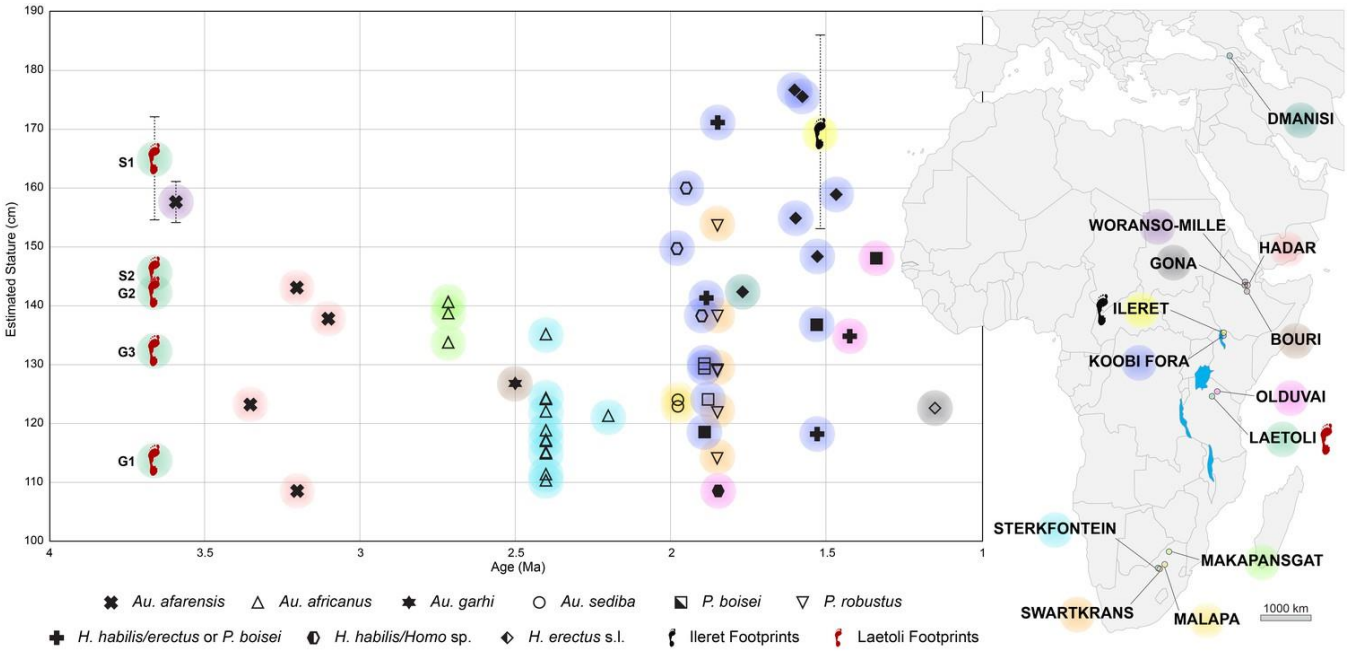
## HOW TO USE THIS RESOURCE

Show the figure below to your students along with the caption and background information. The "Interpreting the Graph" and "Discussion Questions" sections provide additional information and suggested questions that you can use to guide a class discussion about the characteristics of the graph and what it shows.




*Caption: The data points represent the estimated stature (height) of hominin individuals based on fossilized remains or footprints. The data points are arranged in order of the age of the fossil/footprint, between 4 million and 1 million years ago (Ma). The colors represent where the fossil or footprint was found on the map. The shape of the symbol inside the colored circle represents the hominin species. Shaded symbols represent estimated stature based on femur length. Unshaded symbols represent estimated stature based on the diameter of the femur head. Footprint symbols represent estimated statures based on footprint length. For three of the individuals, several footprints or fossilized remains were used to estimate stature and bars represent the range.*

## BACKGROUND INFORMATION

Laetoli, in northern Tanzania, is a paleontological site made famous in the 1970s when Mary Leakey and her colleagues discovered the tracks of three bipedal hominin individuals (G1, G2, and G3) dating back 3.66 million years. Hominins are a taxonomic group which includes humans and their extinct ancestors. At the time, the footprint discovery was the earliest known evidence of hominins walking upright. Research at Laetoli has been ongoing, and the site has provided evidence for understanding early hominin species (specifically *Australopithecus afarensis*) and the environment in which they lived.

In 2015, scientists were excavating a site in Laetoli when they uncovered two new sets of hominin tracks (S1 and S2) located about 150 meters south of the tracks found by Leakey. These tracks are on the same surface, dated to the same time period, and oriented in the same direction as the Leakey tracks. Using previously established formulas, they inferred the body mass, stature, and walking speed of the two individuals using the size and shape of the footprints.

There is some debate about the variability in body size between hominin individuals. Some paleobiologists hypothesize that as hominins increased in stature, they became better equipped to disperse from Africa to other parts of the world. Such a hypothesis would be supported by evidence showing a linear progression of increasing hominin stature over time. Other biologists hypothesize that variability in hominin stature is linked to sexual dimorphism or adaptation to different environments. For example, in species in which males are expected to compete with each other for a chance to mate with females, there is often a large size difference between males and females, called sexual dimorphism. Such a hypothesis would be supported by evidence showing large variations in stature between individuals of the same species.

## INTERPRETING THE GRAPH

This graph plots the estimated stature of 52 individuals, belonging to at least nine different ancient hominin species, against the age of the fossil specimen or footprint. For three of the individuals, multiple pieces of evidence (e.g., multiple footprints instead of just one) were used to estimate stature, so an average stature and range (error bars) are shown. Data points S1 and S2 are based on the two newly discovered sets of tracks at Laetoli. All other data points are from previously published research.

The two newly identified individuals, members of the species *Au. afarensis*, likely existed at the same time as the G1, G2, and G3 individuals and were possibly members of the same group. Notably, S1 and S2 are taller than the other members of their cohort. At around 165 cm, S1 is also much taller than any other *Au. afarensis* individual found to date, between 3.66 and 3.2 Ma. This discovery not only broadens the range of stature for this species of hominin, but it also suggests that this species did not evolve to become taller over time. Instead, the considerable size variation among individuals supports the hypothesis that this species exhibited a large degree of sexual dimorphism.

The variation in stature among the *Au. afarensis* individuals, an estimated 65 cm (the shortest *Au. afarensis* individual found to date is the famous Lucy from Ethiopia, having an estimated stature of less than 110 cm), suggests a larger degree of sexual dimorphism than in most of the other hominin species shown in the figure. This finding could be taken to mean that the species may have practiced polygyny. In this social structure, males grow significantly larger than females as an adaptation for competing with other males for multiple female mates. A modern-day example of such a social structure is found in gorillas, which provides some insight into how our ancestors may have interacted. However, it should be noted that sex cannot be determined from footprints.

The S1 individual was also taller than any other *Australopithecus* species and falls within the height range of modern humans and ancestral *Homo* species. This finding provides additional evidence against a linear trend of increasing body size over time and supports the theory that sexual dimorphism in bipedal hominins existed as long as 3.66 million years ago.

*Teacher Tip: Prompt your students to explain the following:*

- Graph Type: Scatter Plot
- *Y*-Axis: Estimated stature (height) in centimeters (cm) of the individual hominin
- *X*-Axis: Age in millions of years (Ma) of the fossil or footprint

## DISCUSSION QUESTIONS

- What trends do you notice in the data?
- How would you describe the variations in hominin stature over time?
- Among which species is the variation in stature greatest? Provide evidence.

- Why do three of the data points have bars? Explain what the bars mean.
- Which hypothesis (in the background reading) does this data support? Provide evidence from the graph.
- Would your answer to the previous question have been different before specimens S1 and S2 were added to the graph? Use evidence from the graph to justify your answer.
- How does the range in stature of *Homo erectus* compare to that of *Australopithecus afarensis*?
- What can footprints or femur size tell us about the sex of these ancient hominins?
- What do the trends in the data indicate about the social behavior of early hominins?
- The average height range globally for men is 159.8 to 182.5 cm and for women is 149.4 to 169.8 cm (eLife, 2016). Take some sample measurements of yourself and your peers and plot them on the graph. What do you notice?
- Is there a relationship between the number of data points in a time period and the range of stature measurements? How does this affect how you interpret the data?
- Explain why the data points with the same color are often clustered or grouped on the graph.
- Each data point contains a lot of information (color, shape, filled/open, date, stature). Why do you think the scientists included so much data in each point? Which piece or pieces of information do you think are the most critical?

## KEY TERMS

fossil, hominin, human evolution, human origins, Leakey, paleobiology, sexual dimorphism

## SOURCE

Figure 12:

F. T. Masao *et al*. (2016). New footprints from Laetoli (Tanzania) provide evidence for marked body size variation in early hominins. eLife. [doi: 10.7554/eLife.19568] https://elifesciences.org/articles/19568

## CITATION

NCD Risk Factor Collaboration (2016). A century of trends in adult human height. [doi: 10.7554/eLife.13410] https://elifesciences.org/articles/13410

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