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Diachronic and geographic diversity of the femoral structure in Neanderthals

Quentin Cosnefroy, Isabelle Crevecoeur, Patrick Semal, Gilles Berillon, François Marchal, Thibaut Devière, Hélène Rougier

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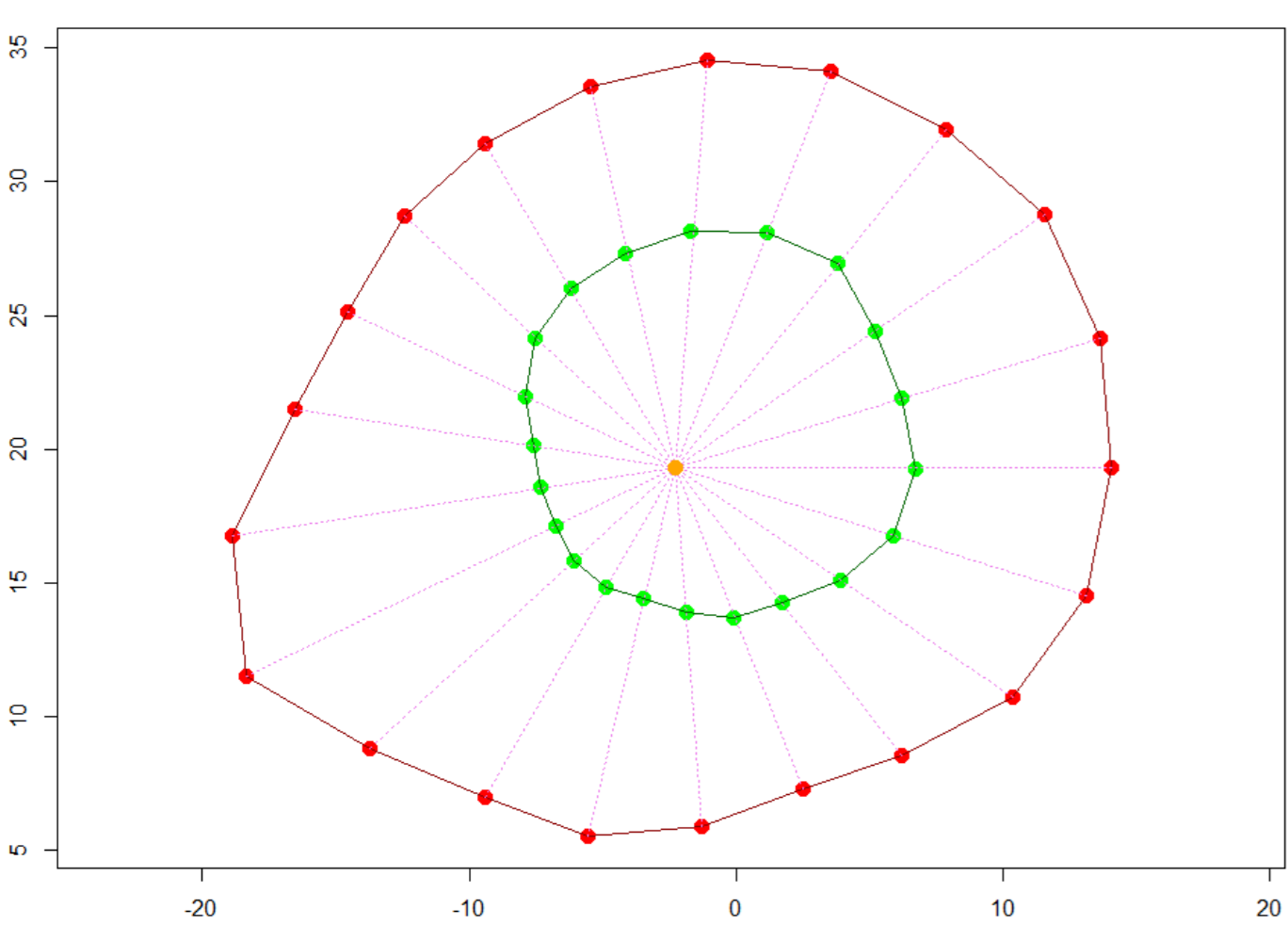
Introduction

Neanderthals exhibit documented differences in their femoral morphology compared to those of other *Homo* species, including *Homo sapiens*, particularly concerning the femoral diaphysis [1]. However, the **intra-specific diversity** of femoral morphology within the Neanderthal lineage remains poorly understood [2]. Here, we aim to study this diversity by comparing femoral diaphyseal morphology in specimens from distinct **chronological** and **geographical** contexts.

Materials & methods

We analyzed the cross-sectional shape of 18 Neanderthal and 1 Middle Pleistocene *Homo* femora using a two-dimensional landmark-based geometric morphometric approach [3].

Chronology	MIS 3 (11), MIS 4 (5), MIS 5-7 (2), MIS 12 (1)
Geography	△ Northern (6), ○ Western (10), and □ Central Europe (2); ◇ Levant (1)



Landmark conformation at midshaft of the La Ferrassie 1 right femur. Performed with the morphomap R-package on the 3D reconstruction of the bone from microCT scans.

For each femur, we focused on sections at 35%, 50%, 65%, and 80% of their biomechanical length. We used Principal Component Analysis on **Procrustes coordinates** from 42 landmarks placed on the endosteal (21) and periosteal (21) surfaces. Procrustes ANOVA was used to assess the influence of both chronology and geography.

Discussion & perspectives

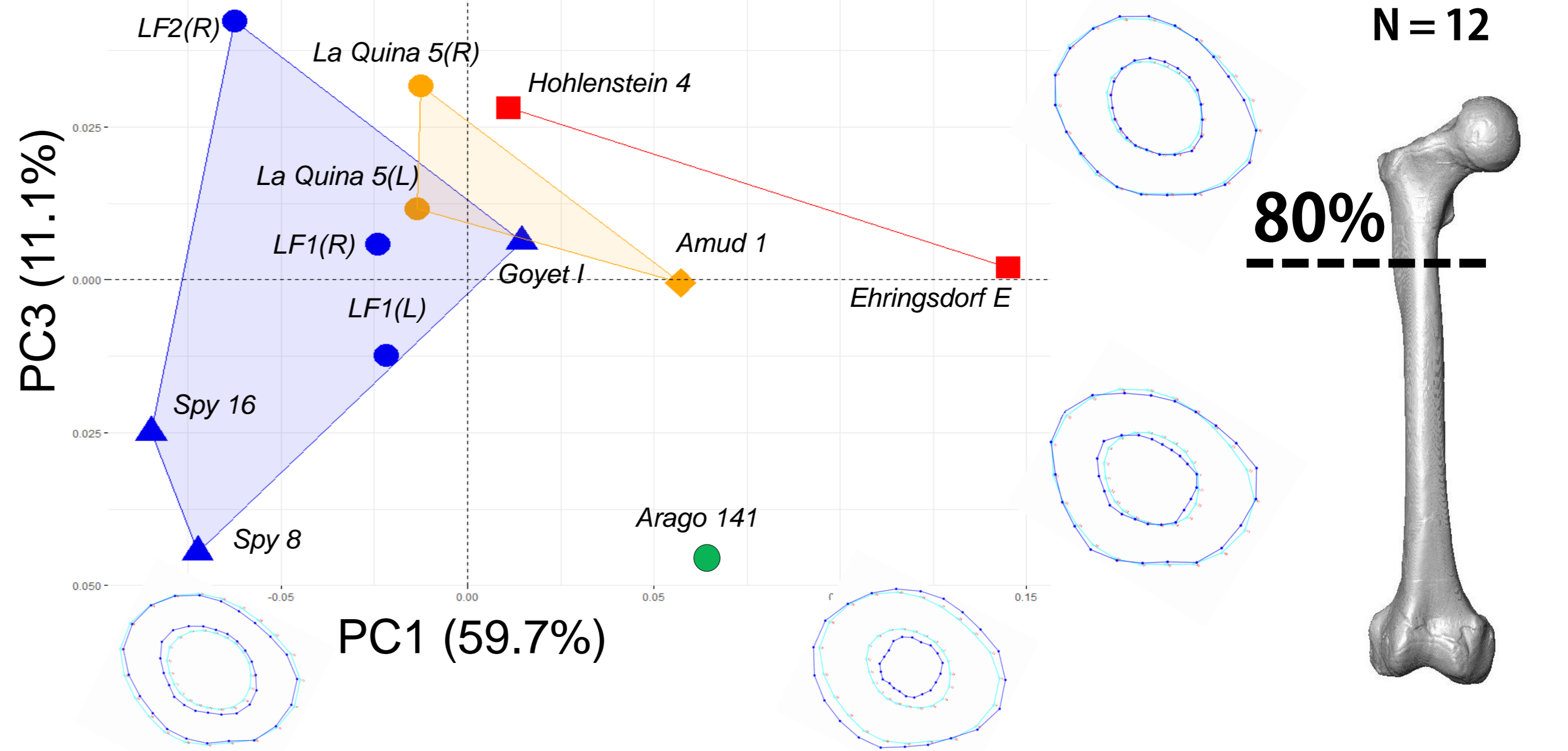
These preliminary results reveal **chronological distinctions** in femoral cross-sectional shape. (1) MIS 3 and MIS 4 specimens exhibit distinct patterns from each other, while (2) MIS 5-7 specimens appear to differentiate from both the late Neanderthal and ancestral morphology depicted by the Middle Pleistocene *Homo* specimen.

Geographical differences are also likely since (3) the Levantine specimen stands out as an outlier in all sections and (4) within MIS 3, Northern and Western European specimens tend to exhibit different morphologies at midshaft. More data are however needed to confirm this trend.

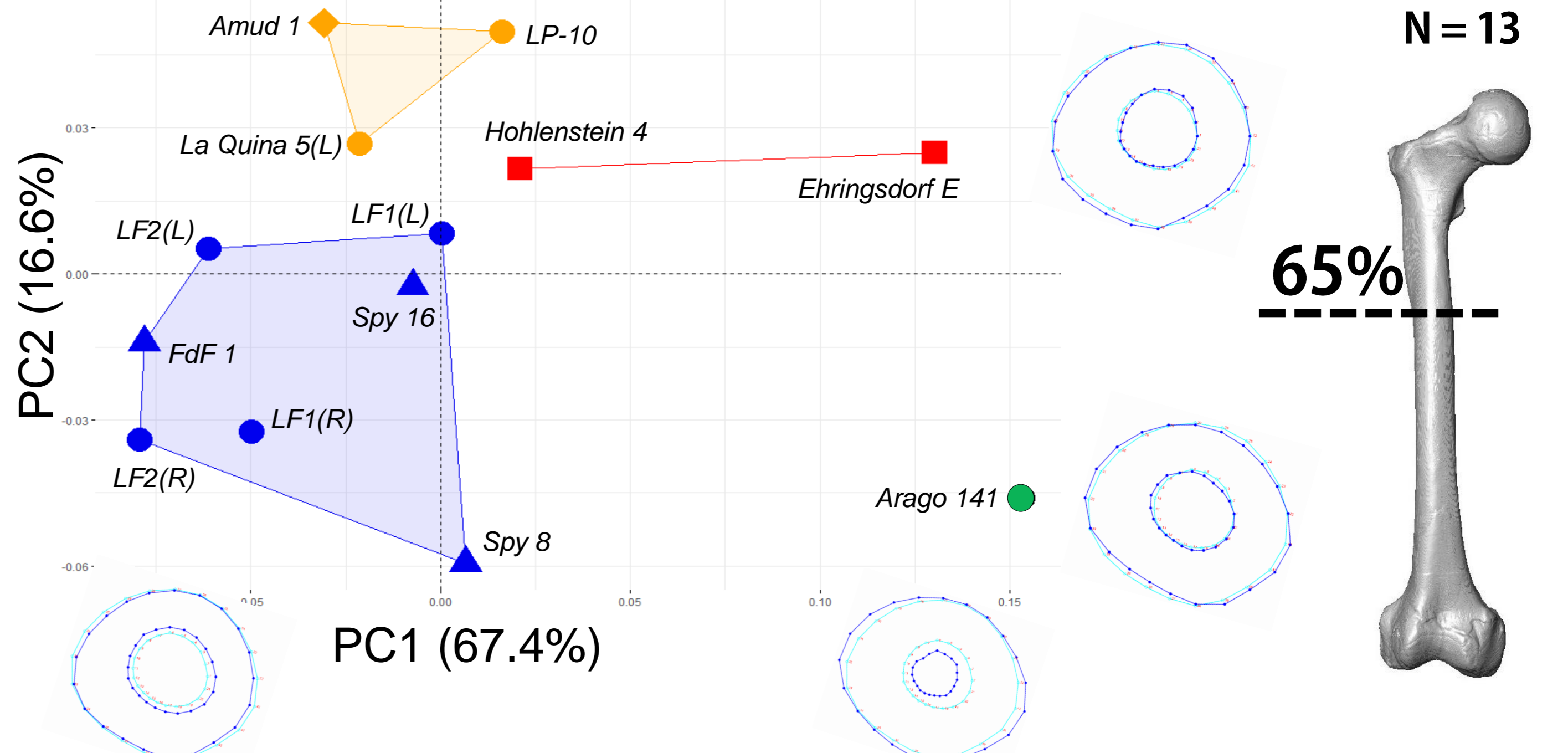
A **diachronic analysis** of specimens from a **single region** will provide deeper insights into the intra-specific diversity of Neanderthal postcranial morphology.

Results

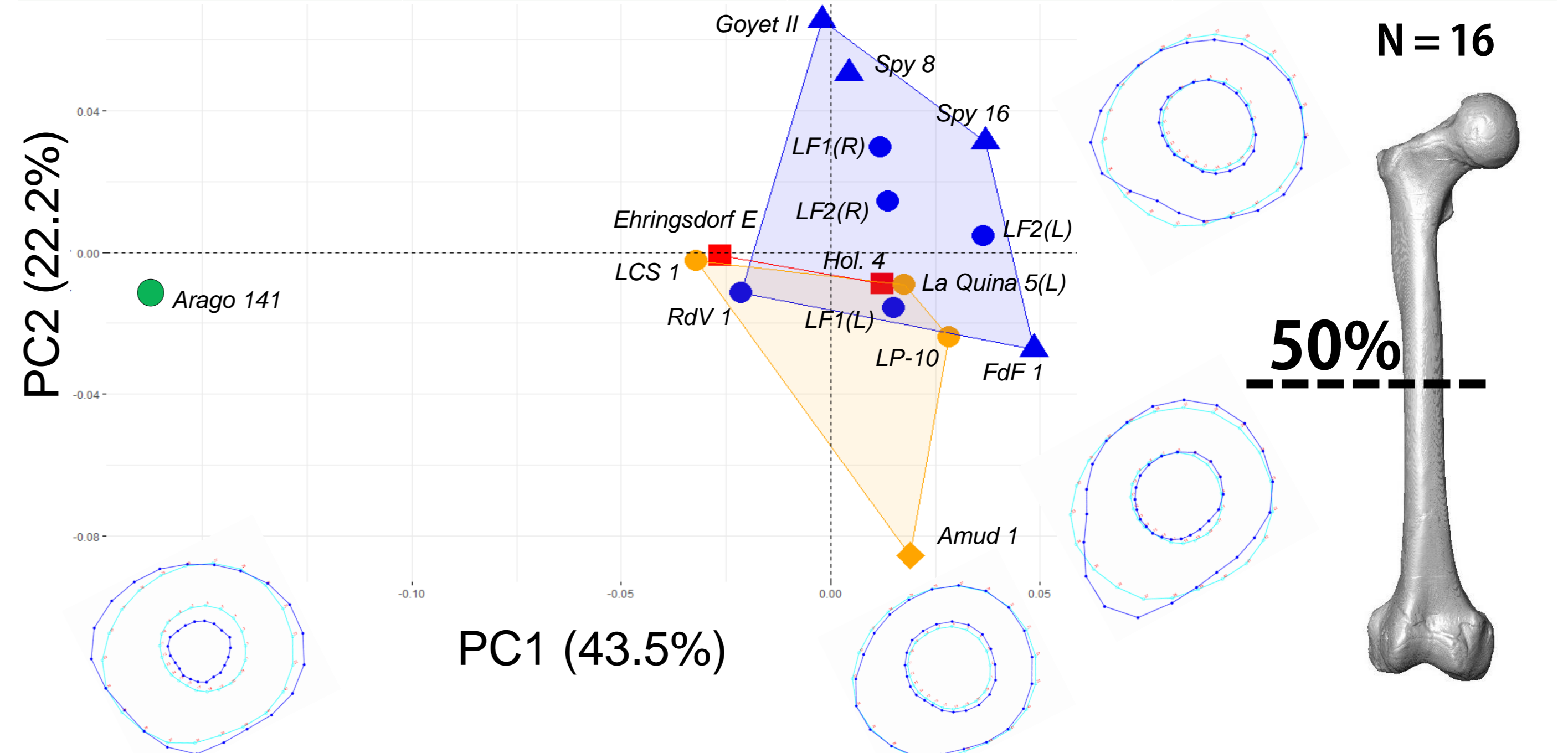
PROXIMAL	Df	R ²	p value
Chronology	3	0.464	0.057
Geography	3	0.448	0.087



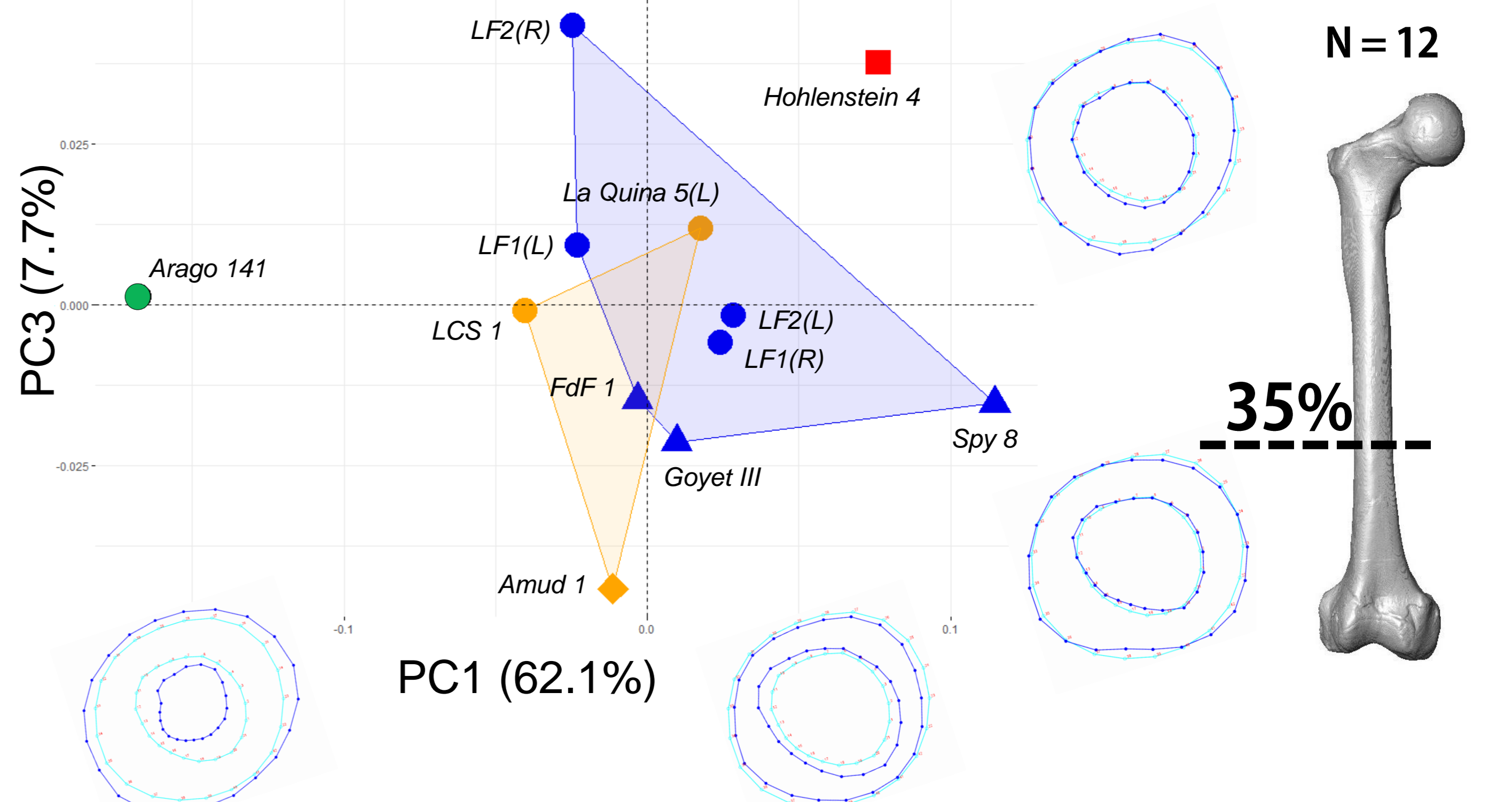
MID-PROXIMAL	Df	R ²	p value
Chronology	3	0.661	0.001***
Geography	3	0.287	0.297



MIDSHAFT	Df	R ²	p value
Chronology	3	0.466	0.02*
Geography	3	0.251	0.178



MID-DISTAL	Df	R ²	p value
Chronology	3	0.572	0.035*
Geography	3	0.322	0.295



Acknowledgements

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References: [1] Trinkaus, E., Ruff, C.B., 2012. Femoral and tibial diaphyseal cross-sectional geometry in Pleistocene Homo. *PaleoAnthropology* 2012, 13–62. [2] Puymerail, L., Condemi, S., Debénath, A., 2013. Comparative structural analysis of the Neanderthal femoral shafts BD 5 (MIS 5e) and CDV-Tour 1 (MIS 3) from La Chaise-de-Vouthon, Charente, France. *Paléo* 24, 257–270. [3] Profico, A., Bondioli, L., Raia, P., O'Higgins, P., Marchi, D., 2020. Morphomap: An R package for long bone landmarking, cortical thickness, and cross-sectional geometry mapping. *American Journal of Physical Anthropology*. 174, 129–139.