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# Geometric morphometric reassessment of the Omo 323-76-898 Talus with a large Catarrhine sample

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## Objective:

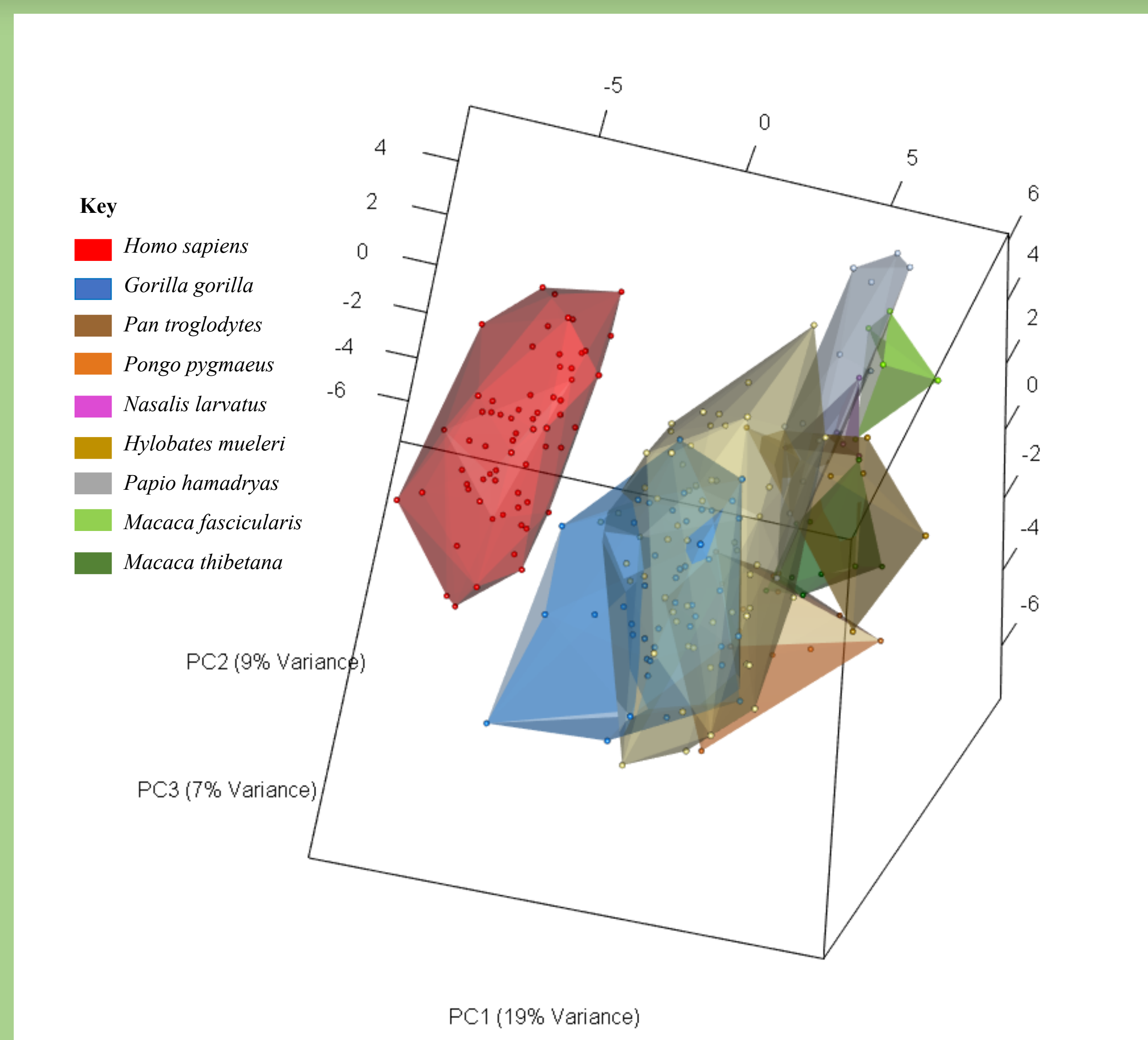
- Reassess previous research suggesting ankle use in Omo 323-76-898 is similar to modern humans using Geometric Morphometrics.

## Introduction:

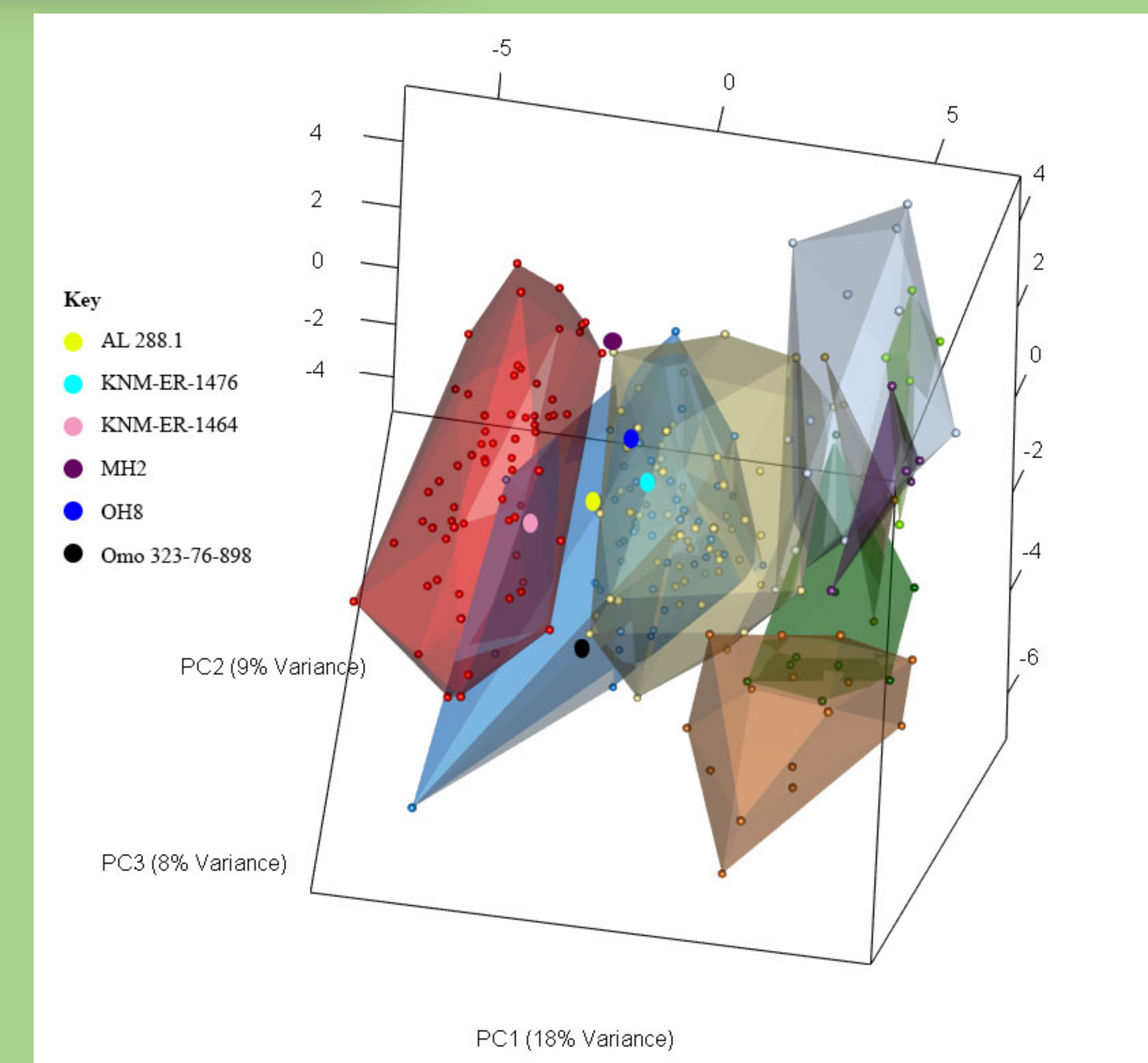
- The Omo talus, catalog number 323-76-898 was found in lower Member G of the Shungura Formation, Ethiopia. Alemseged et al.<sup>1</sup> described a partial skull found in the same locality and attributed it to *P. boisei*. At this time only to hominins were known from the Shungura Formation, a robust Australopith and early *Homo*.
- Deloison<sup>2</sup> suggested the Omo talus could belong to a primitive species of *Homo*, with morphological features intermediate between *Homo sapiens* and *Pan troglodytes*.
- Gebo and Schwartz<sup>3</sup> reassessed the Omo talus and suggested it was more human-like than ape-like.

## Material and Methods

- We placed 30 landmarks, covering all articular facets, on 3D laser surface scans of 219 extant catarrhine and 6 fossil hominin tali using Landmark editor (Figure 1, Table 1)<sup>6,9</sup>
- We performed Generalized Procrustes Analyses (GPA) using Morphueus<sup>6</sup>.
- We analyzed landmark data using R to perform a Principal Component Analysis (PCA), a Canonical Variance Analysis (CVA), and a boxplot using centroid size.<sup>5</sup>



**Figure 2:** Principal Component analysis using only the extant specimens and all 30 landmarks shows clear separation between humans and non-human primates.



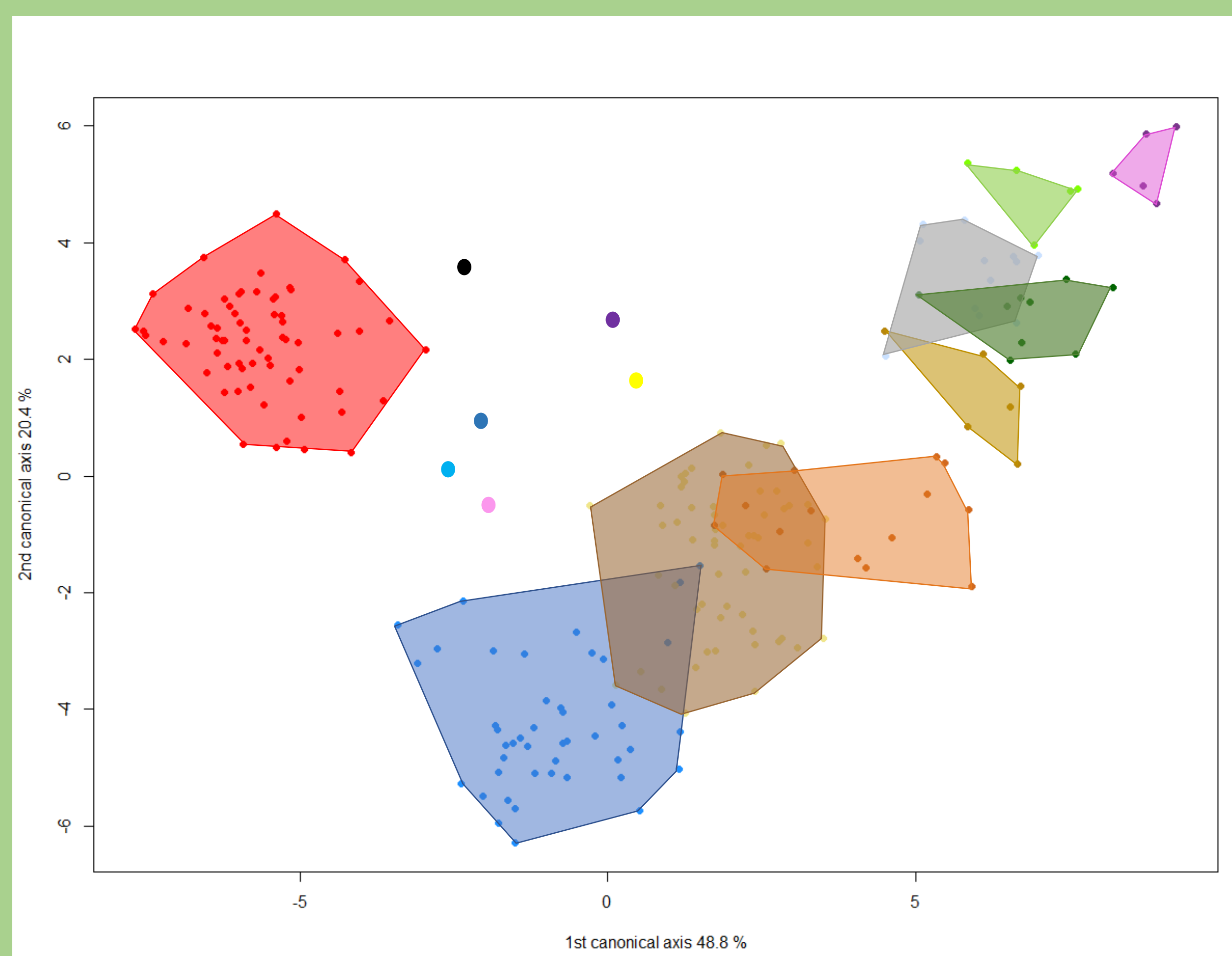
**Figure 3:** Principal Component analyses using reduced 18 landmark dataset to include fossil hominins shows fossil hominins intermediate between apes and modern humans.

Sample Specimen	Sample Size
<i>Homo sapiens</i>	65
<i>Gorilla gorilla</i>	45
<i>Pongo pygmaeus</i>	15
<i>Pan troglodytes</i>	57
<i>Macaca thibetana</i>	9
<i>Macaca fascicularis</i>	5
<i>Nasalis larvatus</i>	5
<i>Hylobates muelleri</i>	6
<i>Papio hamadryas</i>	12

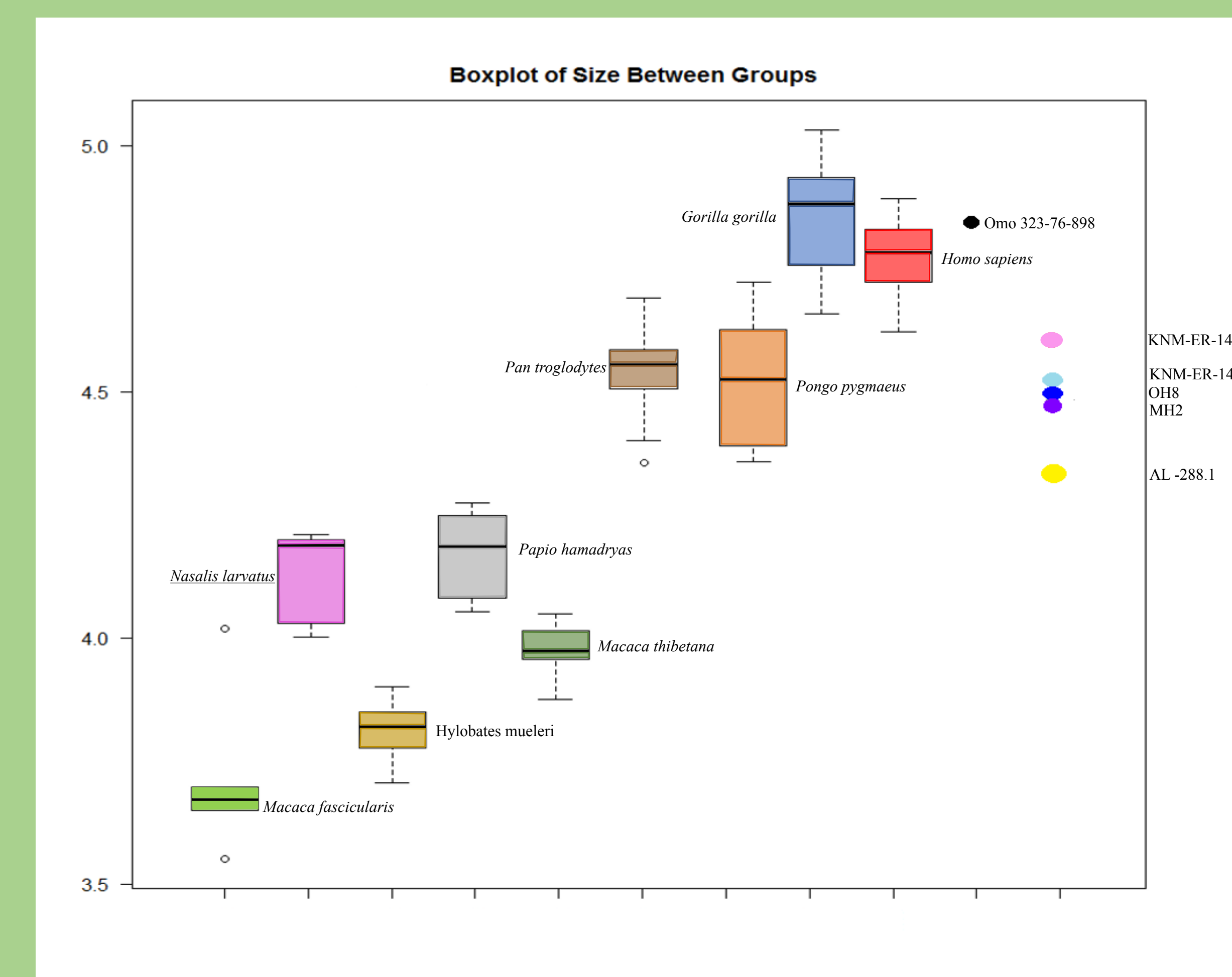
**Table 1:** Extant specimens and sample size

Catalog number	Taxon	Age	Site
AL 288.1	<i>Australopithecus afarensis</i>	3.2 Ma	Kada Hadar Mb. 1, Hadar Fm., Ethiopia
KNM-ER-1476 (reconstructed)	cf. <i>Paranthropus boisei</i>	1.9 Ma	Koobi Fora Fm. U. Burgi Mb., Kenya
KNM-ER-1464	cf. <i>Homo erectus</i>	1.9 Ma	Koobi Fora Fm., U. Burgi Mb., Kenya
MH2	<i>Australopithecus sediba</i>	1.9 Ma	Malapa, South Africa
OH8	<i>Homo habilis</i>	1.8 Ma	Bed I, Olduvai, Tanzania
OMO-323-76-898	Hominini indet.	2.2 Ma	Omo Fm., L. Mb. G., Shungura, Ethiopia

**Table 2:** Fossil Hominins included.



**Figure 4:** A Canonical Variance Analysis separates humans and non-human primates, with fossil hominins intermediate.



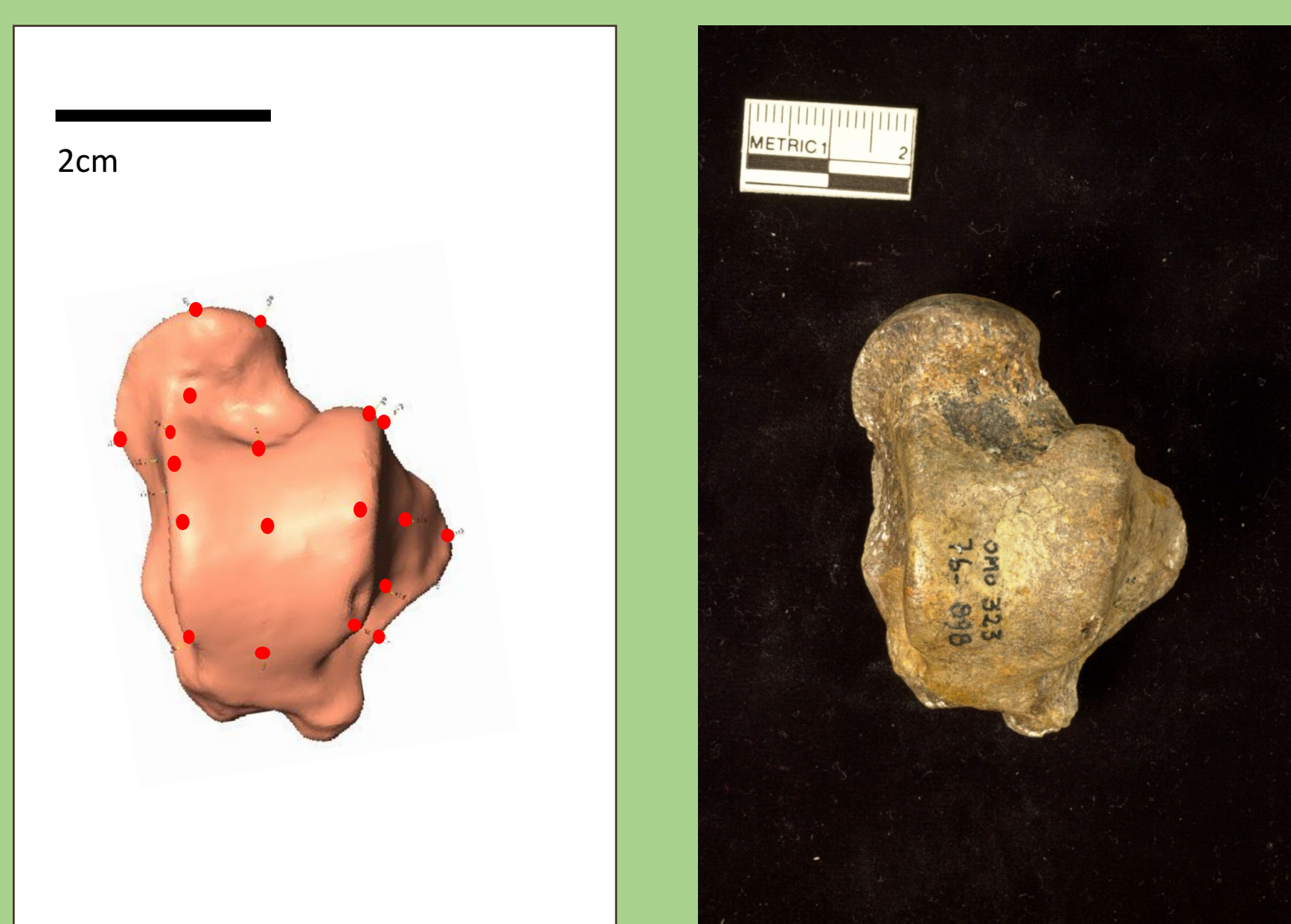
**Figure 5:** The Boxplot uses the natural logarithm of centroid size

## Results:

- Principal Component Analysis of extant specimens based on the complete 30 landmark dataset, and shows clear separation between humans and all other non-human primates, where PC1 is responsible for 19% of the variance (Figure 2).
- The corresponding PCA based on an 18 landmark reduced dataset to include fossil hominins (Figure 3) yields similar results. Omo 323-76-898 falls outside of apes and close to modern humans. AL 288.1, *Australopithecus afarensis* falls closer to apes.
- The first Canonical Variates Axis (49%) separates humans from all non-human primates. The fossil hominins lie between humans and non-human primates, with Omo 323-76-898 closest to modern humans among fossil hominins (Figure 4).
- Omo 323-76-898 is larger than other early hominins and lies within ranges of humans and gorillas.

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**Figure 1:** (Left) Superior view of the 3D laser scan of Omo 323-76-898 with superiorly visible landmarks placed using Landmark editor, (Right) photograph of Omo 323-76-898

## Discussion:

- The comparatively large size of the Omo talus makes it difficult to suggest affinities to either *Paranthropus boisei* or *Australopithecus*.
- Omo 323-76-898 is older than the *Paranthropus* and other *Homo* specimens in our sample, and yet our findings suggest a more human-like ankle joint, supporting Gebo and Schwartz.<sup>3</sup> This is interesting as *Australopithecus afarensis* (AL-288.1), has been shown to be more human-like, but later hominins like *Homo habilis* (OH8) and KNM-ER-1476 (cf. *Paranthropus boisei*) appear more ape-like.
- Our findings support previous research that *Australopithecus sediba* (MH2) appears more ape-like. *A. sediba* has been shown to have a combination of morphological features similar to great apes, specifically the likely absence of a longitudinal arch, an architectural feature driven by the inclination of the talar head.<sup>4</sup>
- A possible driving force for some of the morphological differences among all of the fossil hominin tali in our sample could be bone remodeling in response to use during life, especially during development.<sup>7</sup>

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