

A new distal hallual phalanx from the Neandertal holotype site in the Neander Valley (Germany)

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In the early and mid-19th century, a few discoveries of ancient human remains in Europe led to the birth of paleoanthropology or prehistory. One of these sites (Kleine Feldhofer Grotte, Neander Valley, Germany) yielded several human remains belonging to an incomplete skeleton that was identified as the holotype of *Homo neanderthalensis* [1]. Almost 150 years after the initial discovery of this Neandertal individual in 1856, new excavations and research of the old material from the site have been undertaken and new human remains have been identified. Of these new remains, three directly fit on the Neandertal holotype, and two different individuals have been identified with a direct dating chronology of around of 42 ka cal BP; an adult male (Neandertal 1-holotype) and a gracile female individual (Neandertal 2) [2].

Soon after the 1997 and 2000 excavations, two foot bone fragments were identified: the dorsal portion of a lateral cuneiform – NN22 and a fragment of the calcaneal tuberosity – NN38 [3]. They do not duplicate any of the elements found in 1856 and could represent elements of Neandertal 1. The cuneiform is metrically and morphologically consistent with the range of variation of those of other Neandertals [3], but the dimensions of Neandertal tarsals are similar to those of recent modern humans [4]. The fragmentary nature of the calcaneal fragment precludes any taxonomic assignment. In a recent review of the material recovered during the contemporary excavations, a left human distal hallual phalanx corresponding to an adult individual was identified among the faunal remains from the Kleine Feldhofer Grotte.

Fossil foot bones associated with the genus *Homo* are extremely rare before the existence of Neanderthals and *Homo sapiens*. In this work, we provide a complete metric and morphological study of this foot phalanx within a global comparative framework in relation to other Pleistocene fossils and recent human samples. We include Neandertals, Middle Paleolithic Modern Humans (MPMH), Upper Paleolithic Modern Humans (UP) and several recent modern human samples as comparative samples for the study of the Feldhofer foot phalanx. The age at death for this specimen is that of an adult, based on its fully fused proximal epiphysis. The bone is compressed in its dorsoplantar (DP) dimension, and the proximal articular facet is slightly bi-concave. The distal tuberosity has a slight lateral tilt.

The metrical variables of this hallual phalanx fit well with the ranges of variation in morphology and dimensions of those of Neandertals throughout the world fossil record. This is particularly relevant for the medio-lateral widths, which in Neandertals and the Feldhofer phalanx are wider than those of recent and fossil *Homo sapiens*. This fact confirms the Neandertal nature of this fossil. Despite the scarcity of Neandertal distal hallual phalanges, the Feldhofer phalanx groups better with those identified as male. If all of this is confirmed, this phalanx could probably belong to the holotype of *Homo neanderthalensis*.

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References: [1] King, W., 1864. The reputed fossil man of Neanderthal. Quarterly Review of Science 1, 88-97. [2] Schmitz, R.W., Serre, D., Bonani, G., Feine, S., Hillgruber, F., Krainitzki, H., Pääbo, S., Smith, F.H., 2002. The Neandertal type site revisited: Interdisciplinary investigations of skeletal remains from the Neander Valley, Germany. Proceedings of the National Academy of Sciences of the United States of America. 99, 13342–13347. [3] Smith, F.H., Ostendorf Smith, M., Schmitz, R.W., 2006. Human skeletal remains from the 1997 and 2000 excavations of cave deposits derived from Kleine Feldhofer Grotte in the Neander Valley, Germany. In: Schmitz, R.W. (Ed.), Neanderthal 1856-2006. Verlag Philipp von Zabern, pp. 187–246. [4] Trinkaus, E., 1975. A functional analysis of the Neandertal foot, Faculty of the Graduate school of Arts and Sciences. University of Pennsylvania, Pennsylvania, p. 533. [5] Pablos, A., Arsuaga, J.L., 2024. Metatarsals and foot phalanges from the Sima de los Huesos Middle Pleistocene site (Atapuerca, Burgos, Spain). The Anatomical Record. 307, 2665–2707.