



# **From footprints to locomotor anatomy? The contribution of geometric morphometrics to the study of the hominin footprints from the Upper Pleistocene site of Rozel (Normandie, France)**

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Hominin footprints represent a unique snapshot of a moment in the life of extinct individuals. In addition to the original information they may provide about group composition, many authors have taken an interest about the anatomical information they can reveal by benefiting from the development of new recording techniques and 2D/3D morphometric studies. We report here a morphometric study of 8 human footprints recently discovered at the Middle Palaeolithic site of Le Rozel (Normandie, France)

### Issue & Aim

What anatomical information about the “Le Rozel” hominins is it possible to obtain from the morphometric study of their footprints?

➤ Comparative geometry morphometrics analysis of the “Le Rozel” footprints with experimental and fossil footprints

### Material

8 3D models of «Le Rozel » footprints coming from a single stratigraphic unit compared to models of footprints made in various ground natures by different hominin species.

Site	Period	Associated taxon	Depositional settings	Number of footprints	Number of individuals
Experimental <sup>1</sup>		<i>H. sapiens</i>	Nearby the site in a similar sediment	46	20
Le Rozel <sup>1</sup>	Upper Pleistocene	<i>H. neanderthalensis</i>	Sand/Sandy mud	8	8
Happisburgh <sup>2</sup>	Lower Pleistocene	<i>H. antecessor</i>	Silt	1	1
Laetoli <sup>2</sup>	Pliocene	<i>Au. afarensis</i>	Volcanic Tuf	17	3 (G <sub>1</sub> , S <sub>1</sub> , S <sub>2</sub> )

<sup>1</sup>3D surfaces digitized in situ

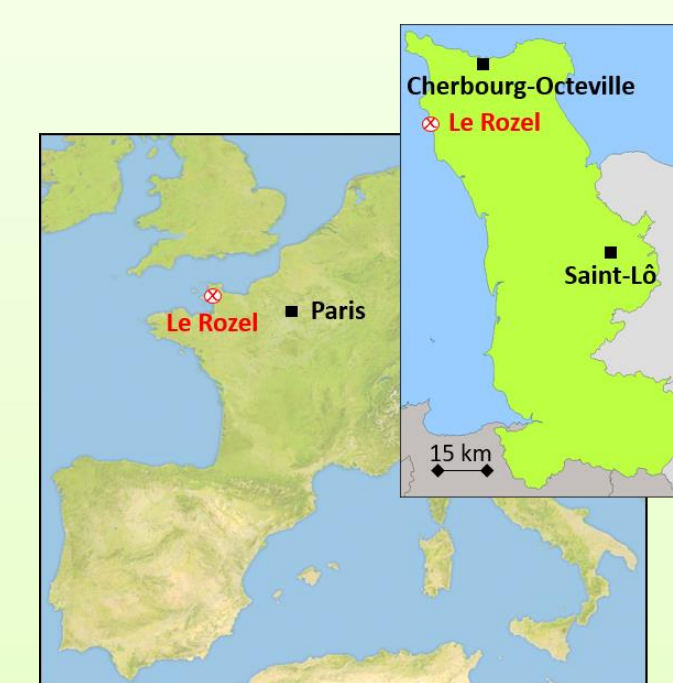
<sup>2</sup>3D surfaces from a freely accessible database



One of the experimental footprint (photo: J. Duveau)

### Le Rozel

- Discovered during the early 60's
- New excavations since 2012
- Located in a paleodune system
- Several occupation layers having delivered a rich archaeological material (faunal remains, lithic industries, charcoals...) attesting to several Neandertal occupations 80 000 years ago (Mercier *et al.*, 2017)
- Discovery of 290 hominin footprints since 2012 made in muddy flows covering sandy elements

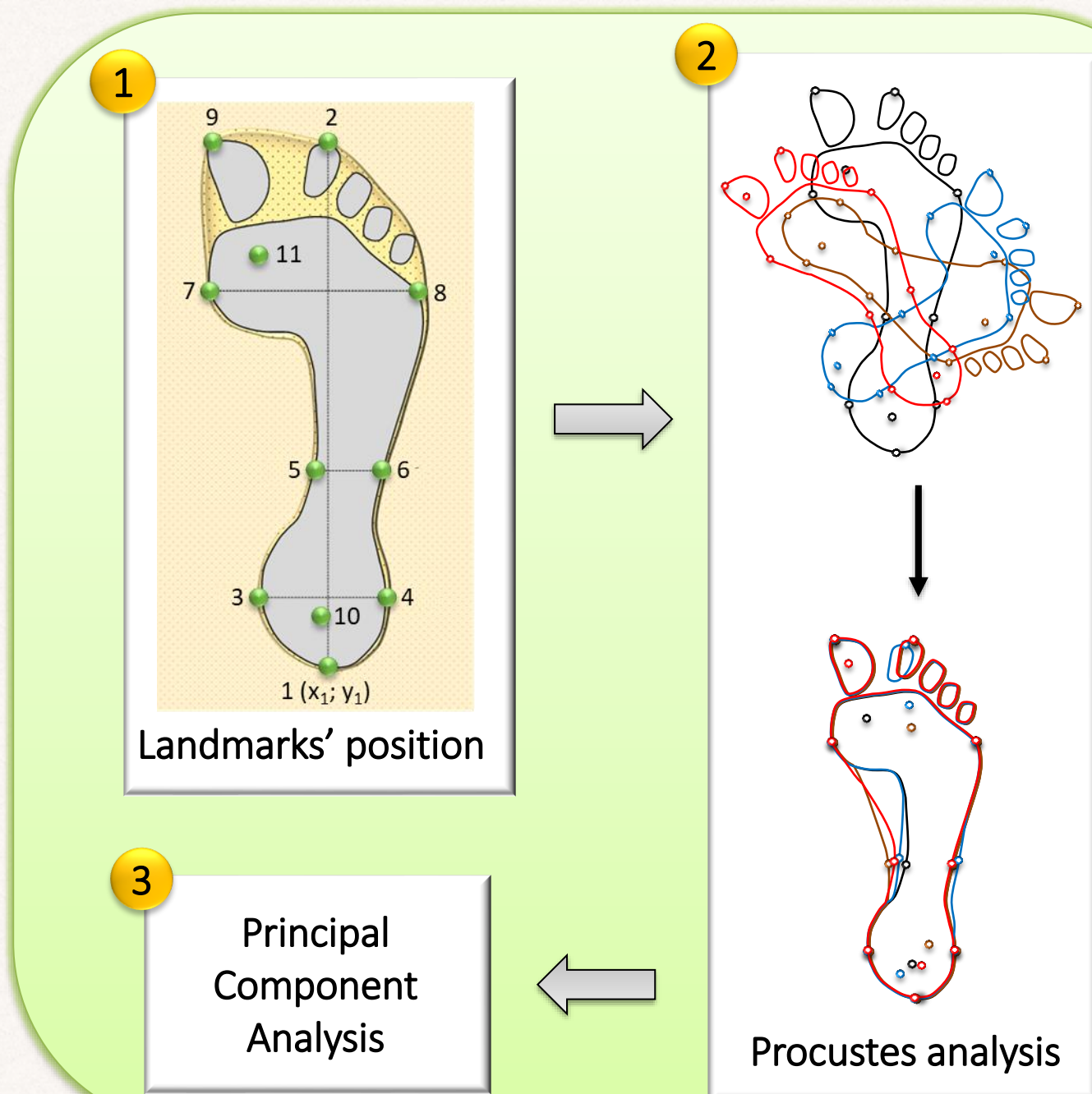


The archaeological site of « Le Rozel »

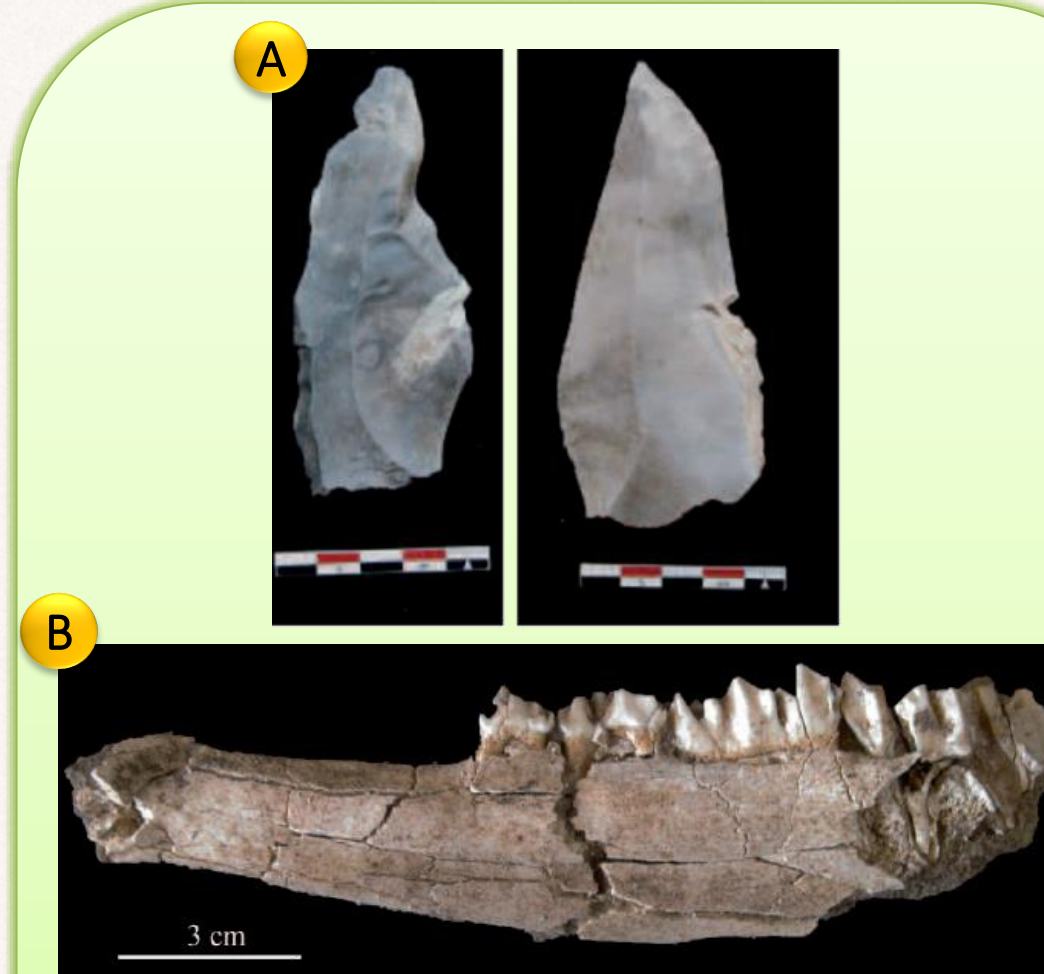
### Methods

Using 11 landmarks that represent the foot outline (1-9) and maximum depth points (10-11) based on Bennett *et al.*, 2009:

- 1-2 : Longitudinal axis of the footprint
- 3-4 : Maximal width of the heel
- 5-6 : Minimal width of the midfoot
- 7-8 : Maximal width of the forefoot
- 9 : Distal inflection point of the hallux
- 10 : Maximal depth of the heel
- 11 : Maximal depth of the forefoot

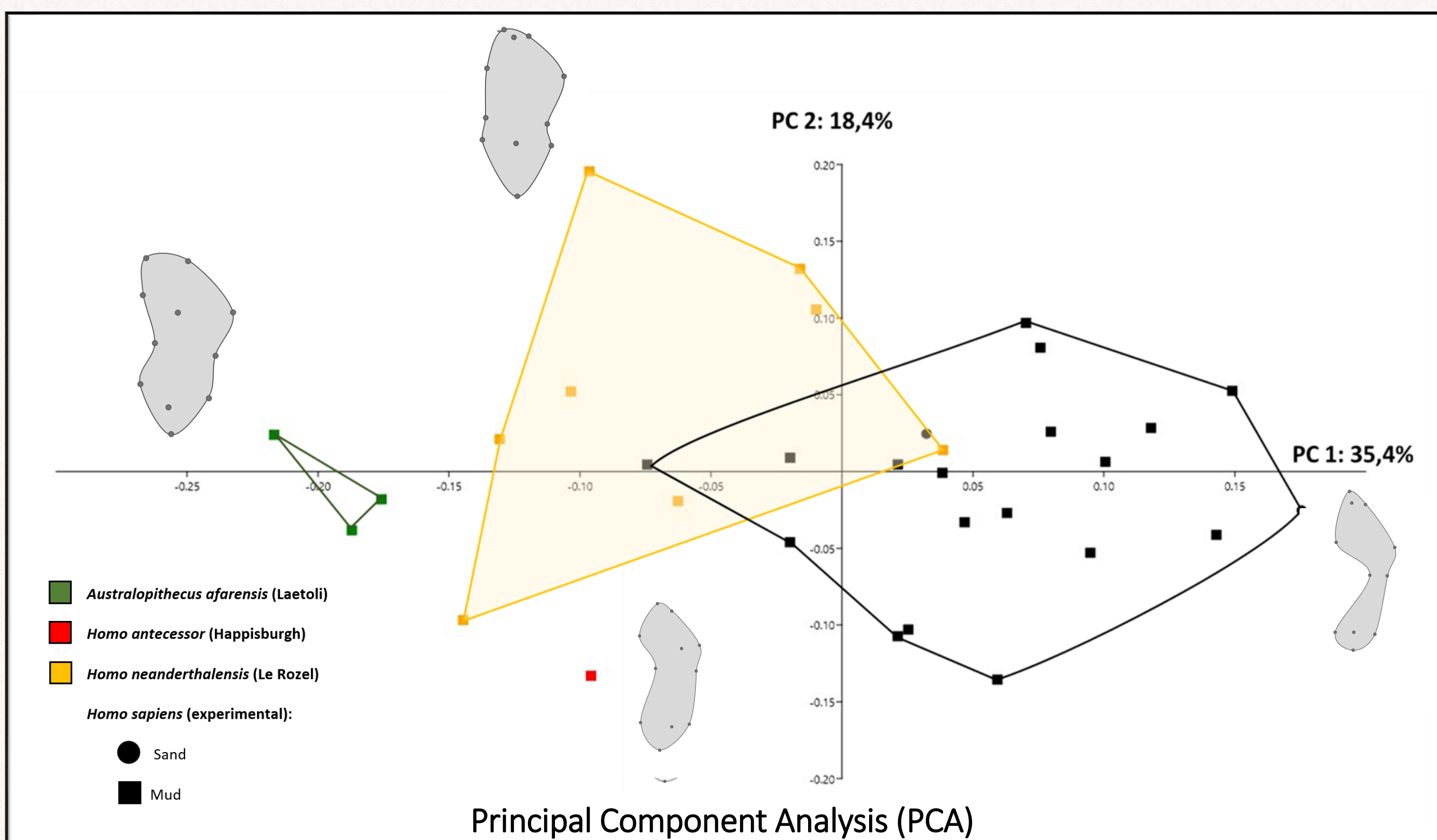


« Le Rozel » hominin footprints (photos: D. Cliquet)



Levallois flakes (A) and a deer's lower jaw (B) discovered in “Le Rozel” (photos: D. Cliquet)

### Results



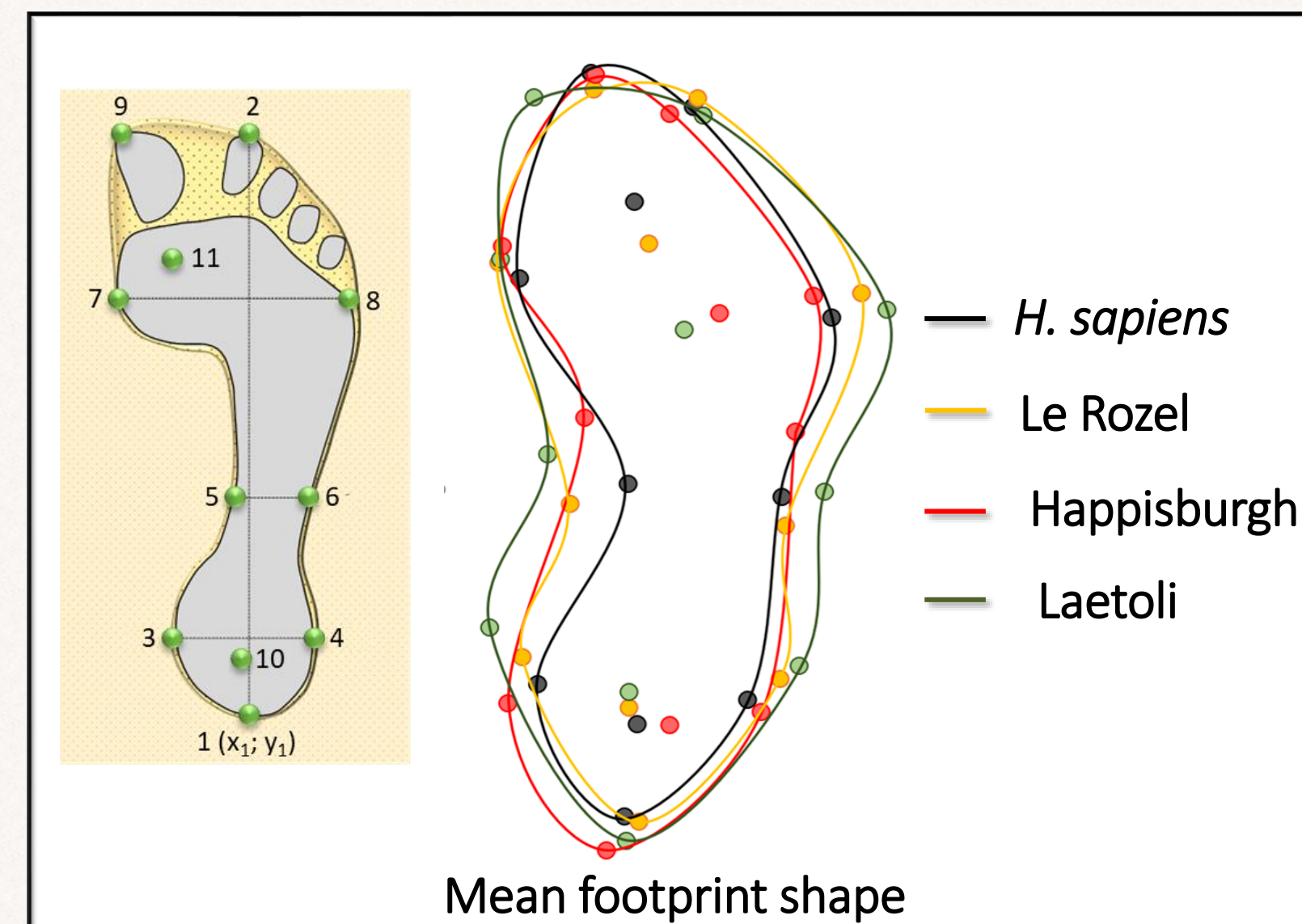
Principal Component Analysis (PCA)

PCA analyses show that « Le Rozel » footprints differ on average from the other footprints. They are closest to the anatomically modern footprints.

The locations of the maximum depth areas of the heel and the forefoot are similar to *Homo sapiens* footprints. Besides, the adduction of the hallux is identical to anatomically modern footprints.

However, 2 main differences with *H. sapiens* :

- A slightly wider heel
- A wider midfoot reflecting a less pronounced plantar vault than for *Homo sapiens*



Mean footprint shape

Morphometric analysis have shown that Le Rozel footprints differ from *Homo sapiens* footprints, reflecting anatomical features such as a wider heel or a less pronounced plantar vault. These anatomical features of Le Rozel footprints are consistent with our knowledge of the anatomy of the Neandertal foot. Ongoing analyses of the impact of taphonomic agents on the footprints' morphology will help improving our interpretation of Le Rozel footprints.



A Neandertal foot : La Ferrassie 2 (photo: G. Berillon with the permission of the Musée de l'Homme)

#### References:

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Mercier, N., Martin, L., Kreutzer, S., Moineau, V., Cliquet, D., 2017. Dating the palaeolithic footprints of « Le Rozel » (Normandy, France). *Quaternary Geochronology*.

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