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The first modern Europeans

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The discovery of new human fossil remains is one of the most obvious ways to improve our understanding of the dynamics of human evolution. The reanalysis of existing fossils using newer methods is also crucial, and may lead to a reconsideration of the biological and taxonomical status of some specimens, and improve our understanding of highly debated periods in human prehistory. This is particularly true for those remains that have previously been studied using traditional approaches, with only morphological descriptions and standard calliper measurements available. My own interest in the Uluzzian, and its associated human remains grew from my interest in applying recently developed analytical techniques to quantify morphological variation.

Discovered more than 40 years ago, the two deciduous molars from Grotta del Cavallo (Apulia, Italy) are the only human remains associated with the Uluzzian culture (one of the main three European 'transitional' cultures). These teeth were previously attributed to Neanderthals. This attribution contributed to a consensus view that the Uluzzian, with its associated ornament and tool complexes, was produced by Neanderthals. A reassessment of these deciduous teeth by means of digital morphometric analysis revealed that these remains belong to anatomically modern humans (AMHs). This finding contradicts previous assumptions and suggests that modern humans, and not Neanderthals, created the Uluzzian culture. Of equal importance, new chronometric analyses date these dental remains to ~43,000-45,000 cal BP. Thus, the teeth from Grotta del Cavallo represent the oldest European AMH currently known.

Few topics in human evolution have attracted the attention of so many scholars as the transition between the Middle to Upper Palaeolithic in Europe, a period characterized by the arrival of anatomically modern humans (AMHs) and the demise of the Neanderthals. Despite efforts to unravel the problem, the time and mode of the replacement are still a matter of intense debate. It has been suggested that climate played a role in Neanderthal extinction, but on its own, this hypothesis is weak when one considers that the Neanderthal lineage is likely to have evolved in glacial environments. Even the presumed dietary restriction of Neanderthals, which was mainly based on meat consumption, may be excluded given that strong eco-geographic dietary variation and the exploitation of a wide range of food types is now associated with Neanderthals (*i.e.*, Fiorenza *et al.*, 2011). Another hypothesis that has been proposed suggests that AMH's more advanced culture provided a distinct advantage, and this led to the disappearance of the Neanderthals. This hypothesis has been hampered by evidence which suggests that the

last Neanderthals were also exceptionally innovative developing various “transitional” cultures within Europe. This includes the Châtelperronian in West Europe, the Szeletian in Central and Eastern Europe, and the Uluzzian, in Italy and perhaps also Greece. These attributions to Neanderthals have been based on a few, mostly fragmentary, Neanderthal fossil remains found in the Châtelperronian assemblages of Arcy-sur-Cure (Grotte du Renne) and La Roche-à-Pierrot (St. Cesaire), and two deciduous molars from the Uluzzian levels of Grotta del Cavallo (Apulia, southern Italy) (Churchill & Smith, 2000). These human remains strengthened the idea that Neanderthals possessed highly symbolic, and culturally distinct cognitive capabilities, attributes which are generally associated with early AMHs only.

Despite regional variations, these ‘transitional’ cultures are characterized by particular lithics, such as blades and bladelets, bone tools, personal adornment in the form of shell beads and the wide exploitation of colorants – items that have a stronger association with the early Upper Palaeolithic rather than the Mousterian. The earliest evidence of these items appears in North and sub-Saharan Africa (and possibly the Near East) during the Middle Stone Age (MSA) (i.e. ~82 ka ago at the Grotte des Pigeons, Morocco; ~75 ka ago at Blombos Cave, South Africa) (d’Errico *et al.*, 2009). Evidence suggests that ~100,000 years ago, modern humans were widespread on the African continent. In contrast, at this time, unambiguous evidence of symbolic modern human behaviour is absent outside Africa in all European and Near Eastern Middle Palaeolithic sites. These particular technologies appear to be specific to Africa until their appearance ~50–45 ka cal BP (calibrated years before present) in Levantine and Near Eastern Initial Upper Palaeolithic transitional cultures, such as at sites like Ksar ‘Akil (Lebanon), and slightly later at Üçağizli Cave (Hatay, Turkey) (Kuhn *et al.*, 2009). Not surprisingly, the place (Levant) and time (~50–45 ka cal BP) of their appearance strongly indicates both the route and the time period when early AMHs spread into Eurasia, thus suggesting that modern humans were the creators of these technocomplexes.

Regardless of this evidence and the chronological overlap (~45 ka cal BP), the transitional cultures of Europe were attributed to the last Neanderthals, both due to the direct association of fossil remains with the transitional technocomplexes (see above) and because the earliest European AMH remains (Peștera cu Oase, Romania) were dated to ~40 ka cal BP (Trinkaus *et al.*, 2003), thousands of years after the earliest evidence of the European transitional cultures. Accordingly, it was suggested that either Neanderthals developed modern human-like culture independently or that they were ‘acculturated’ by or borrowed from incoming AMHs. Debate regarding these alternatives has been long and extensive.

Recently, however, the attribution of the Châtelperronian culture to Neanderthals has been questioned. This reconsideration is based primarily on the lack of stratigraphic integrity at Châtelperronian sites, such as Arcy-sur-Cure and La Roche-à-Pierrot (Bar-Yosef & Bordes, 2010; Higham *et al.*, 2010). This recent research led our group to focus on the evidence supporting an association between Neanderthals and the Uluzzian culture. Analyses were conducted on the two deciduous molars (Cavallo-B and Cavallo-C) discovered in the undisturbed Uluzzian levels from Grotta del Cavallo, the type site of the Uluzzian technocomplex (Palma di Cesnola and Messeri, 1967). Analysis of the general morphology of these dental remains supported an affiliation with *Homo sapiens*, and not Neanderthals. Comparisons of these dental remains required the creation of digital microCT models of the Grotta del Cavallo material, which were compared directly with a large modern human and Neanderthal dental sample. Two independent morphometric methods were used to compare both the internal and external features of the dental crown, including enamel thickness and the general outline of the crown.

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The finding that the Grotta del Cavallo specimens were modern humans bolsters the proposition that modern humans, and not Neanderthals, were the makers of the Uluzzian culture. Moreover, based on new radiocarbon dating of the Uluzzian levels at Grotta del Cavallo, the two teeth represent the oldest European AMH remains currently known (45-43 ka cal BP). This supports the idea of a rapid dispersal of modern humans onto the European continent, and extends the period of coexistence with Neanderthals in Europe (Benazzi *et al.*, 2011). These findings coincide with the recent reassessment of human remains from Kent's cavern (near Torquay in Devon, UK), which corroborates the presence of modern humans in north-west Europe by ~42.5 ka cal BP (Higham *et al.*, 2011).

By removing the association between the Uluzzian and Neanderthals, the general assumption that Neanderthals were engaged in a range of highly symbolic behaviour is no longer supported. Of course, this conclusion cannot be applied outside the distribution area of the Uluzzian and to the rest of Europe. The results do suggest, however, that caution should be applied in associating Neanderthals with other European transitional cultures. Overall, it is plausible to suggest culture might have played an important role in the demise of Neanderthals and their replacement by AMHs. Certainly, more diagnostic human remains associated with transitional technocomplexes are required to provide further evidence relating to these hypotheses. Nonetheless, our recent work (Benazzi *et al.*, 2011) emphasizes how fruitful, reanalyses of known fossils remains can be. Despite the reluctance of some "traditionalists", the development of two-dimensional (2D) and three-dimensional (3D) computer-based methods makes it possible to reconsider hominin fossil evidence. Naturally, in a field where fossil remains are so scarce and yet are the basis upon which hypotheses are developed and tested, the expansion of our knowledge base must be welcomed.

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