Supporting Information

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SI Text

Details on the Classification of Specimens. Although a recent direct accelerator mass spectrometry (AMS) radiocarbon dating result of ≈24 kya is available for Brno 2 (1), Brno 3 was not used because of its uncertain age [the specimen was destroyed in a fire (2)]. With regard to their age, questionable specimens of the UP AMH group are Fish Hoek and Mladeč 5 and 6. The Fish Hoek material was excavated at Peers Cave in the 1920s and assumed to be Middle Stone Age (3). In 1967 a date of ≈36 kya was published for a supposedly overlying layer (refs. 4 and 5, cited in ref. 6), but relating this layer to the location where the skeleton had been discovered was problematic. Another date of 18.5 kya seemed equally plausible (7). Minichello (8), however, reports a new dating performed "directly on the Fish Hoek Man" that suggests an age of 4.8 kya, but since this result has never been published by R. Singer, we refer to this specimen in our study as "Upper Paleolithic."

Recently, the Mladeč specimens 1, 2, 8, 9, and 25c were directly dated (9, 10), but the absolute age of the hominids Mladeč 5 and 6 remains unknown, because they do not derive from the Main Cave but from the close-by Quarry Cave (Side Cave). Nevertheless, archaeological evidence supports an Upper Paleolithic origin and in literature they are usually discussed in that context (refs. 11–17 and others).

We placed Jebel Irhoud 1 and 2, Ngaloba, Omo 2, Qafzeh 6, Qafzeh 9, and Skhūl 5 in "early AMH." Following the extensive literature on these specimens (12, 18–23) it is impossible to distillate a general consensus about their actual classification. However, we defined the following three statements as the least common denominator for our early AMH group: (*i*) none of these specimens is a Neanderthal; (*ii*) all of them are close to anatomical modernity or are definitely anatomically modern, although most of them retain as well some archaic features to a different extent; and (*iii*) all of them are chronologically clearly distinct from the Upper Paleolithic group.

In the archaic *Homo* group we included two specimens, Ngandong 7 and 14, that are both rather controversial in terms of dating and species assignment . Initially the Solo/Ngandong were described as having affinities to Neanderthals (24). Subsequently, however, the discussion emphasized the morphological similarities with archaic *Homo* and *Homo erectus*, respectively. The published dating results from faunal remains vary from ≈27 to ≈101 kya (25, 26), but the hominids have never been directly dated and association of the faunal elements is still disputed (27). Despite their potential Upper Paleolithic age, we place Ngandong 7 and 14 in the archaic *Homo* group following the opinion of the majority of authors (24, 26, 28–32) (contra, refs. 27 and 33) who either consider them as being evolved forms of *H. erectus* or early archaic forms of *Homo sapiens*.

Finally, we include the Paderborn specimen in the recent AMH group (see subfossil sample Table 1), as the presumptive age of ≈27 kya was recently disproved by a direct AMS dating of the specimen that resulted in an age of ≈238 years (34, 35).

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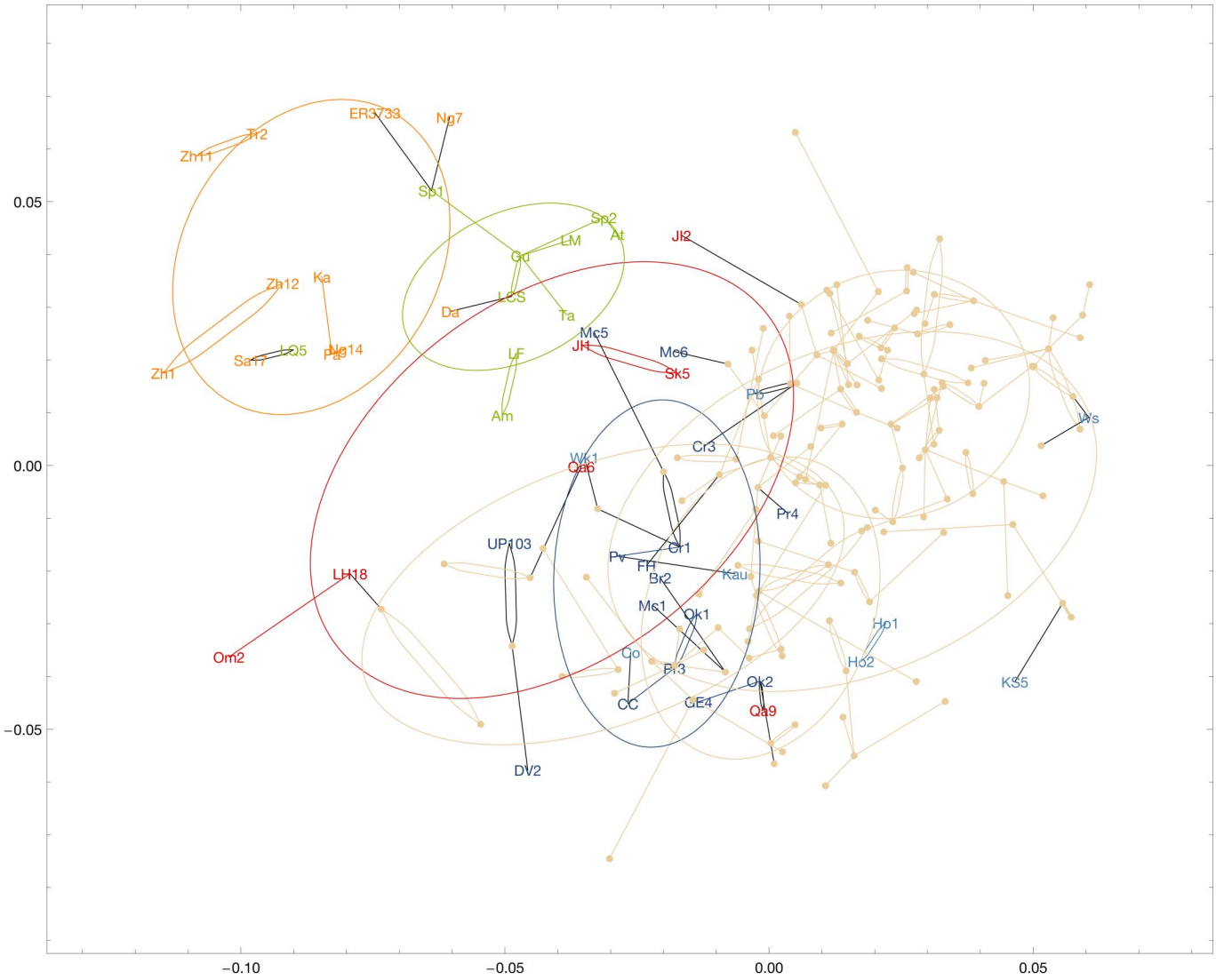
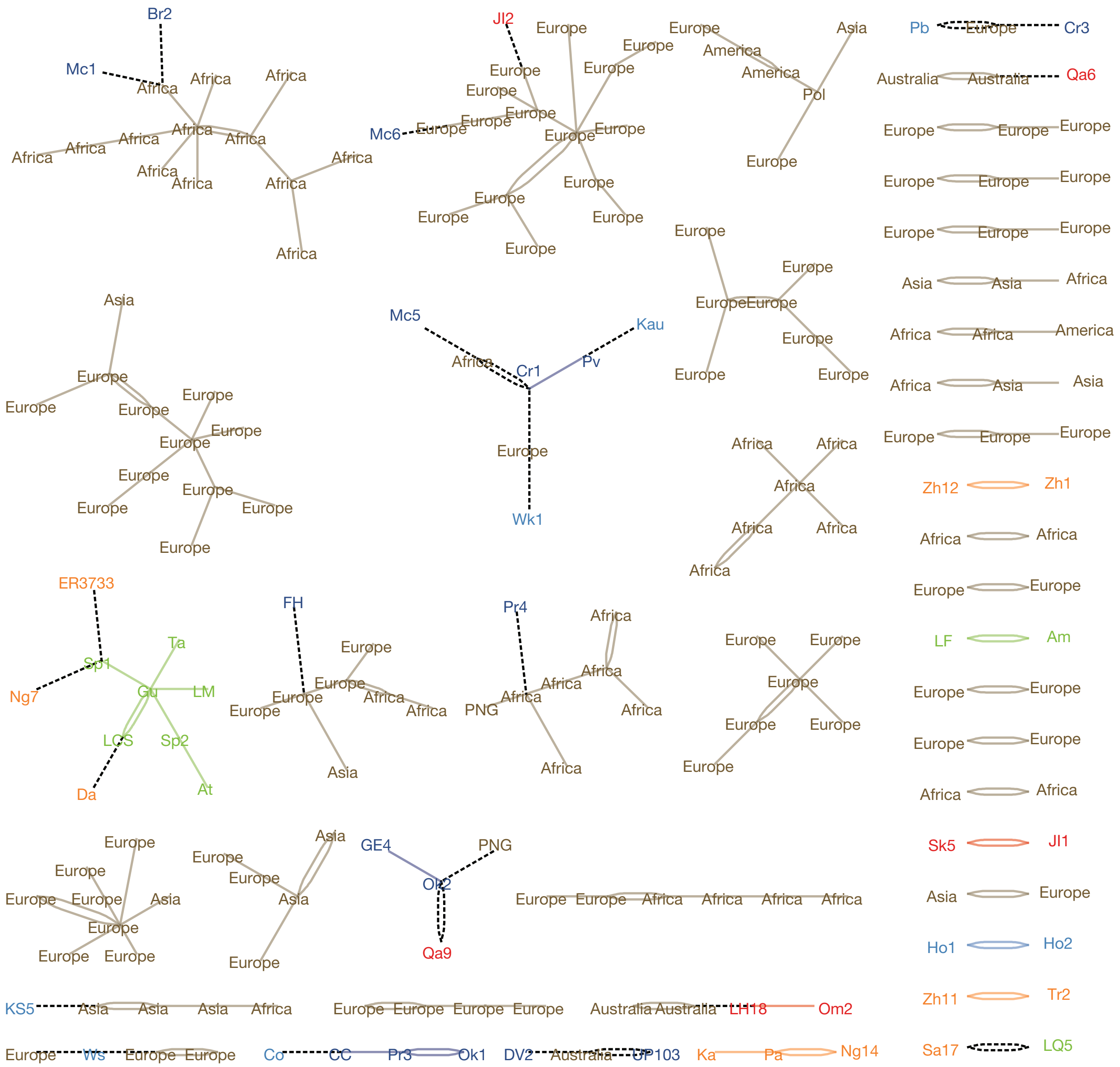


Fig. S1. 2D PC plot and nearest neighbor connections. (*a*) Shape space PC1 vs. PC2. Similar to Fig. 1 in the main text but focuses just on the first two PCs. All specimens except recent humans are labeled according to the abbreviations introduced in Table 1. Recent humans in light brown; UP fossils in blue; early AMH in red, Neanderthals in green, archaic *Homo* in orange. The graph is based on the first two principal components (PCs, 64% of total variation), and includes nearest neighborhood connections according to full Procrustes shape distance. Connections between nearest neighbors from the same group are shown in their group color, connections between nearest neighbors from different groups are drawn as black lines. Equal frequency ellipses (75%) are plotted in group color for all groups. Ellipsoids for recent humans are based on their geographic origin: Africa, Asia, Australia, and Europe. (*b*) Connected specimens. Nearest neighbor connections (the links in *a*) in Procrustes space are shown here as a graph. Note that the clusters roughly correspond to group affiliation and geographical origin. Labels for fossils correspond to abbreviations given in Table 1. Recent humans are labeled according to geographical origin with Africa, Asia, Australia, and Europe, except PNG (Papua New Guinea) and Pol (Polynesia). Connections between nearest neighbors from the same group are shown in their group color; connections between nearest neighbors from different groups are drawn as black dashed lines



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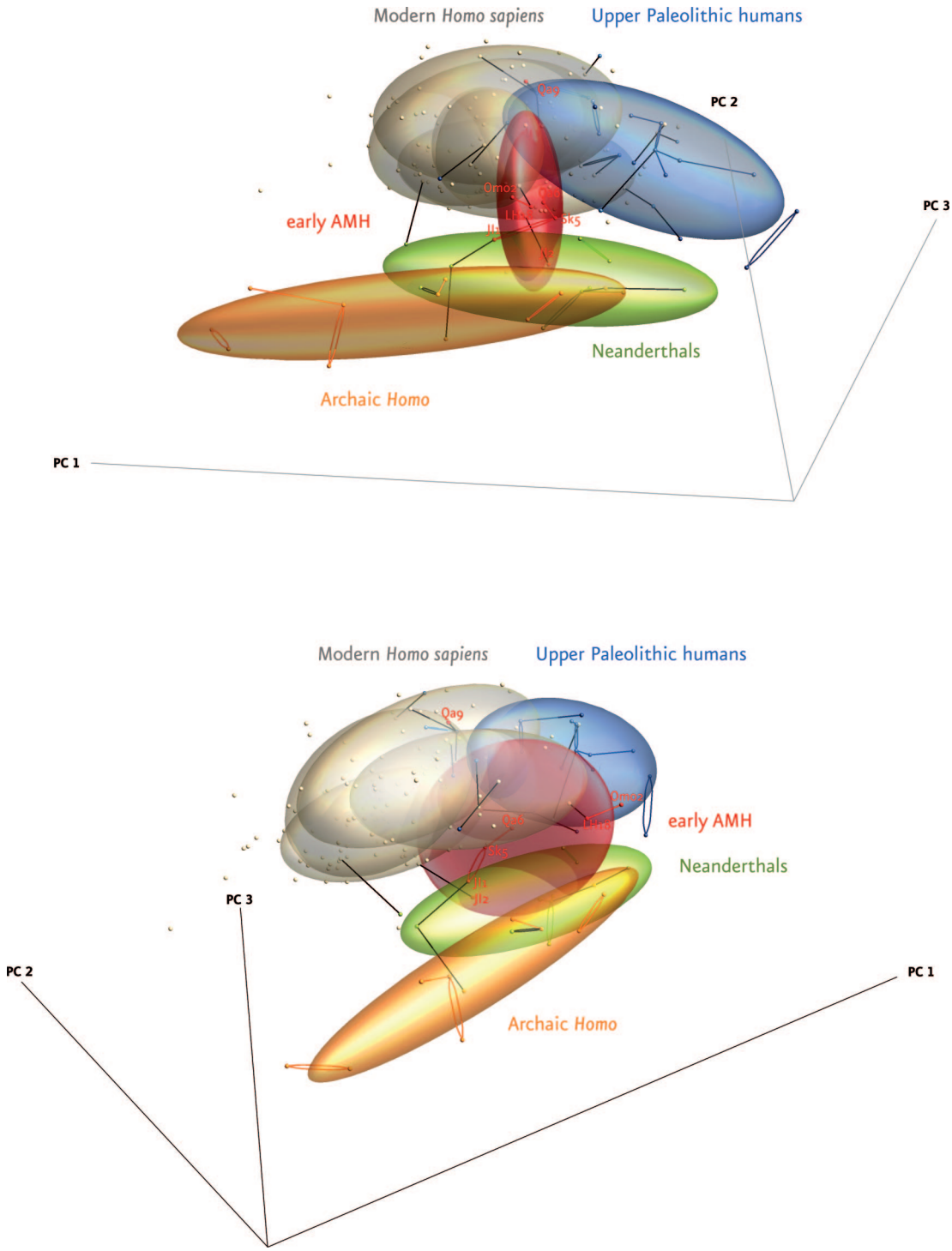

Fig. S2. Form-space. Two projections of the first three principal components of Procrustes form-space (''size-shape space''; cf. ref. 36). Recent humans in light brown; UP fossils in blue, early AMH in red, Neanderthals in green, archaic *Homo* in orange. Equal frequency ellipsoids (75%) are plotted in group color. The first PC axis is closely aligned with the overall allometry axis and thus largely reflects differences in log centroid size. Note the considerable size variability among crania of archaic *Homo*. Note also that the separation between AMH and AFH remains when size is part of the analysis. However, a few of the nearest neighbor relationships change in form space. Because size was shown to be associated with climatic variables (37, 38), an analysis in form space is more prone to effects of nonneutral patterns of evolution than it is in shape space. We therefore put more weight on results in shape space to track population history (cf. 39).

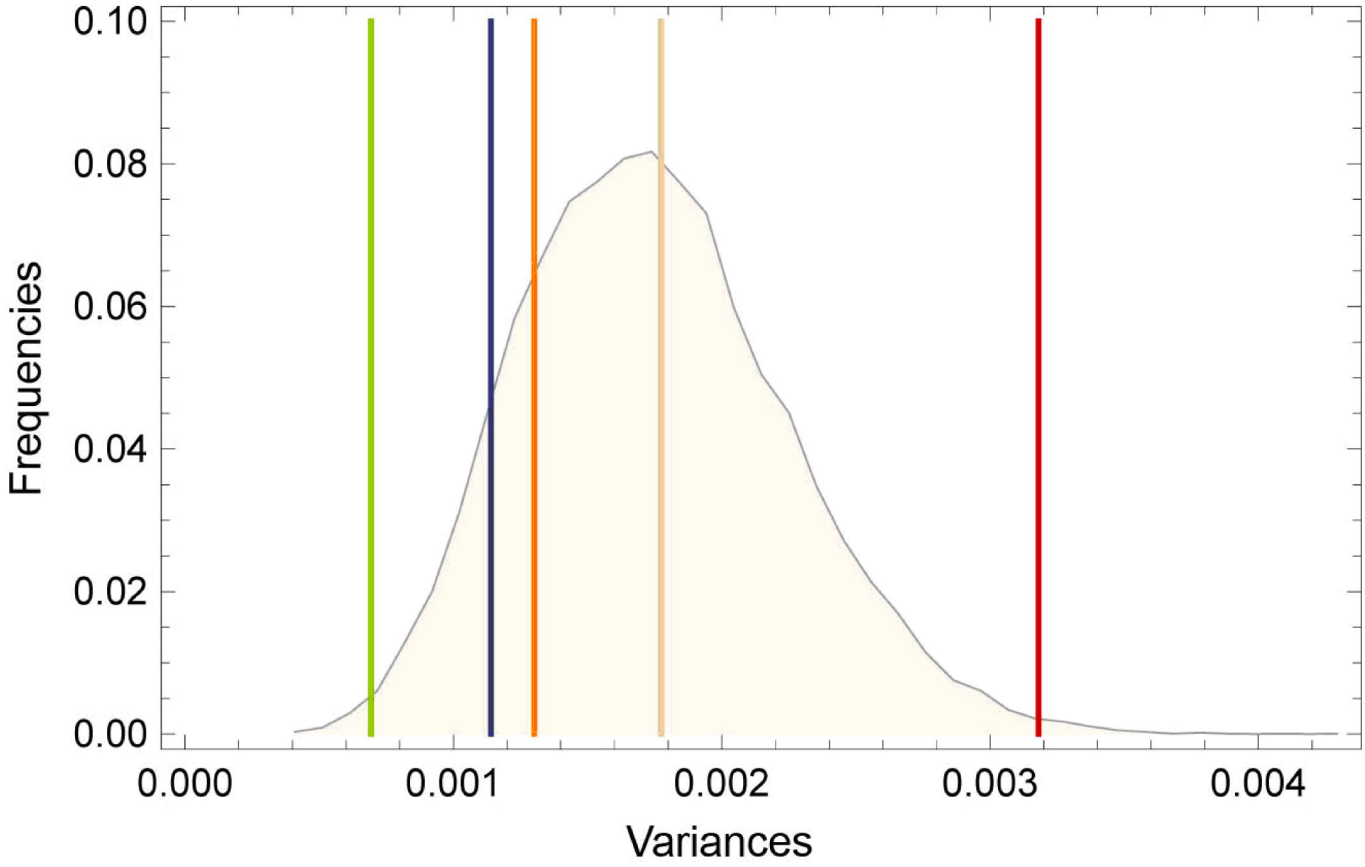

Fig. S3. Variances of small subsamples of modern humans. The graph shows the result of a slightly different test for variability as Fig. 2 of the main text. To check if the high variability of the early AMH and the low variability of the Neanderthals could be a sampling artifact due to the small sample sizes, we randomly picked 10 modern humans and computed the total variance from these small subsamples. Shown here are the group variances in shape space (recent humans in light brown, UP fossils in blue, early AMH in red, Neanderthals in green, archaic *Homo* in orange.) and the distribution of variances (gray curve) obtained from 10,000 small modern human subsamples.

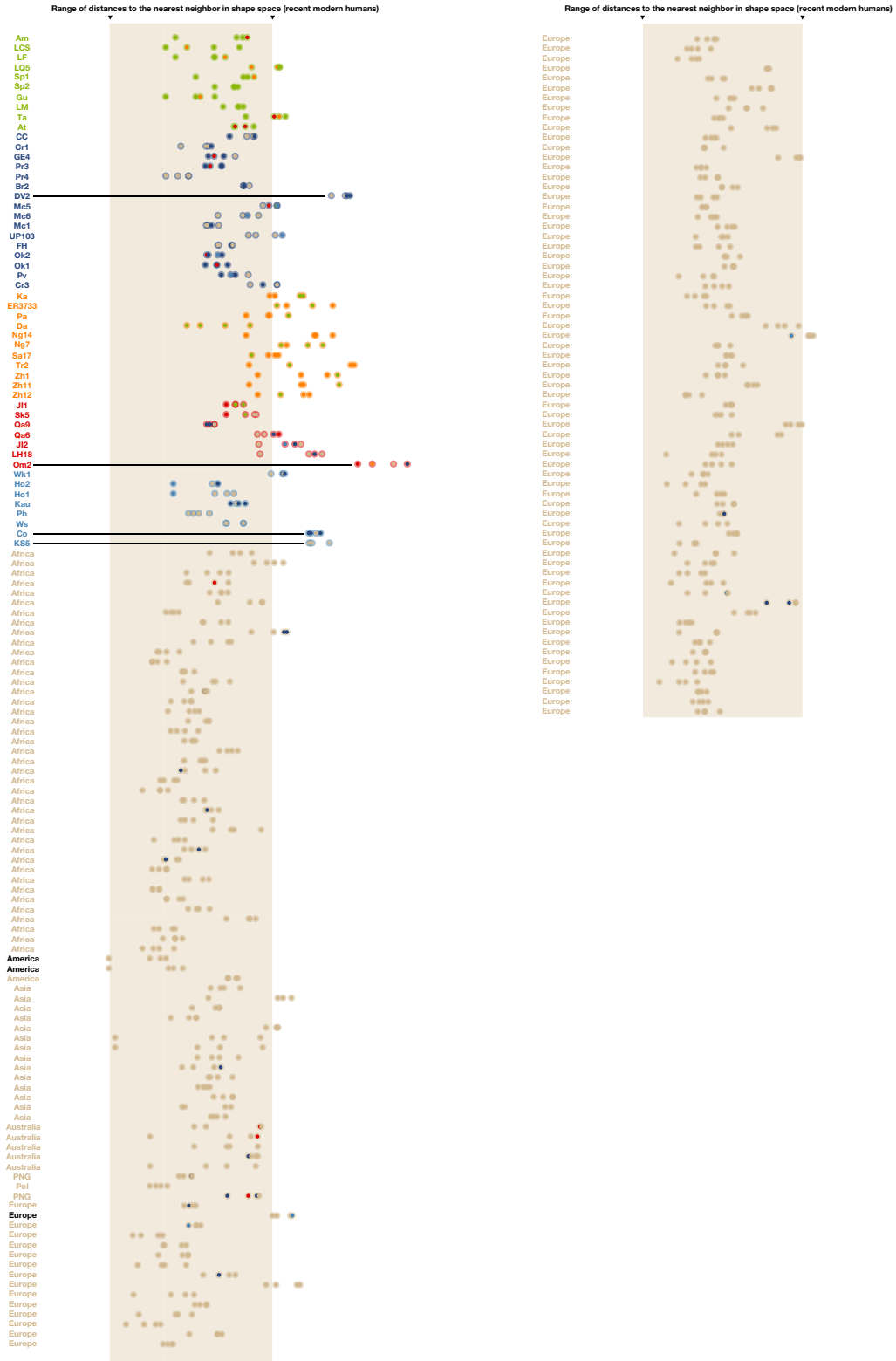

Fig. S4. The values for Procrustes distances in full shape space. Procrustes distances for the four closest neighbors in full shape space. Recent humans in light brown, UP fossils in blue, early AMH in red, Neanderthals in green, archaic *Homo* in orange. The smaller disk codes the group affiliation of the neighbor: For instance, a beige dot with a small inset red dot means that the closest neighbor to a modern human cranium is an early AMH cranium. The beige area in the plot is the minimum to maximum distance within recent modern humans to their closest neighbor. We find four outliers for the closest neighbor if modern human variation is taken as an indicator: Omo 2, Dolni Vestonice 2, Cohuna, Kow Swamp 5 (the latter two obviously due to distortion).

Table S1. Landmarks in the study

No.	Landmarks	Abbreviation
1	Nasion	N
2	Glabella	G
3	Bregma	B
4	Inion	I
5	Auriculare left	AUL
6	Auriculare right	AUR
7	Mastoidale left	MSL
8	Mastoidale right	MSR
9	Stephanion left	STL
10	Stephanion right	STR
11	Frontomalare temporale left	FMTL
12	Frontomalare temporale right	FMTR
13	Frontomalare orbitale left	FMOL
14	Frontomalare orbitale right	FMOR
15	Frontotemporale left	FTL
16	Frontotemporale right	FTR