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# The first Neandertal thumb phalanx displaying osteoarthrosis


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## Introduction

The Baume de Moula-Guercy lies on a calcareous cliff close to the village of Soyons, 10 kilometers south of Valence, Ardèche, France (Fig. 1).

The filling of the cave corresponds to three climatic phases: MIS 6 to 4. The layer XV has yielded an age of 120-130 ka, corresponding to MIS 5 and contains the hundred or so human remains excavated on this site.

Because of marrow extraction and consumption (Defleur et al., 1993), all Neandertal remains from Moula-Guercy are highly fragmentary, except the nearly marrowless hand and foot bones, which are intact.

Manual and pedal remains have been attributed to Neandertals mostly on the basis of their stratigraphic position (i.e. Mersey et al. 2013a, b). However, recent discoveries in the area show that modern humans could have arrived much earlier than previously thought (Slimak et al. 2022).

The aim of this study is to evaluate the pathology of a left proximal pollical phalanx (I2-104) and attribute the latter to a human group (Neandertal or modern).


***Figure 1 :*** Location of Baume de Moula-Guercy (Moula-Guercy cave) in France.

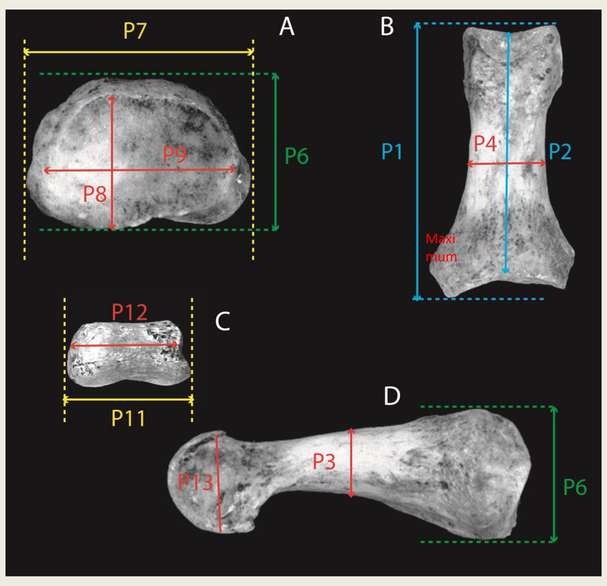


**Figure 2:** Phalanx measurements (not shown P5, which is the circumference at the middle)

## Material and method

*Method*

- The left pollical proximal phalanx (I2-104) is stored at the *Musée Archéologique de Soyons*.
- Visible features that are commonly associated with osteoarthritis (OA) on the external surface of the bone, as well as those affecting the internal structure (Table 1) were used. Computed tomography examination was performed at the Hôpital Nord in Marseille in an angiographic unit (Allura FD 20, Philips Healthcare).
- Thirteen measurements were also taken with a sliding caliper (Fig. 2). The statistical processing was carried out using PAST ® software, version 4.03 (Hammer et al. 2001). The principal components analysis (PCA) relies on a correlation matrix.

**Table 1:** Features of OA potentially observable on bones (after Pritzker, 2003; Rogers and Dieppe, 2003). The ground-glass appearance is found in numerous pathologies including OA.

| Rarely found on small fossil bones | Commonly found on fossils regardless of size |
|---|---|
| Articular plate fractures | Eburnated bone surface (unequivocal marker) |
| Corrugated bone surface | Osteophyte formation |
| Osteonecrosis | Ground-glass appearance of the subcortical bone |

*Material*

- The comparative data for other pollical proximal phalanges from Neandertals and upper Paleolithic individuals come either from the literature or from Erik Trinkaus' personal dataset, except for the Taforalt remains, which were measured by us.
- Our comparative data from modern *Homo sapiens* were taken for this study from three collections of adult individuals of known sex and age: the Georges Olivier collection (Musée de l'Homme, Paris, France), the Certosa collection (University of Bologna, Bologna, Italy), and the Tepe Hissar (Pen Museum, University of Pennsylvania, Philadelphia, USA).

## Results

**❑ Description of the I2-104 phalanx**

I2-104 has a slightly roughened tuberosity on the lateral side of the proximal diaphysis located at the distal end of a dorso-distributed muscle insertion zone. On the lateral side, a crest extending from the proximal part to the distal and dorsal part of the phalanx is present, delimiting the dorsal and palmar surfaces of the bone. The preserved part of the lateral edge is straight and not curved both in palmar or dorsal direction.

**❑ Taxonomic status of the I2-A04 phalanx**

The Neandertal pollical proximal phalanx does not differ from that found in modern humans. In any case, the I2-104 phalanx is within the Neandertal variation and thus can be assumed to be Neandertal, which is coherent with the other remains found at Moula-Guercy (Fig. 3).

**❑ The pathology**

The distal articular surface of this phalanx is pathological (Fig. 4) with:

- ✓ a large asymmetric eburnation on the palmar surface of the bone,
- ✓ an extensively developed osteophyte on the lateral surface forming an almost beak-like projection of the bone continuous with the articular surface.
- ✓ a subcortical ground-glass appearance with no periosteal bone reaction (Fig. 4).

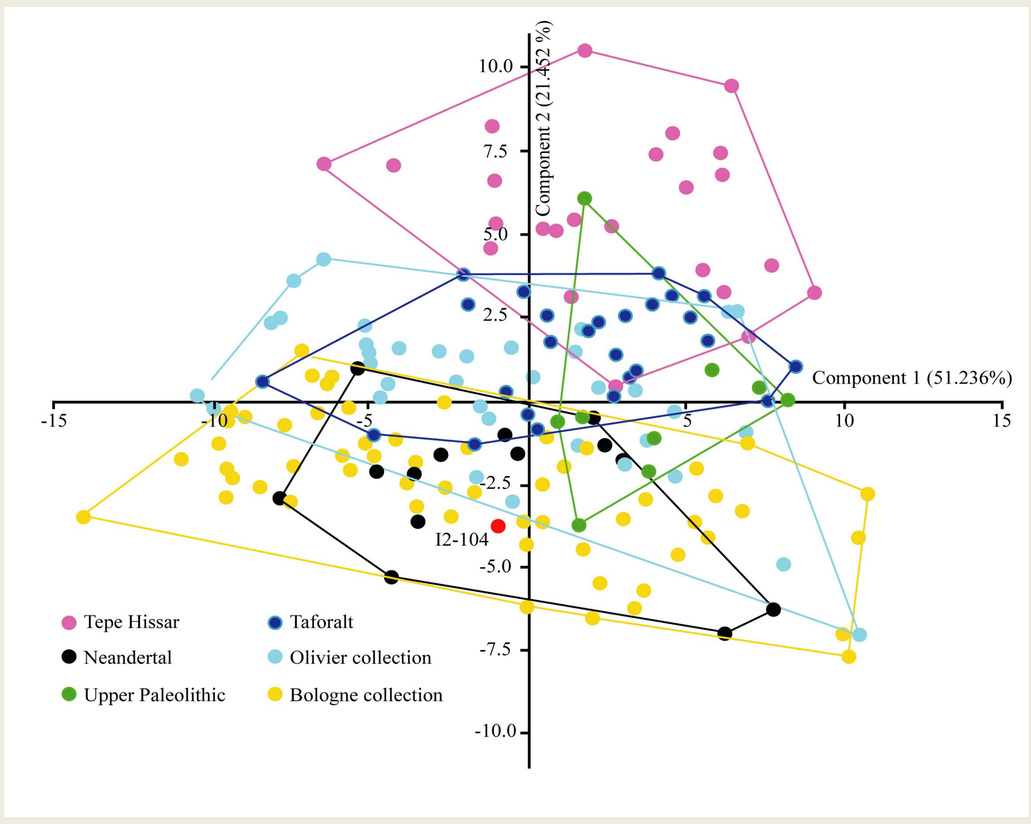


***Figure 3 :*** The first two components of the PCA representing 72,67% of the total variance.

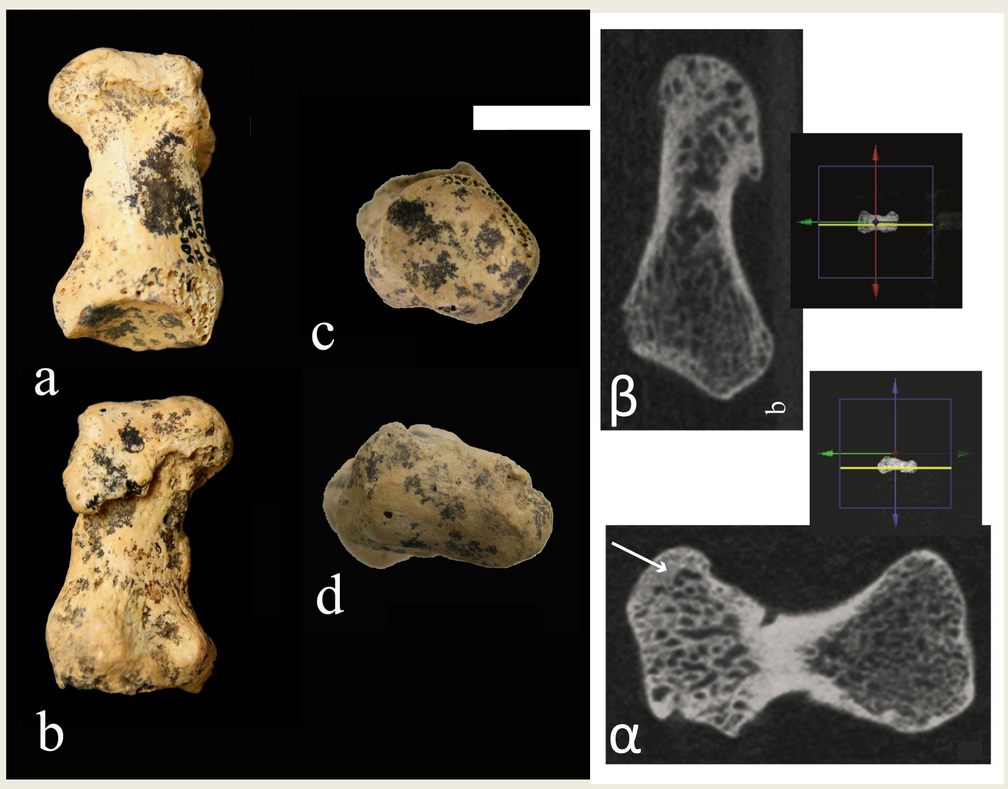


***Figure 4***: *Right:* I2-104 phalanx of Moula-Guercy. a: dorsal view, b: palmar view, c: proximal view and d: distal view. Scale: 1cm. *Left*: CT images of I2-104 α: coronal slice showing thickening of trabeculae and a subcortical ground-glass appearance (yellow line and white arrow); the coronal section passes through the diaphysis. β: sagittal slice showing osteophytic-like changes of the tuft along the section (the yellow line).

## Discussion

The pathological aspects of this phalanx, point out the presence of osteoarthritis (OA).

The OA origin is multi-factorial, and can result from:

- ❑ extrinsic factors such as obesity (Rydberg et al., 2020), infection, and overuse
- ❑ intrinsic ones, such as degeneration and trauma,
- ❑ systemic factors due to age, genetic makeup, diet, or metabolic and endocrine functions (Felson, 2003).

**Obesity**

OA due to obesity seems unlikely in Neandertals, because this pathology is extremely rare within hunter-gatherer populations.

**Infections and trauma**

Septic arthritis seems unlikely because it is both rare and potentially lethal in the absence of antibiotic treatment long before it brings permanent damage to the bones.

The trabeculae of the cancellous bone are thick and remain spatially organized. The articular surface is regular and, adjacent to it, areas of ground-glass appearance are observed with no periosteal reaction on the adjacent metaphysis. Effects of trauma or chronic infection do not show these patterns.

**Degeneration or overuse**

The radiological pattern observed in this case, along with the presence of eburnation, suggests a diagnosis of a degenerative or overuse OA (Rogers and Dieppe, 2003).
Joint degeneration, associated with aging, is well known in Neandertals who die at an advanced age (Trinkaus, 2018). Thus, the phalanx I2-104 fits in well with the Neandertal health pattern already known. This thumb phalanx is the first one known displaying OA within Neandertals, although this pathology is frequent on thumb joints in modern humans, but mostly at the proximal joint.
It is possible that diet could facilitate the development of osteoarthritis (Felson, 2003), but, with our limited knowledge, it cannot be proved in Neandertals. Hand bones with OA known among Neandertal fossils do not indicate that genetic factors have an effect on hand joints. But the genetic origin can be supported by the fact that OA is also associated with Neandertals' short limb bones (Capellini et al. 2017). This genetic predisposition could have been aggravated by aging and/or hand overuse.

## Conclusion

The I2-104 phalanx from Moula-Guercy shows an OA which may be due to aging and / or overuse. It is the first thumb phalanx within Neandertals showing an OA although this pathology is well known in Neandertals. The thumb OA is frequent in modern humans and seems to be much more less frequent among Neandertals.

It is difficult to determine which activities could have led to such a pathology, but knapping stone tools could provide a good explanation.

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