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# New Neandertal wrist bones from El Sidrón, Spain (1994–2009)

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ABSTRACT

Twenty-nine carpal bones of *Homo neanderthalensis* have been recovered from the site of El Sidrón (Asturias, Spain) during excavations between 1994 and 2009, alongside ~2500 other Neandertal skeletal elements dated to ~49,000 years ago. All bones of the wrist are represented, including adult scaphoids ($n = 6$), lunates ($n = 2$), triquetra ($n = 4$), pisiforms ($n = 2$), trapezia ($n = 2$), trapezoids ($n = 5$), capitates ($n = 5$), and hamates ($n = 2$), as well as one fragmentary and possibly juvenile scaphoid. Several of these carpals appear to belong to the complete right wrist of a single individual. Here we provide qualitative and quantitative morphological descriptions of these carpals, within a comparative context of other European and Near Eastern Neandertals, early and recent *Homo sapiens*, and other fossil hominins, including *Homo antecessor*, *Homo naledi*, and australopiths.

Overall, the El Sidrón carpals show characteristics that typically distinguish Neandertals from *H. sapiens*, such as a relatively flat first metacarpal facet on the trapezium and a more laterally oriented second metacarpal facet on the capitate. However, there are some distinctive features of the El Sidrón carpals compared with most other Neandertals. For example, the tubercle of the trapezium is small with limited projection, while the scaphoid tubercle and hamate hamulus are among the largest seen in other Neandertals. Furthermore, three of the six adult scaphoids show a distinctive os-centrale portion, while another is a bipartite scaphoid with a truncated tubercle. The high frequency of rare carpal morphologies supports other evidence of a close genetic relationship among the Neandertals found at El Sidrón.



## 1. Introduction

The El Sidrón Cave site (Asturias, Spain) has yielded over 2500 Neandertal (*Homo neanderthalensis*) skeletal elements from at least 13 individuals, making it the largest sample of this taxon in the Iberian Peninsula (Fortea et al., 2003; Rosas et al., 2006, 2015; Bastir et al., 2010). These remains were recovered from the El Sidrón karst system and have been dated to 49,000 years ago based on direct radiocarbon dating of a Neandertal bone fragment (Wood et al., 2013), as well as electron spin resonance, optically stimulated luminescence, and amino acid racemization of the Neandertal remains and surrounding sediments (de Torres et al., 2010). The total sample represents seven adults, three adolescents, two juveniles, and one infant, and all skeletal elements are represented (Rosas et al., 2006, 2013). Geological, archaeological, and paleontological evidence suggests that these individuals likely represented a contemporaneous social group of Neandertals (Rosas et al., 2006; Santamaria et al., 2010). Genetic analyses confirm that these individuals represented a small, patrilocal community with low genetic diversity (Lalueza-Fox et al., 2011). Congenital defects are also present in the sample and likely reflect the low genetic diversity within this social group (Dean et al., 2013; Ríos et al., 2015).

Several morphological studies of the El Sidrón Neandertals have been conducted, including analyses of the crania (Rosas et al., 2008; Bastir et al., 2010; Peña-Melián et al., 2011), dentition (Rosas et al., 2006, 2013; Dean et al., 2013), ribs (Bastir et al., 2015, 2017),

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clavicles (Rosas et al., 2017b), humeri (Rosas et al., 2015) and tali (Rosas et al., 2017a). Among the preserved Neandertal remains at El Sidrón are multiple hand bones, including carpals, metacarpals, and phalanges that were discovered between 1994 and 2009. Like the whole El Sidrón sample, the hand remains were recovered from a restricted area in the Galeria del Osario within the El Sidrón cave system (Fig. 1). The carpals, metacarpals, and phalanges were found mixed with the rest of the skeletal elements without any special distribution (F5, F7, F8, F9, G6, and G8 $m^2$ of the archaeological excavations; Fig. 1). Although the handedness of the El Sidrón individuals has been addressed through analyses of their dentitions, showing a right-hand preference (Estalrrich and Rosas, 2013), the hand bones have not yet been described. Here we describe and analyze the El Sidrón carpals, including 29 specimens representing all eight carpal elements, and compare them with those of other European and Near Eastern Neandertals, recent and early *Homo sapiens*, other *Homo* taxa, and australopiths.

## 2. Materials and methods

All of the El Sidrón carpal bones were compared qualitatively and quantitatively to a sample of female and male recent modern humans (*H. sapiens*), including Europeans, small-bodied Khoisan, and skeletally robust Tierra del Fuegians, and a sample of fossil hominins (Table 1). The morphometric variables used for the comparative analyses are listed in Tables 2–9 and images of these measurements are provided in the box-and-whisker plots (see below) and elsewhere (Kivell and Begun, 2009; Begun and Kivell, 2011; Kivell et al., 2013a, b). All measurements were collected by one of us (TLK) on original specimens or surface models of original specimens, apart from the following specimens: the Shanidar 4 and La Chapelle capitates and the Regourdou 1 triquetrum, pisiform, and hamate, for which measurements were derived from surface models of casts. Measurements on 3D surface models were taken in Avizo® 6.3 (FEI Visualization Sciences Group). Furthermore, data for some Shanidar carpals and all of the early *H. sapiens* Dolní Věstonice specimens were obtained from Trinkaus (1983) and Sládek et al. (2000), respectively. Table 1 provides the details and sources of the comparative sample.

Since body mass is typically not available for fossil specimens or most extant specimens in comparative collections, each morphometric variable was divided by a geometric mean derived from a subset of variables on each carpal bone to adjust for carpal size (i.e., to create shape ratios; Mosimann, 1970; Jungers et al., 1995). For all carpals, a geometric mean was derived from the maximum mediolateral (ML) breadth, dorsopalmar (DP) height, and proximodistal (PD) length of the bone, unless otherwise stated. We investigated variation in the shape ratios (with sexes pooled) visually via box-and-whisker plots and principal components analysis (PCA) using a variance-covariance matrix. We used Spearman's rank correlation to test for potential significant correlations between the geometric mean and shape ratios (only significant correlations are reported). All statistical analyses were conducted in PAST.3.14 (Hammer et al., 2001).

## 3. Anatomical description of the El Sidrón carpal bones

### 3.1. Scaphoids (Table 2, Fig. 2)

SD-744 right scaphoid Preservation. This bone is largely complete and generally well-preserved apart from the distomedial region. There is a large fragment missing from the distomedial border that reaches proximally to the capitate facet. Much of the capitate articular surface is eroded but trabeculae are not exposed. Small fragments are missing from the proximopalmar portion of the capitate facet and distal and medial regions of the tubercle.

*Morphology.* This scaphoid is large both DP and PD. The tubercle is long and robust, especially at its base. The trapezium-trapezoid articulation extends almost to the tip of the tubercle and the relatively flat trapezium facet is distinguished from the smaller trapezoid facet by a slight concavity and change in orientation. The radial facet is DP taller than it is PD long and mildly convex throughout. There is a deep groove between the radial and trapezoid facets. The borders of the lunate facet are poorly defined, but it is PD narrow

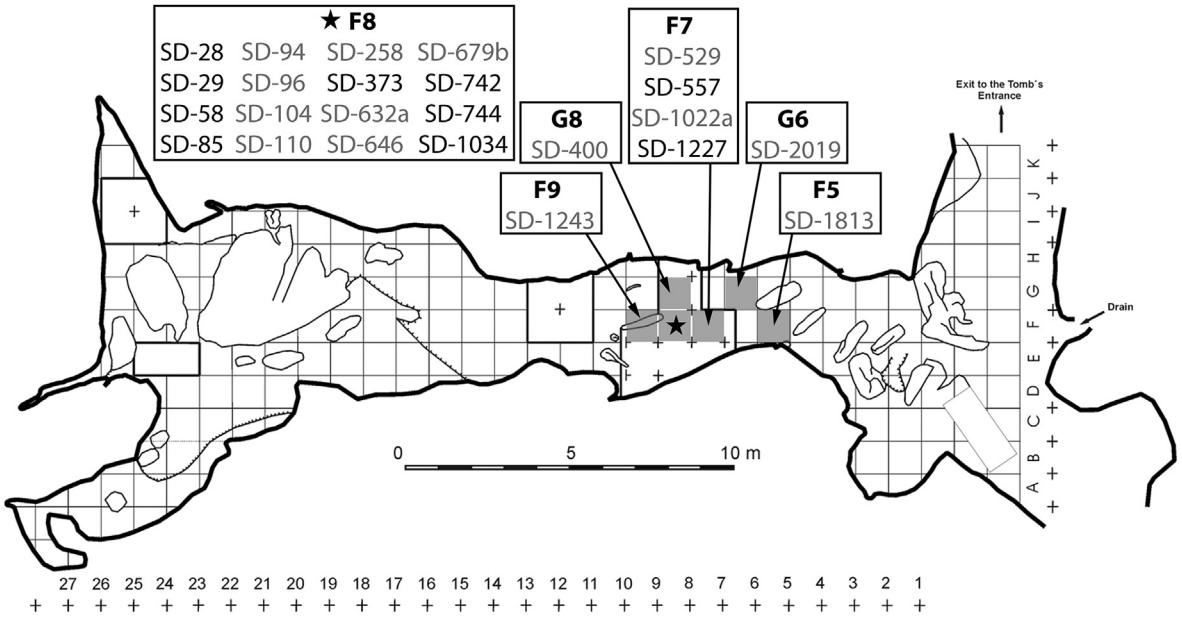


**Figure 1.** Map of El Sidrón Osario Gallery. Map showing excavated area and location that each carpal bone was recovered. Gray squares indicate areas from which carpals were recovered; the star indicates the square (F8) from which most of the carpals were recovered, including specimens thought to be associated with the same individual (black text, see discussion of Hand 1 in the main text). Specimens SD-1011a, SDR-063, SDR-064, and SDR-158 do not have a known context. For a complete map of the cave system and location of El Sidrón within Spain, see Rosas et al. (2006).