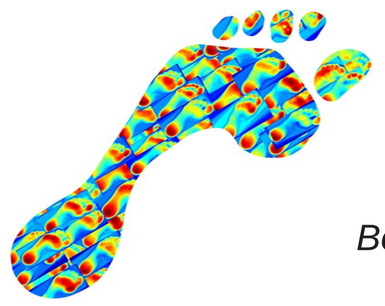
Homostasis in Foot Function?



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ABSTRACT

It is generally held that early hominins of the genus *Australopithecus* had a foot transitional in function between that of the other great apes and our own, but that the appearance of genus *Homo* was marked by acquisition of an essentially biomechanically modern foot, as well as modern body proportions. Here we report the application of topological statistical analysis to compare populations of footprints from Laetoli (3.66 Ma, Tanzania) and Ileret (1.5 Ma, Kenya), spanning the *Australopithecus* - *Homo* transition, with footprints from both shod and unshod anatomically modern humans. Contrary to previous analyses, we find no evidence of any statistically significant difference in footprint form and therefore by extension, we may also reasonably assume a lack of difference in the external foot mechanics, between *Australopithecus* and *Homo* before the appearance of habitual shoe-wearing. This suggests that the essentially arboreally-adapted foot of *Australopithecus* is compatible with long-distance, striding terrestrial bipedalism, and any limitations in abilities for the latter were set in the proximal postcranium.

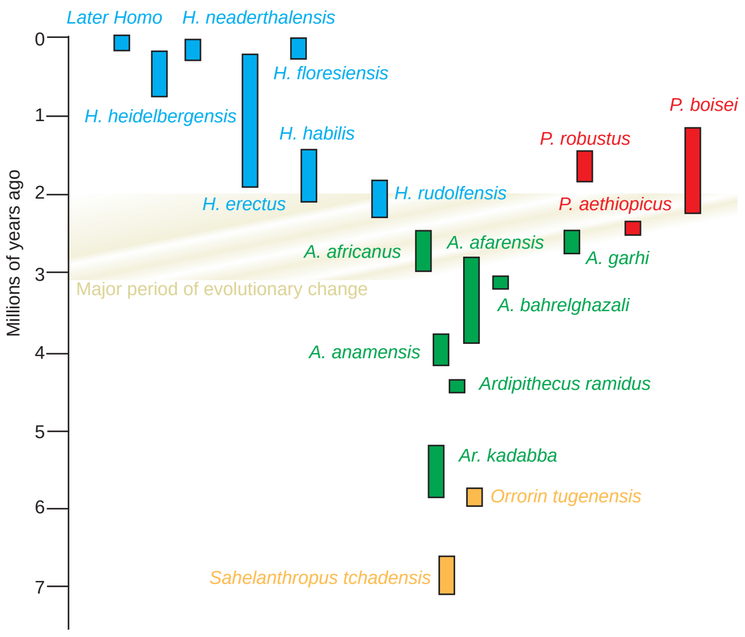
Bennett MR and Morse SA (2014). *Fossilised Locomotion: What can footprints tell us?* Springer.

Our feet and hands are under immense evolutionary pressure; in contact as they are with the ground or with objects at all times. How have our ancestors feet changed through time?

A particularly important period was the transition from the *Australopiths* to *Homo*; a time of rapid evolutionary change in which body proportions changed and we became adapted to endurance walking and running. It would be logical to anticipate changes in foot anatomy and locomotive style as well. But did these changes actually take place?

The discovery of a new fossil footprint site in northern Kenya in 2009 (*Science*; 2009) attributed to Homo erectus provided an opportunity to examine this idea in detail for the first time. In a major piece of research funded by the Natural Environment Research Council (NERC) Bennett, with colleagues at the University of Liverpool, examined this hypothesis.

They developed new methodologies for the study of human tracks, worked in at recent footprints sites in Namibia, South Africa, Argentina and in the UK, as well as in the laboratory to explore new models of how footprints are formed and preserved. In particular they looked at the role of substrate properties as a variable in determining track morphology. New models allow us to understand the way the pressure we apply through our feet are recorded in a footprint, allowing ancinet tracways to be interpreted accurately for the first time.



A version of the our evolutionary tree

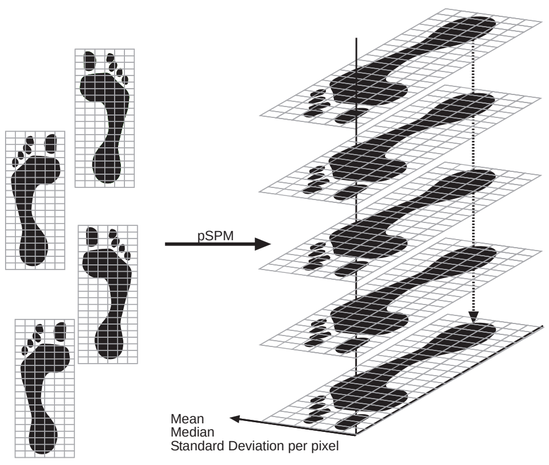
An example of a partial hominin track at Ileret in northern Kenya, documented for the first time by Bennett et al. (2009; *Science*). These tracks are preserved in fluvial silts and fine sands deposited furing periods of flooding. The tracks have been dated to 1.5 Million years ago by reference to dated volcanic ash layers that occur in between the sediment layers.

Latolie Footprint [3.66 Ma]
Autralopithicus aferensis

Ileret Footprint [1.5 Ma]
Homo erectus

Sefton Coast (UK) [3.5 ka]
Homo sapiens

Oldest Tracks → Recent Tracks

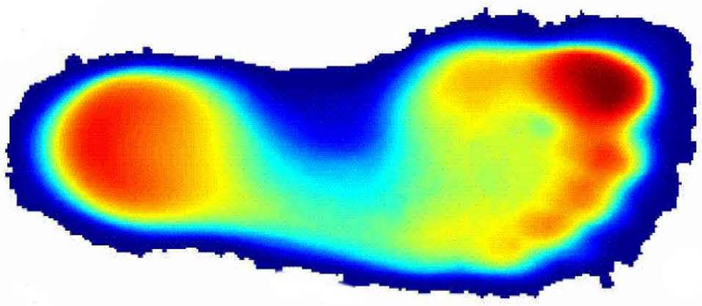


One of the challenges in the study of human tracks has been to find ways of statistically comparing footprints. For example, how representative is a single track of a whole trackway? And how representative is that trackway of an entire species? How much of the observed variation is down to geology rather than the biomechanics of the track-maker?

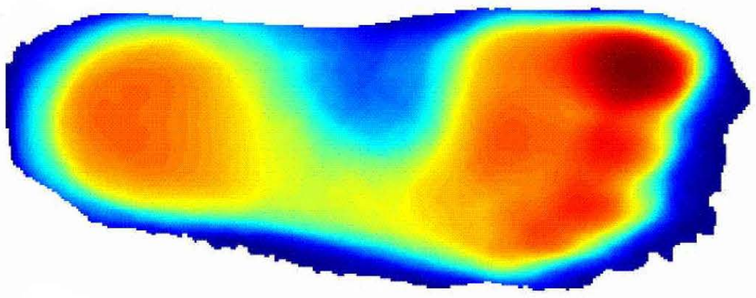
The development of new analytical tools have allowed us to tackle and explore these issues. These tools involve the co-registration of tracks as shown to the left so that an anatomical point on one track corresponds to points on another in that way measures of central tendancy can be calculated and entire trackways compared by the use of a mean. It is also possible to compare means statistically, pixel-by-pixel, using simple t-tests due to the topological properties of the statistical maps created. This methodology is derived from the same mathematics that are used to analise MRI scans in medical applications.

The figure below shows the results of our analysis and four populations are compared statistically: (A) modern human tracks, in fact a sample drawn from100 members of BU Staff; (B) a mean track created from habitually unshod individuals in Namibia, these fossil tracks are between 500 and 1000 years old (*Homo sapiens*); (C) a mean track created from the Ileret tracks reported by Bennett et al. (2009) which date from 1.5 Ma and have been attributed to *Homo erectus*; and (D) a mean track created from eleven tracks from Laetoli which is the oldest known hominin footprint site in the World. While the mean tracks show some differences, these can largely be explained with reference to the influence of geology. This suggests that little change occured during the *Australopith* to *Homo* transition contary to what one might expect and in fact that little has changed in the walking styles in the last 4 Million years!

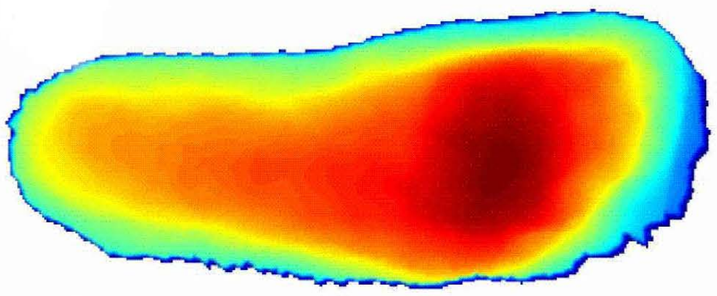
A. Homo sapiens (Shod)



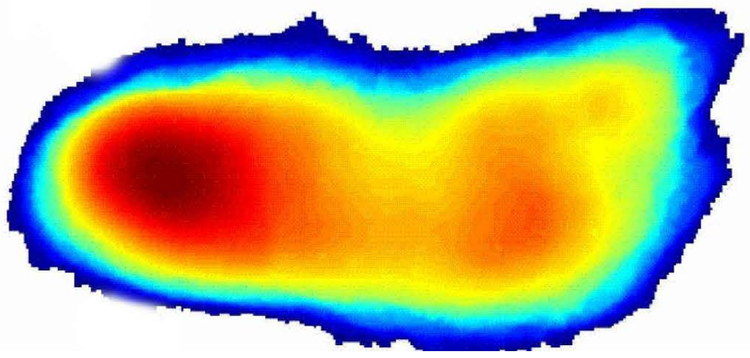
B. Homo sapiens (Unhod)



C. Homo erectus (Ileret)



C. Australopithicus aferensis (Laetoli)



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