



A Data-Driven Paradigm Shift for the Middle-to-Upper Palaeolithic Transition and the Neandertal Debate

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ABSTRACT

Based on morphologically undiagnostic human remains from the southern Balkans and central Europe, it has been argued that the Bachokirian and Ranisian industries stand for modern humans, have roots in the IUP (Initial Upper Palaeolithic) of the Near East, and emerge ~45,000 years ago. Coevally, Siberia and Central Asia would also have been reached by IUP moderns and, in the process, Western Europe's Neandertals would have been acculturated, explaining the innovations (namely, body ornamentation) seen in the Châtelperronian. However, current usage of the IUP label confuses terminology and conceals issues of association raised by syn- and post-depositional disturbance, genomic patterns do not correlate with skeletal morphology, and the people of the Bachokirian and the Ranisian had Neandertal ancestors who lived many centuries after those technocomplexes' start dates, as did a Neandertal from Spy (Belgium), a site of the Ranisian. Moreover, the stratigraphic provenience and taxonomic affinity of the fossils associated with the Uluzzian, the Protoaurignacian, and the Ahmarian are uncertain. The former is coeval with the Châtelperronian, the latter two emerge no earlier than ~41,500 years ago, and the sufficiently complete fossils of broadly the same age are of mosaic anatomy and mixed ancestry. For western Eurasia, our review supports the Assimilation model, whereby ten millennia of converging cultural developments and increased demic interaction bridge the initial (Neandertal) and final (Cro-Magnon) terms of a complex evolutionary and historical process. Throughout, the observed diversity cannot be reduced to a taxonomic dichotomy. As human biology varied in a continuous space and material culture varied in a discrete space, no one-to-one correspondence between the two domains can exist. Advancing our understanding of the Middle-to-Upper Palaeolithic transition requires abandoning outdated frameworks and fully embracing the taphonomic perspective and the potential of genetics to approach the evidence in terms of communities, populations, and short-term history.

"Very often among a certain highly intelligent type of people, quite paradoxical ideas will establish themselves. But they have suffered so much in their lives for these ideas and have paid so high a price for them that it becomes very painful, indeed almost impossible, for them to part with them." **Fyodor Dostoyevsky, The House of the Dead**

"But man is so partial to systems and abstract conclusions that he is ready intentionally to distort the truth, to turn a blind eye and a deaf ear, only so as to justify his logic." **Fyodor Dostoyevsky, Notes from Underground**

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1. Introduction

Through the late twentieth century, the Recent Out of Africa (ROA) model of human origins was the favoured explanation for the origins of anatomical and behavioural modernity, i.e., of the emergence of humans that resembled present-day people in body morphology and cognition, with corresponding genetic underpinnings. ROA characterised this process as a speciation event whereby certain elements of the skeleton, especially the facial skeleton and, over time, even minute details of dental anatomy, were thought to be proxies for an integrated package of putatively species-specific morphological and behavioural traits, namely the possession of a symbolic material culture (Klein, 2003; Stringer and Andrews, 1988).

In this context, the Châtelperronian technocomplex of south-western Europe represented an anomaly: it includes items definitionally indicative of their makers' behavioural modernity, such as personal ornaments and decorated bone tools but, at two sites in France, the Grotte du Renne and St.-Césaire, it was reportedly found in stratigraphical association with Neandertal, i.e., definitionally non-modern, skeletal remains (Leroi-Gourhan, 1961; Leroi-Gourhan and Leroi-Gourhan, 1965; Lévêque and Vandermeersch, 1980). The Acculturation Hypothesis (henceforth, "Acculturation") for the Middle-to-Upper Palaeolithic transition in Europe and western Asia (henceforth, "Transition") sought to resolve this apparent contradiction. Under the axiomatic tenet that Neandertals were a different species and lacked the cognitive capability required for symbolic thinking, Acculturation posited that, if not spurious (e.g., resulting from post-depositional mixing), the Châtelperronian's symbolic artefacts had to be extraneous: they would reflect borrowing, scavenging, or "imitation without understanding" of a putatively coeval culture rich in beads and mobiliary art, the Aurignacian. The latter's emergence was taken as a proxy for the pioneer colonisation of Europe by modern humans (henceforth, "Moderns"), and it was further put forth that the two technocomplexes coexisted in close proximity for a long time. Such overlap in territory and site occupancy would in turn explain why objects and ideas could have moved across the bio-cultural boundary (Hublin, 1990; Hublin et al., 1996; Stringer and Gamble, 1993).

In 1998–1999, however, "The Neandertal Problem" debate, hosted by *Current Anthropology*, with a follow-up in the *Journal of World Prehistory*, revealed significant inconsistencies in the core argument of Acculturation, namely with regard to the notion that the Châtelperronian's symbolic artefacts were not the Neandertals' independent innovation (d'Errico et al., 1998; Mellars, 1999; Zilhão and d'Errico, 1999). While the debate unfolded, the discovery of the Lagar Velho child skeleton from Portugal challenged another basic tenet of ROA. Claimed to present a mosaic of Neandertal and modern human features, this Gravettian fossil was argued to (a) contradict the notion that the Neandertals' fate had been extinction without descent and (b) support extensive population admixture at the time of contact, many millennia earlier (Duarte et al., 1999; Zilhão and Trinkaus, 2002).

These developments favoured the rival Assimilation Hypothesis (henceforth "Assimilation") of recent human origins (Smith et al., 2005; Trinkaus, 2007), an alternative view of the process since further supported by several major discoveries:

- Going by the criteria used to assess the sub-Saharan record, European Neandertals were shown to be as behaviourally modern as coeval Africans and to have possessed cognitive capabilities like "our own," as illustrated by: (a) the making of adhesives for hafting, including ochre-based compound ones, via complex *chaînes opératoires* (Baumer et al., 2001; Niekus et al., 2019; Schmidt et al., 2024); (b) the use of jewellery and the engraving and painting of cave walls, going back >115 ka (thousands of years) ago and >65 ka ago, respectively (Caron et al., 2011; Finlayson et al., 2012; Hoffmann et al., 2018a; Hoffmann et al., 2018b; Leder et al., 2021; Lorblanchet and Bahn, 2017; Marquet et al., 2023; Marquet et al., 2014; Peresani

et al., 2011; Peresani et al., 2013; Pitarch Martí et al., 2021; Radović et al., 2015; Rodríguez-Vidal et al., 2014; Zilhão, 2020; Zilhão et al., 2010); and (c) the even earlier engagement with symbolic activities deep in the underground world, as revealed by Bruniquel cave's round structures, which date to ~175 ka (Jaubert et al., 2016).

- The notion that the Africans' putative superiority was rooted in demographic growth and social complexification processes triggered by the adoption of diets rich in fatty acids derived from marine foods, favouring brain tissue development (Marean, 2014), was refuted by the revelation that, in comparable coastal environments of south-western Iberia, Neandertals engaged in the harvesting and consumption of such resources on a similar, if not more intensive, scale (Zilhão et al., 2020).
- All fossils dated to within a few millennia after the disappearance of the Neandertal phenotype, namely those from Oase, Cioclovina, and Muierii, in Romania, or Mladeč, in the Czech Republic, were shown to bear anatomical mosaics comparable to the Lagar Velho child's (Soficaru et al., 2006; Soficaru et al., 2007; Teschler-Nicola, 2006; Trinkaus et al., 2013).
- Nuclear aDNA showed that (a) 2–4 % of the human-specific parts of the genomes of living Eurasians are inherited from the Neandertals, (b) coeval Pleistocene populations frequently interbred irrespective of taxonomy, and (c) there was gene flow between Africa and Europe all through the Middle Pleistocene (challenging the notion that Neandertals were distinct at the species level, having become so as a result of isolation and drift, and supporting instead that anatomical modernity, not Neandertal-ness, is the derived condition; Li et al., 2024; Reilly et al., 2022; Trinkaus, 2003).
- The Neandertals' contribution to present-day humans was shown to have impacted not just the genome but also aspects of skeletal morphology, as revealed by the association between patterns of cranial globularity and the presence of Neandertal alleles in chromosomes 1 and 18 (Gunz et al., 2019).
- Bearing in mind the different continents' inferred population sizes and the exogamic nature of hunter-gatherer mating networks, the new skeletal and genomic data implied that the null hypothesis should be that anatomical modernity spread as a punctuated, wave-of-advance process whereby admixture was the rule, not the exception (Eswaran, 2002; Eswaran et al., 2005; Relethford and Bolnick, 2018).

Views of the emergence of modern humans in Eurasia as a straightforward process of species replacement whereby the arrival of newcomers led the locals to extinction without descent were further challenged by developments in the Upper Pleistocene prehistory of the African continent, namely:

- The detection of so-called archaic genes in present-day Africans, which carries the implication that, rather than representing the rapid expansion of a speciated population originating in a restricted core area, modern human emergence in the continent was, as in Europe, a process in which fossil, anatomically non-modern people participated (Durvasula and Sankararaman, 2020; Hollfelder et al., 2021; Scerri et al., 2018).
- The cranial morphology of the Nazlet Khater 2 individual, an Egyptian fossil from ~40 ka ago, was shown to fall outside the variation observed among extant humans, implying that, anatomically, the people living in north-eastern Africa just before or around the time Assimilation was taking place in Eurasia were in fact not quite "modern" — which the calvaria and chinless mandible from Iwo Eleru show to have still been the case in Nigeria as late as 13 ka ago (Crevecoeur et al., 2009; Harvati et al., 2024; Harvati et al., 2011).

One would expect these developments to have brought about some sort of a comeback for the understanding of human evolution that

prevailed during post-war times — one whereby human diversity across time and space was framed in terms of palaeodemes, not Linnean taxonomic categories. In that framework, Neandertals were considered to be a west Eurasian-specific variant of a single, Old World-wide human species undergoing an anagenetic, even though geographically uneven development of *Homo sapiens* out of Lower Pleistocene *Homo erectus*-like ancestors (Howell, 1996, 1998; Trinkaus, 1990). Instead, the terminology and the concepts generated and popularised in the context of ROA remained in widespread use, and there have been attempts to resuscitate Acculturation. Why is this so? Are such attempts justified? These are the questions that prompted us to write the present paper.

In their original formulations, ROA and Acculturation relied upon the Aurignacian technocomplex as a proxy for the timing, the rhythms, and the geographical patterning of the Moderns' spread across Eurasia, from Afghanistan to Iberia (Kozłowski and Otte, 2000; Mellars, 2004). In the current version of this view of the process, a rather ill-defined entity, the Initial Upper Palaeolithic (IUP), plays the same role. However, it seems to us that this is done largely as before, i.e., under the same twin assumptions that (a) Neandertals and Moderns are different species and (b) a one-to-one correspondence exists between Moderns-On-The-Move and a technocomplex representing the archaeologically visible manifestation of the spread of their species-specific material culture (Goder-Goldberger and Malinsky-Buller, 2022; Hublin et al., 2020).

Having closely followed the abundant literature that, over the last decade or so, has promoted this revamped narrative of modern human origins in Eurasia, we find its foundations to be no more solid than those of the original edifice: they remain plagued by issues of ambiguous definition, taphonomically uninformed interpretation of stratigraphy and site formation processes, uncritical acceptance of patterns of association (between samples and assemblages, or between assemblages and fossils), lack of appreciation of the uncertainties involved in the measurement of radiocarbon ages, usage of the latter as precise ages as opposed to probability intervals, and cavalier dismissal, if not outright omission of consideration, of any and all contradictory evidence. In addition, we find that the multiple layers of interpretative complexity introduced by ancient genomics and the widespread application of modelling software have been either treated in the same simplistic, dichotomic manner (in the case of the ancient DNA evidence) or have remained hidden under applications of the algorithms that more often than not fall for the fallacy of affirming the consequent (in the case of the dating evidence).

We therefore believe that the time is ripe to offer a systematic review of recent developments in the spirit of the 1999 *Journal of World Prehistory* paper that is widely acknowledged to have been instrumental in raising the issues of archaeology, stratigraphy, and dating that have inspired the last twenty-five years of Transition research. Given the geographical extent claimed for the IUP phenomenon, we must extend our analysis beyond the European and west Asian theater that Transition debates tended to restrict themselves to until the end of the last century. Thus, we devote particular attention to the sites of Central Asia (e.g., Denisova, Kara-Bom) that have played a pivotal role in recent debates on the origins of Upper Palaeolithic blade technology, personal ornamentation, the chronology of modern human emergence in Eurasia, or the interaction between taxonomically distinct human populations.

Our conclusion is that, because of the errors, inconsistencies, and methodological flaws that we identify, the updated, IUP-based, ROA/Acculturation hypothesis cannot be considered as a valid model of modern human emergence. In the following, we will endeavour to substantiate this argument. We begin with a brief review of the advancements made with regard to the questions raised twenty-five years ago, which set the background for current debates. We then proceed to address the theoretical and empirical underpinnings of the controversies surrounding the authorship of the technocomplexes of the Transition, including a discussion of the evidence contributed by ancient DNA studies and a critical assessment of what the IUP is and of what it means. We do so based on published reports for the key sites and our reanalysis

of their stratigraphy, dating, and material. We conclude with a synthesis that, building on previous suggestions (d'Errico, 2003; Zilhão, 2011), provides an outline of the foundations for a paradigmatic reorientation of research addressing the evolution and prehistory of Late Pleistocene humans.

2. “The Neandertal Problem” in retrospect

There is no question that the emergence of the so-called “modern” skeletal gestalt — or at least of most of the traits that Human Palaeontology considers to be diagnostic of Modern-ness in the fossil record — occurred in sub-Saharan Africa earlier than anywhere else. Initially based on the TL dating of burnt flints associated with the Qafzeh and Skhul burials to ~100 ka ago, this precociousness is now supported by the dating of the Omo and Herto fossils to within the 100–200 ka ago interval (Clark et al., 2003; Leakey, 1969; Vidal et al., 2022; Wolpoff and Lee, 2012; Zollikofer et al., 2022).

Based on the geographical and temporal unevenness of the process, ROA inferred that a speciation event must have occurred. The iron logic of that understanding implied (a) the removal of coeval non-Africans from the ancestry of present-day people, (b) the modelling of recent human evolution as the expansion of the new species, *Homo sapiens*, and (c) the extinction of the coeval, anatomically archaic species that for a while had persisted alongside elsewhere, namely the Neandertals. Often, the process was depicted as a “humans vs. neandertals” scenario that, by implication, set Neandertals beyond the boundaries of Humanity (unwittingly following William King's footnote contention that *Homo neanderthalensis* fell short of the magnitude of the separateness, which would in fact justify assignment of the Kleine Feldhofer Grotte remains to a different genus; King, 1864). For such a competitive exclusion scenario to work, the species that prevailed had to have enjoyed a decisive superiority, and so it was that demonstrating the Neandertals' putative inferiority became a research programme geared towards “debunking” arguments for the equivalence between Africans and Europeans of the Middle Palaeolithic in both material culture and spiritual behaviour based on (a) the Levallois technology and burial rituals that both held (e.g., Leakey and Lewin, 1977), or (b) the notion that the abstract markings and signs found in the bone tools of the Neandertal-associated Châtelperronian represented the first, pre-figurative stage of Palaeolithic art (Leroi-Gourhan, 1964).

Given this theoretical context, it is easy to understand why (a) all bits of evidence seemingly going for ROA and Acculturation were readily accepted and widely promoted, while (b) any contradicting evidence, even if strongly supported by the data, was considered suspect by default. And so it was that a powerful current of opinion came to relegate the Neandertals to the role of mere scavengers or to deny them the practice of burial and the control of fire. Yet, as the 1998–1999 papers in *Current Anthropology* and the *Journal of World Prehistory* demonstrated, and many other papers have since further substantiated, such arguments did not stand up to scrutiny. Let us briefly recollect why.

2.1. Châtelperronian and Aurignacian

In its original formulation, Acculturation implied the long-lasting coexistence of Neandertal- and anatomically modern human-associated cultures at the regional scale; for the jewellery found in Châtelperronian contexts to reflect scavenging, exchange, or copying, direct contact with, or at least awareness of a spatially immediate Other, must be presupposed. Support for the empirical reality of such a spatio-temporal patterning was sought in (a) the putative interstratification of the Châtelperronian and the Aurignacian at sites in France (Le Pige, Roc-de-Combe, Grotte des Fées) and Spain (El Pendo), and (b) radiocarbon ages in the Châtelperronian range purportedly obtained for the Aurignacian at sites in Austria (Willendorf II), Germany (Geissenklösterle), and Spain (El Castillo and L'Arbreda) (Bischoff et al., 1989; Cabrera-Valdés and Bischoff, 1989; Cabrera et al., 2001; Conard and

Bolus, 2003; Demars, 1990, 1996; González Echegaray, 1980; Nigst et al., 2014). In this scenario, the occurrence of both technocomplexes at the same site would reflect the fluctuation over time of the boundaries between segregated territories. Several (often implicit) assumptions underpinned these arguments, namely:

- A one-to-one correspondence exists between the two technocomplexes (Châtelperronian and Aurignacian) and the two human “species” (Neandertals and Moderns, respectively), i.e., the Châtelperronian is exclusive to the Neandertals, and the Aurignacian is exclusive to the Moderns.
- Each of those four categories (Châtelperronian, Aurignacian, Neandertals, Moderns) is a monolithic entity with discrete boundaries across which the flow of genes or culture will be both readily apparent and of knowable direction; therefore, the identification of diagnostics (e.g., a fossil’s dental or skeletal features, a given stone- or bone-tool type) suffices to demonstrate the presence of the corresponding category.
- Each entity’s diagnostic markers adequately represent the entire suite of associated characteristics even if the corresponding physical evidence is absent from the archaeological record; for instance, the presence of carinated “scrapers” would imply the Aurignacian culture, which, in turn, would imply the existence of jewellery, complex bone tools, cave art, and Moderns — finding a carinated “scraper” in site *x* dated to age *y* allowing one to infer that fully modern biology and behaviour were present at that time and location.

Eventually, these assumptions were shown to be at odds with observation. With regard to the archaeological aspects of Acculturation, the problems concerned issues of association, dating, and definition:

- Stone tool refitting, analysis of excavation records, and revision of the artefact assemblages showed that the “interstratifications” at Le Piage, Roc-de-Combe, Grotte des Fées, and El Pendo were the result of post-depositional mixing (Bordes, 2002; Zilhão, 2006b; Zilhão et al., 2006, 2008).
- Direct dating of diagnostic bone tools to the expected chronological range corroborated the view that the earlier-than-expected charcoal ages for L’Arbreda’s Aurignacian reflected the dating of inherited material, i.e., of redeposited charcoal particles derived from the immediately underlying Middle Palaeolithic (Wood et al., 2014; Zilhão, 2006b).
- Direct dating of faunal remains to the Middle Palaeolithic and of the manufacturing debris of Aurignacian bone tools to the expected chronological range (Wood et al., 2014, 2018) corroborated that El Castillo’s “Level 18 (Transitional Aurignacian)” is a Late Mousterian deposit containing the odd Aurignacian intrusion (as previously suggested based on the earlier-than-expected results obtained on charcoal samples; Zilhão, 2006b; Zilhão and d’Errico, 1999, 2003).
- Even though reliably dated to ~43.5 ka ago and coeval with the Châtelperronian, the stone tool assemblage retrieved in the 2006–2011 re-excavation of Willendorf II was shown to be devoid of Aurignacian affinities, and the lateral correlation posited for the lens that the dated samples came from (with the thick, multi-layer deposit that had yielded the early 20th-century excavations’ Aurignacian material) was found to be unsubstantiated (Teyssandier and Zilhão, 2018).
- Rather than a phenomenon with geographically diverse manifestations, the Aurignacian was confirmed to be a chronologically structured technocomplex. It begins with the Protoaurignacian sometime within the 41.1–42.1 ka ago interval. It is followed by the Early Aurignacian or Aurignacian I, beginning after 39.6–40.9 and ending before 36.3–36.8 ka ago. Next is the Evolved Aurignacian or Aurignacian II, and finally there is the poorly defined Late Aurignacian or Aurignacian III/IV. These age intervals are from Banks et al.’s (2013b) Bayesian model run with the newer IntCal20 calibration

curve (Bard et al., 2020; Reimer et al., 2020) and are concordant with those recently obtained with an exclusively French dataset (Teyssandier, 2023).

- Despite claims to the contrary — based on the dating of fragments lacking diagnostic features (e.g., Trou de la Mère Clochette; Szmidt et al., 2010), of objects classified by special pleading (e.g., as split-based points lacking a split base because of the object being supposedly unfinished; Doyon, 2020), or of charcoal samples from contexts for which the association with the lithic assemblage is contentious (e.g., Fumane; cf. Falcucci et al., 2022) — the split-based osseous point was shown to be a true index fossil of the Aurignacian I (Teyssandier and Zilhão, 2018).
- The carinated “scraper”, a common occurrence in the Aurignacian I, and the regular Dufour bladelet, which is characteristic of the Protoaurignacian, were shown not to be in and of themselves diagnostic of a specific phase of the technocomplex, as the former persists into the Aurignacian II, the latter persists throughout with various subtypes, and both can occur in later Upper Palaeolithic periods (e.g., the Protosolutrean; Aubry et al., 1995; Zilhão and Aubry, 1995).
- The Châtelperronian and coeval technocomplexes of central and eastern Europe (e.g., the Uluzzian, the Szeletian, the Bohunician) were shown to either underlie the Aurignacian (in every *bona fide* stratigraphic sequence), or to date to the expected, pre-Aurignacian time range (wherever associated with reliable age determinations) (d’Errico and Banks, 2015; Zilhão, 2007).
- Stone tool refitting, lithic technology, and the analysis of spatial patterns showed that the Aurignacian occupation of Geissenklösterle is of unambiguous Aurignacian I affinities and that the earlier-than-expected ages obtained for a few dating samples could be parsimoniously explained by the impact of the post-depositional disturbance processes that affected the stratigraphic integrity of the archaeological sequence (demonstrated by stone tool refitting and precluding conclusive correlation between the human activity represented by the dated samples and the cultural complexes represented by the artefacts found alongside) (Discamps et al., 2015, 2019; Hahn, 1988; Teyssandier, 2007, 2023; Zilhão, 2013; but see Higham et al., 2013, and Higham and Heep, 2019).

These developments established both the precedence of the Châtelperronian over the Aurignacian and the time horizon for the latter’s emergence that had been proposed in the context of “The Neandertal Problem” debate (Zilhão and d’Errico, 1999): ~36,500 BP (uncalibrated radiocarbon years Before Present), i.e., based on the current calibration curve (Bard et al., 2020; Reimer et al., 2020), ~41,500 cal BP (calendar years Before Present; henceforth, unless otherwise explicitly stated, this is the timescale used for all ages given herein). At the same time, research leading to the accumulation of this chronostratigraphic evidence also shed much light on the other key issue around which the late 20th- and early 21st-century debates revolved: the patterns of association between technocomplexes and human types.

2.2. The “Whodunnit?” question

Is it true that the Châtelperronian is of Neandertal authorship and that the Aurignacian is of Modern authorship? In the case of St.-Césaire, the artefacts found in association with the Neandertal skeletal remains were shown to be mostly of Mousterian affinities, suggesting that the context’s few Châtelperronian stone tools are incidental and an artefact of post-depositional processes (Gravina et al., 2018; Todisco et al., 2023). Even though entirely plausible, this interpretation is inconsistent with the age returned by the direct dating of the skeleton to the later part of the Châtelperronian (36,200 ± 750 BP, OxA-18099; 39.9–42.2 ka cal BP) (Hublin et al., 2012). In addition, the mixed nature of the context does not rule out that the skeleton be of a Châtelperronian individual interred in an underlying Mousterian deposit (Zilhão, 2013). On the other hand, because ultrafiltration does not always successfully remove

all contaminants (Devièse et al., 2017), the direct date could be an underestimation, as may well be also the case with the ETH-99102.1.1 result obtained for a genetically identified Neandertal bone from La Ferrassie ($36,171 \pm 222$ BP; $40.8\text{--}41.7$ ka cal BP) (Balzeau et al., 2020). In these circumstances, the true age and cultural association of the St.-Césaire Neandertal must be treated as an open issue.

A similar challenge has been raised with regard to the Grotte du Renne. Abundant evidence for symbolism — copious amounts of red ochre, tens of decorated bone tools and personal ornaments — was retrieved across the site's ~1 m-thick Châtelperronian deposit (subdivided, from top to bottom, into three main units, layers VIII, IX and X). Like the site's Neandertal skeletal remains, these finds were mostly made in layer X. It has been argued that this stratigraphic association would be spurious and result from post-depositional disturbance causing (a) downward displacement, from the overlying Aurignacian, of the items of symbolic material culture, or (b) upward displacement, from the underlying Mousterian, of the Neandertal dental and skeletal remains found alongside (Bar-Yosef and Bordes, 2010; Higham et al., 2010). Yet, it cannot be so, as revealed by several lines of enquiry (Caron et al., 2011; Zilhão et al., 2011b):

- Stone tool refitting shows that migration across stratigraphic boundaries is limited and mostly concerns adjacent Châtelperronian units (Connet, 2002).
- The ornaments and bone tools found in the Châtelperronian levels are distinct from those seen in the Aurignacian, rendering void the notion that they are either mere copies or items that had been borrowed, scavenged, or stratigraphically displaced (Caron et al., 2011; d'Errico et al., 1998; Julien et al., 2019; Vanhaeren et al., 2019).
- The distribution of lithics characteristic of the Mousterian, the Châtelperronian, and the Aurignacian is stratigraphically consistent across the sequence, and so the selective post-depositional displacement, in whichever direction, of only two find categories

— human remains and symbolic artefacts — is a statistical impossibility (Caron et al., 2011).

- The presence of stone tools of Mousterian affinities (e.g., side-scrapers) in the basal Châtelperronian (level X) and, conversely, of two Châtelperronian bone awls and a few ochre pieces in the uppermost Mousterian (level XI), are parsimoniously explained not by post- but by syn-depositional disturbance — that generated by the installation of level X's habitation features, including post-holes, paving, and intact, well-preserved hearths (Couraud, 1991; d'Errico et al., 1998; David and Girard, 2019; Julien and Hardy, 2019; Leroi-Gourhan, 1961; Leroi-Gourhan and Leroi-Gourhan, 1965).
- A recently rediscovered deciduous premolar germ (catalogue number Arcy 1963 R Xb2 B6 460) is the antimer of a previously published tooth retrieved in the same area and stratigraphic subunit alongside immature remains representing two <1 year-old Neandertal individuals — a spatially tight distribution pattern that further contradicts the notion that said remains could be *ex situ* and derive from the Mousterian (Henrion et al., 2023) (Fig. 1).
- The ages returned by the direct dating of the associated faunal remains are stratigraphically consistent, further supporting the integrity of the sequence (Banks and d'Errico, 2019; Hublin et al., 2012).
- A genetically confirmed Neandertal bone fragment from layer X has been dated to $36,840 \pm 660$ BP (MAMS-25149; $40.7\text{--}42.3$ ka cal BP; Welker et al., 2016), well within expectations for the Châtelperronian and in the same time range as the St.-Césaire individual (even if the possibility that the result is just a minimum age cannot be excluded in this case either).

With regard to the human type with which the Aurignacian is associated, Acculturation and ROA were countered by the claim that, in the Croatian cave site of Vindija, the Aurignacian was of Neandertal authorship. The claim was based on the association in level G1 of a split-based bone point with diagnostic cranial fragments. In fact, G1 is a palimpsest containing much pre-Aurignacian material, and the

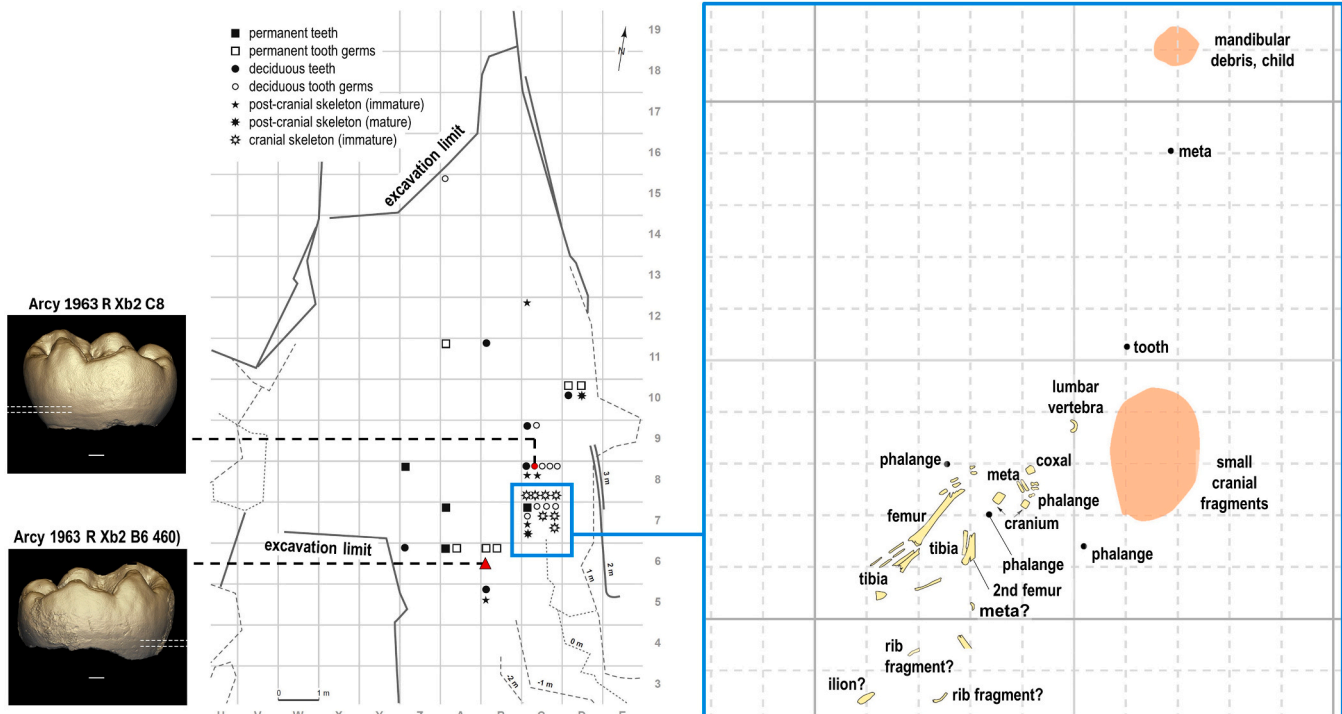


Fig. 1. Grotte du Renne (Arcy-sur-Cure), level X: site plan, and distribution of the human remains. The distribution of the partial skeleton of a less than one year-old individual is shown to the right, and the buccal faces of dP4 antimeres of a child of that age retrieved in the same general area are shown to the left (top, the left dP4; bottom, the right dP4; the white dotted lines indicate hypoplasias; the scale bars are 1 mm). After Maureille and Hublin (2019) and Henrion et al. (2023), modified.

Neandertal remains must be associated with the components of Mousterian or Szeletian affinities (Zilhão, 2009b; Zilhão and d'Errico, 1999), as eventually supported by the dating of associated fauna and of the Neandertal remains themselves (Devièse et al., 2017). This research settled the Vindija case but did not suffice to assert that the correspondence between the Aurignacian and the Moderns was indeed one-to-one because, conversely, direct dating also showed that, at other sites, the anatomically modern human fossils found in Early Aurignacian contexts were intrusive and much younger. The case most in point is the cave of Vogelherd, in Germany, where, in the 1930s, an ensemble of very anatomically modern crania had been retrieved in association with a rich collection of stone tools, jewellery, and ivory figurines. As it turned out, those crania were all as modern in age — specifically, Late Neolithic — as they were in anatomy (Conard et al., 2004).

These developments left us with a panorama whereby, in the time frame of the Transition in Europe, the skeletally diagnostic remains reliably associated with the Mousterian or the Châtelperronian were of the Neandertals, while anatomically diagnostic remains of the Moderns were found in reliable association with the second phase of the Aurignacian technocomplex, the Aurignacian I (e.g., at La Quina-Aval; Verna et al., 2012). For the intervening millennia, including the interval during which the Protoaurignacian emerged across the continent, the evidence was either absent or contentious. As we now proceed to argue, that remains the case.

3. Fossils and technocomplexes

After much debate, the palaeontological and genetic evidence for Neandertal/Modern admixture is now accepted. Therefore, asking the

archaeology of the Transition to answer the traditional, dichotomic authorship question makes little sense to begin with (Zilhão et al. 2015a). Yet the question continues to be asked. Let us review the most recent developments.

3.1. Makers of the Protoaurignacian and the Ahmarian

Two deciduous incisors assigned to Moderns (but see below, Section 4.1) have been claimed to demonstrate who made the Protoaurignacian. They were found at two rock-shelter sites in northern Italy: Bombrini and Fumane (Benazzi et al., 2015).

At Bombrini, however, the faunal remains found immediately adjacent to the fossil in level III of the 1976 excavations have been dated to 36.8–39.5 ka cal BP. At best, if the association is genuine, the tooth would thus fall in the time span of the Aurignacian I. However, charcoal as young as 22.6–23.0 ka cal BP has since been retrieved from the 2002–2005 excavation of the same unit. Even if we deem this outlier result intrusive, the other samples from the 2002–2005 excavations nonetheless span the entire duration of the Aurignacian (Fig. 2). Until directly dated, the true age of the Bombrini tooth must therefore be treated as an open issue.

At Fumane, the fossil also remains undated. It comes from level A2 and is posited to represent the makers of the associated Protoaurignacian stone tools. However, as Banks et al. (2013a), (2013b) cautioned, the stratigraphic integrity of the upper part of Fumane's sequence (levels D1d-to-A2, Gravettian-to-Protoaurignacian) cannot be taken for granted, due to (a) dating anomalies, ones that strongly suggest significant vertical migration across the sequence and that the incomplete decontamination of the charcoal samples used (Higham et al.,

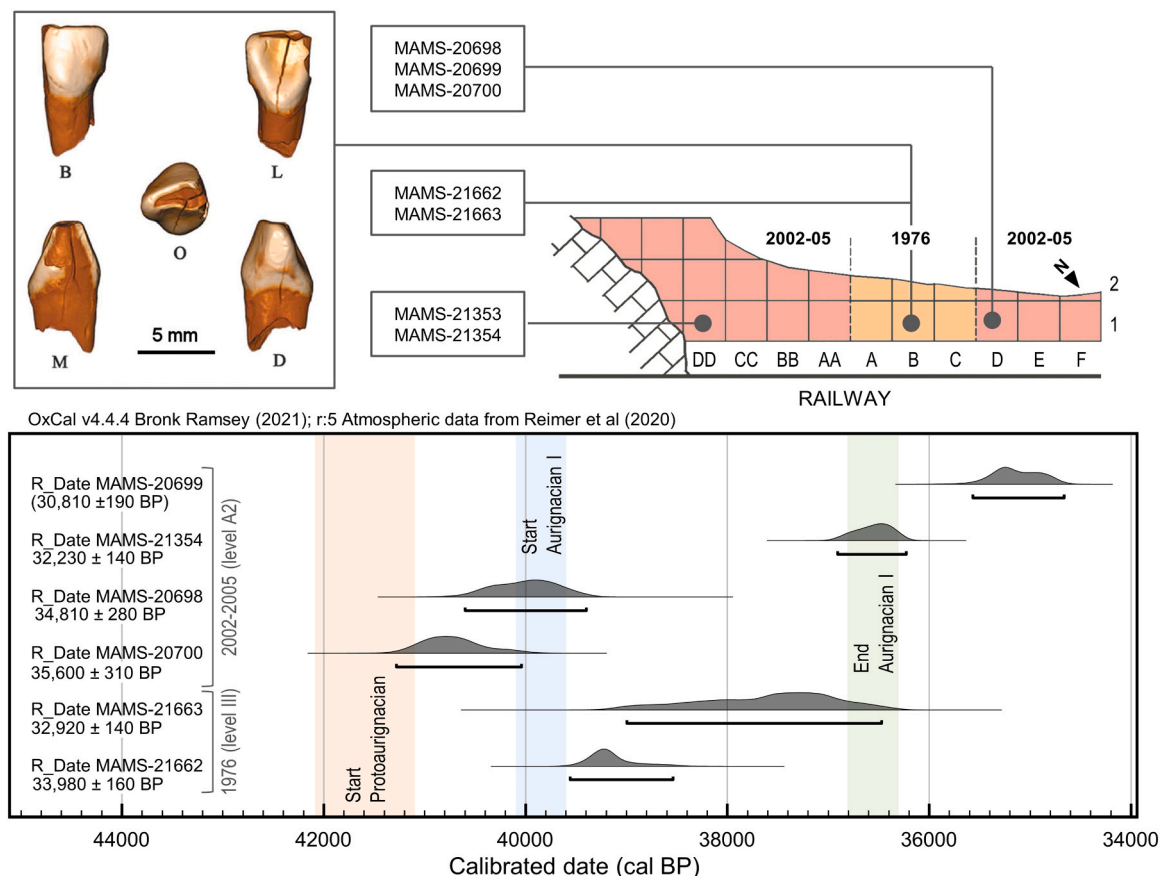


Fig. 2. Riparo Bombrini: the uncertain chronology of the fossil. The deciduous lower left lateral incisor, and the radiocarbon dating results for animal bone samples from the stratigraphic unit of provenience (after Benazzi et al., 2015, modified), plotted against the boundaries of the Protoaurignacian and the Early Aurignacian (after Banks et al., 2013b, updated under IntCal20).

2009) can only explain to some extent, and (b) the presence of a stone tool component of Protoaurignacian affinities in levels D3-D6, which yielded split-based bone points and dating results consistent with the Aurignacian I.

The data from Fumane have been used to support the claim that, in Italy, the Protoaurignacian stands not for a phase but for a cultural-geographic facies, i.e., that it stands for how the Aurignacian would have been expressed in the region for its entire duration (Palma di Cesnola, 1993). This notion contradicts the European-wide pattern and, in Italy itself, the evidence from the cave site of Fossellone, which fully conforms to that pattern (Mussi, 2001). Conceivably, therefore, the composition of the Fumane assemblages could simply reflect post-depositional disturbance, as hinted at by the site's dating record. That is precisely what a refitting study based on the conjoining of blade fragments now conclusively demonstrates (Falcucci et al., 2022): for the D3-D6 ensemble, 34 intra-level connections were found, while the inter-level connections with the underlying units assigned to the Protoaurignacian *sensu stricto* (A1-A2; Falcucci et al., 2017) were 64, almost twice as many. If blade fragments migrated that much across the sequence, we cannot dismiss the possibility that other lithic and bone components of similar or even smaller size also did. Consequently, we cannot rule out that the actual origin of the A2 tooth, which was retrieved in an area affected by these vertical displacement processes, is the overlying Aurignacian I, or even the Gravettian (Fig. 3).

The much more complete Oase remains date to a time frame consistent with either the Protoaurignacian or the Aurignacian I (36.9–41.1 ka cal BP, in the case of the directly dated Oase 1 mandible; Trinkaus et al., 2003), but they have no immediate archaeological context (Trinkaus et al., 2013). Their true age may well lie towards the older end of that interval, and the date may well be an underestimation. Even so, the stratigraphic configuration of the deposit that the fossils are associated with implies that the U-series age of the underlying flowstone (40.28/+1.09/-1.08 ka ago, 2σ error; Trinkaus et al., 2013) is a valid

terminus post quem. Therefore, the fossils can be no older than 41.37 ka ago. If close to that limit, they would be of Protoaurignacian age, but so would the Neandertal ancestor of Oase 1 that, according to the genetic data, lived no more than six generations, i.e., no more than 150 years back in time (Fu et al., 2015); the Neandertal people represented by one of Oase 1's grand- or great-grandparents would therefore have been present in the region at a time when the Protoaurignacian was emerging across Europe, from Asturias in the west to Romania and Bulgaria in the east.

The Oase data make it clear that no one-to-one correspondence of material culture with skeletal type (or Linnean species) can be established for the Protoaurignacian and, possibly, not even for the initial stages of the Aurignacian I (Zilhão et al., 2015a). Moreover, ideas diffuse across time and space via person-to-person or generational transmission, not as a result of natural selection and attending long-term advantage of the descendants of the fittest. Therefore, techniques, objects, and the social or mental templates that underpin them can spread much faster than genes, independently of mating exchanges or migration, and in directions that may differ from those that dominate gene or demic flows. Such spreading can encompass large distances over the lifetime of individuals and, therefore, within time frames well beyond the power of the dating techniques and genetic genealogies used to address origins questions.

Thus, under the assumption that Ahmarian (Gilead, 1981) and Protoaurignacian are different names for the same thing (as supported by detailed analysis of their bladelet production schemes; Gennai et al., 2021), the above considerations allow many different scenarios for the complex interactions between technological developments, population dynamics, and cultural transmission that may have underpinned the emergence and spread of the phenomenon. Detecting it in a given region could signal diffusion, whether from the east or from the west, or the establishment of a contact-and-admixture front, and either allows for different hypotheses concerning the geographical origins and fossil

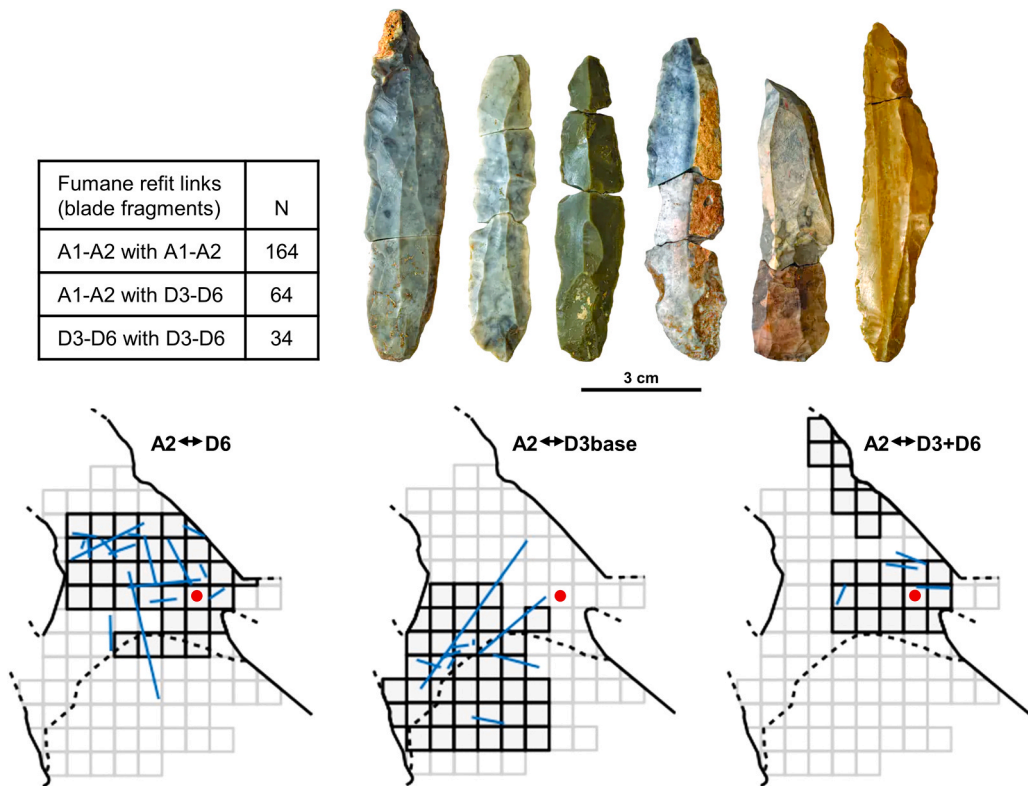


Fig. 3. Riparo Fumane: the uncertain chronology of the fossil. Number of refit links across the two stratigraphic ensembles of the Aurignacian sequence, refitted blades, and planimetric plot of links between blade fragments from the main pairs of stratigraphic subdivisions. The red dot indicates the position of the upper right lateral deciduous incisor retrieved in level A2. After Falcucci et al. (2022), modified.

human associations of the innovations involved. Achieving a robust interpretation of the process requires that such scenarios be explicitly posited and formally tested against theoretical expectations and the empirical evidence instead of assuming that one is “obviously” true and taken for granted (for an extended discussion, cf. Zilhão, 2006a).

Having said this, invoking people or ideas originating outside of Neandertal Europe as an important factor in the genesis of the Protoaurignacian/Ahmarian is legitimate because of an important cultural trait that they share: the use of shell beads of a standard small size, ~1 cm, found in significant numbers in several sites of the Mediterranean basin (Zilhão, 2006c, 2007). This jewellery can legitimately be seen as a manifestation of the expansion into Europe of a tradition of composite beadworks made of perforated *Tritia* (*Nassarius*) sp. shells that goes back to the Middle Palaeolithic of the Maghreb, where, at interior sites such as Grotte des Pigeons, it is found ~80 ka ago, and may go back to as early as ~100–120 ka ago at coastal sites (Bouzouggar et al., 2007; d’Errico et al., 2023; d’Errico et al., 2009; Schasseh et al., 2021; Steele et al., 2019). Later, the tradition is represented in the Ahmarian sites of the Levant, namely at Ksar ‘Akil, a rock-shelter in Lebanon, and Üçağızlı, a cave site in Türkiye (Kuhn et al., 2001; Stiner et al., 2013). In contrast, the jewellery of the Châtelperronian mostly consists of bone and tooth pendants and so, in this regard, the Protoaurignacian does represent a significant break with preceding Neandertal-associated traditions (Fig. 4). However, such a signal of diffusion from Africa via the Levant does not necessarily imply that other elements of the material culture, namely the stone tools, represent a comparable process. For instance, the evidence for a significant bladelet tool component in some Châtelperronian assemblages, namely at Quinçay or Ormesson, in France, shows that a range of interpretations are possible for the diagnostic cultural traits of the Protoaurignacian, namely, but not exclusively, the following: (a) they could have been inherited from the preceding Châtelperronian; (b) they could stand for long-distance interaction featuring exchange mechanisms operating in both east-west and west-east directions; or (c) they could represent convergent technological developments (Bodu et al., 2017; Gravina et al., 2022; Roussel, 2011; Teyssandier, 2023).

This understanding of the cultural dynamics involved in the

Protoaurignacian/Ahmarian phenomenon is based on the notion that we are dealing with a single technocomplex, i.e., per Clarke (1978), with an entity that displays a shared suite of cultural traits across a geographic extent wherein its manifestations are coeval. Claims that the Ahmarian emerged no later than 46 ka ago, five millennia earlier than the Protoaurignacian (Rebollo et al., 2011), are therefore at odds with that understanding. Such claims were initially based on the evidence from the Israeli cave site of Kebara, where, however, the early dates for the Ahmarian deposit at the back of the cave reflect the presence of charcoal (and even large chunks of hearth features) derived from the erosion of the Mousterian deposit found upslope, at the cave’s entrance (Goldberg et al., 2007; for an extended discussion, cf. Zilhão, 2013).

Corroboration of the Kebara claims has been sought in the early charcoal dates obtained for units 6–7 of a talus deposit in Area C of another Israeli site, Manot cave (Alex et al., 2017). However, according to Berna et al. (2021), (a) “numerous fragments of reworked wood ash, charcoal, and sediment aggregates” are found all through Manot’s Area C deposit, (b) units 6 and 7 of this talus are separated by an unconformity representing a hiatus during which erosion and subsurface cementation occurred, and (c) the upper part of unit 6 presents a mix of Aurignacian and Ahmarian artefacts. In fact, per Abulafia et al. (2021), such a mix characterises the entirety of unit 6; only unit 7 would be homogeneously Ahmarian. Notwithstanding, Abulafia et al. contend that the original, Kebara-based claim for the Ahmarian to emerge ~46 ka ago is supported by the Manot evidence because such is the age obtained for two unit 7 samples: RTD-7115 (42,210 ± 390 BP) and RTD-7196 (41,100 ± 450 BP). Alex et al. report that these samples come from square J65 and were retrieved at the absolute elevations of 204.7–204.8 m, for the RTD-7115 result, and 204.6–204.7 m, for the RTD-7196 result. Plotting these elevations against Abulafia et al.’s profiles reveals that the slice of deposit included in such arbitrarily horizontal spits cuts across the boundary with overlying unit 6, which yielded numerous identical or even earlier charcoal results (e.g., those in the ~39–49 ka BP range obtained 30 cm higher-up within a similar thickness of deposit; Fig. 5).

Moreover, in a talus with a 20–25° dip, as is the case with Manot Area C’s, it is entirely to be expected that, much as at Kebara, small particles

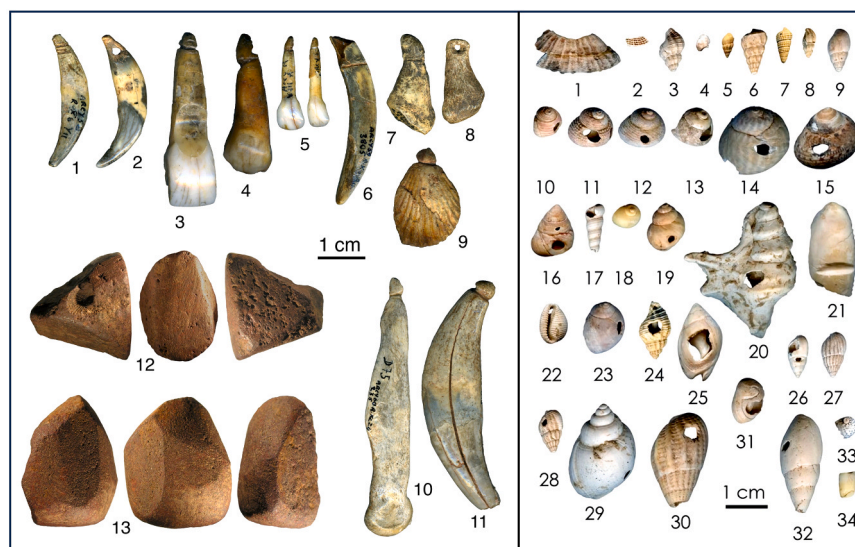


Fig. 4. Personal ornamentation in the Châtelperronian and the Protoaurignacian. Left: pendants (1–6, 11. perforated and grooved teeth of fox, bovid, bear, reindeer, marmot, and wolf; 7–8, 10. perforated and grooved reindeer bones; 9. grooved *Rhynchonella* sp. fossil) and colorant blocks bearing facets produced by grinding (12–13) from the Châtelperronian of the Grotte du Renne. Right: shell beads from the Protoaurignacian of Fumane (1. *Patella caerulea*; 2. *Diodora graeca*; 3. *Pollia dorbignyi*; 4. *Tricolia pullus*; 5. *Rissoa variabilis*; 6. *Cerithium vulgatum*; 7. *Bittium reticulatum*; 8. *Mangelia vauquelini*; 9. *Mitrella gervillii*; 10. *Homalopoma sanguineum*; 11. *Clanculus corallinus*; 12. *Clanculus jussieu*; 13. *Gibbula pennanti*; 14. *Gibbula richardi*; 15. *Osilinus articulatus*; 16. *Jujubinus striatus*; 17. *Turritella communis*; 18. *Littorina obtusata*; 19. *Littorina saxatilis*; 20. *Aporrhais pespelecani*; 21. *Luria lurida*; 22. *Trivia pulex*; 23. *Euspira macilenta*; 24. *Ocenebrina aciculata*; 25. *Nassarius circumcinctus*; 26. *Nassarius corniculus*; 27. *Nassarius costerlotus*; 28. *Nassarius incrassatus*; 29. *Nassarius mutabilis*; 30. *Nassarius reticulatus*; 31. *Cyclope* sp.; 32. *Mitra cornicula*; 33. *Theodoxus* sp.; 34. *Antalis inaequicostatus*). After Caron et al. (2011) and Bertola et al. (2013), modified.

of inherited sedimentary material derived from upslope, including charcoal, will exist in a deposit that is otherwise homogeneous from the point of view of its artefact content. Thus, that unit 7 yielded no stone tools that would be out of place in the Ahmarian does not warrant assuming that its charcoal content is entirely of the same age. Even though the near horizontal interface between units 6 and 7 suggests a different depositional dynamic for the latter, this is based on only 1 m² and the point stands because, at the back, the Manot Area C sequence leans against a pre-existent sedimentary body whose erosion must have contributed particles, including charcoal, all through the adjacent accumulation of both unit 7 and basal unit 6 of square J65 (Fig. 5). Therefore, even if truly belonging in unit 7, there is no reason to rule out that the RTD-7115 and RTD-7196 samples are of, or include, reworked charcoal. In a situation like Manot's and Kebara's, it is only via the direct dating of diagnostic artefacts or of charcoal from intact, *in situ* hearth features that a reliable chronology can be secured. For the Ahmarian, only the shell bead samples from Ksar 'Akil and Üçağızlı satisfy these conditions, and their dating fully supports contemporaneity with the Protoaurignacian (Douka, 2013; Douka et al., 2013) (cf. Section 5.2.2 below for further discussion of these sites and dates).

So much for the chronology, but what about the human remains? The most complete Ahmarian-associated fossil is thought to be the partial child skeleton known as Egbert, which was retrieved 11.46 m below datum in what looks like a burial feature set against the back wall of Ksar 'Akil; the dental remains of a second individual of the same age (about eight years old at death), were also found in that feature. Based on a cast of Egbert's heavily reconstructed cranium, Bergman and Stringer (1989) assign it to "modern humans," as do Bailey and Tryon (2023) based on old photographs and radiographs of the two dentitions. Yet, based on the actual specimens, Ewing (1947) stated that Egbert's mandible was "heavy for the age, in comparison with Modern White Men and with the delicacy of the braincase," and that "there is no mental prominence" — the absence of which being an archaic, not a modern, feature. Given the

loss of the originals, the taxonomic status of the fossil must remain undecided, but the evidence suggests a mosaic anatomy, as seen in the Oase fossils, which would be broadly coeval if Egbert is indeed of Ahmarian age. But is it?

If the context of the Ksar 'Akil children is a burial pit, then it stands to reason that it must post-date the deposit that the pit was excavated into. Following Ewing (1949, 1963), that deposit would correspond to the base of level XVI, separated from the overlying Aurignacian in level XIII by "Complex 2", a nearly sterile deposit of clay and clasts that corresponds to levels XIV–XV of the standard description of the sequence. However, this stratigraphic information must be treated with a large amount of salt because, based on the original drawings (Williams and Bergman, 2010: Fig. 4) and a photo from the year of the fossil's discovery (Bailey and Tryon, 2023: Fig. 1), the excavations were carried out in arbitrarily horizontal spits. At that time, the highly irregular limits of stratigraphic units, which were only recognised post-facto and 4 m away from Egbert's find spot (Fig. 6), were entirely ignored. It cannot be excluded, therefore, that the burial pit was excavated into the underlying Ahmarian during the subsequent, Levantine Aurignacian occupation of the site.

Manot also yielded six human teeth: three permanent and three deciduous (Sarig et al., 2021). MC-10, an upper deciduous molar, was retrieved in the well preserved, *in situ*, Late Aurignacian deposit in Area E, by the original cave entrance. MC-15, an upper deciduous canine not fully erupted at the time of death, comes from Area J, and is in secondary position. The other four come from Area C, but no specific information is provided as to their exact provenience within the stratigraphic succession identified in that trench: all we know is that they must be older than the U-Th age (~27.8 ka ago) obtained for the base of the flowstone that seals the deposit. In this context and given that most of the Area C lithics are of either Ahmarian or Aurignacian affinities, it is relevant that MC-7, a lower right second deciduous molar, matches the comparative Neanderthal material better than the comparative Modern material.

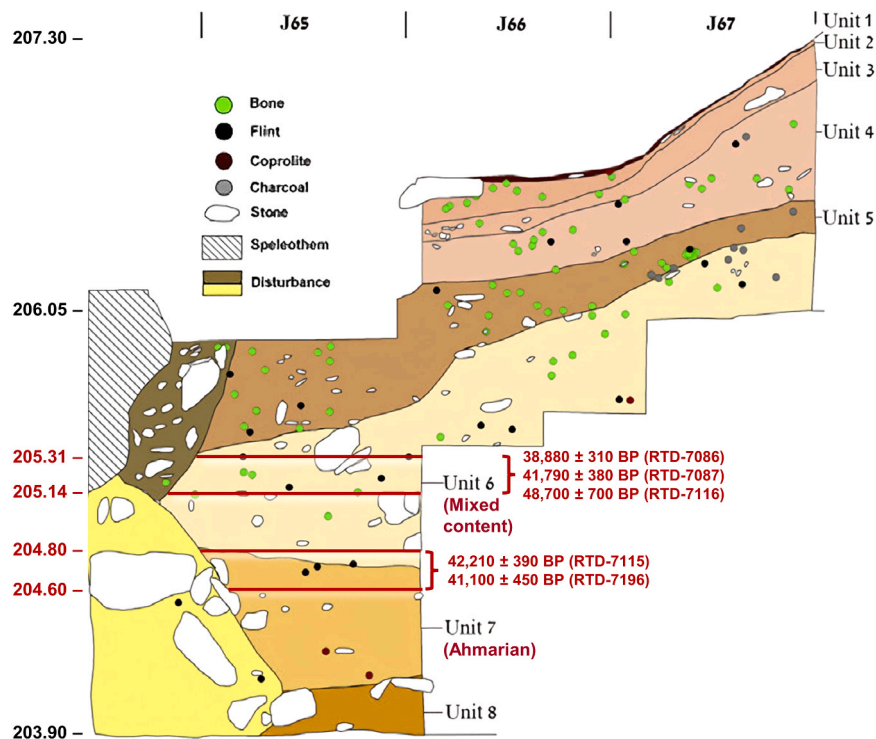


Fig. 5. Chronology of Manot Cave's Area C Transition levels. Position of the radiocarbon dated charcoal samples from unit 7 (RTD-7115 and RTD-7196) plotted against the reference stratigraphic sequence. The [204.6–204.8 m] excavation spits whence those samples come cut across the interface with unit 6, and both units lean against a preexisting disturbed deposit whose sloping surface remained exposed through the accumulation. This geometry implies that, through their build-up, units 6 and 7 incorporated residual material (sediment particles, including charcoal) derived from earlier deposits. Elevations are in metres above sea level. After Alex et al. (2017) and Abulafia et al. (2021), modified.

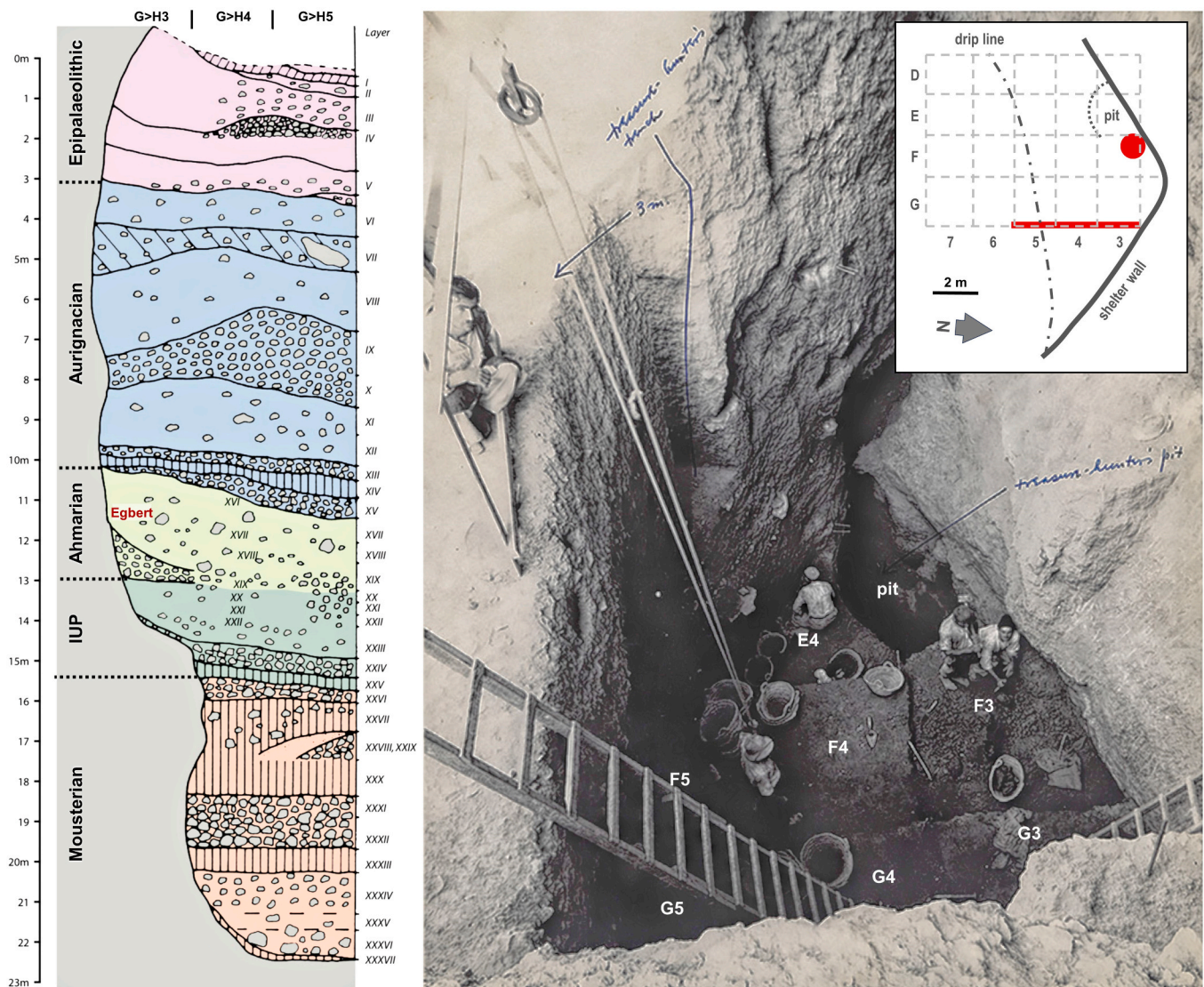


Fig. 6. Ksar 'Akil: excavation and stratigraphy. Left: the stratigraphic sequence, first reproduced by Newcomer (1974) based on an unpublished drawing by J. F. Ewing, the excavator, who must have recorded it along the east profile of the trench and only at the end of the 1948 season, when bedrock was reached (after Bosch et al., 2015, modified). Right: photo of the excavation taken in 1938, the year Egbert was found (given the scale provided by the workers, that the treasure hunter's pit reached a depth of 15 m, and that the depth annotated for the surface in row 6 is 3 m, the photo must record the excavation of the Ahmari deposit at about the elevation of the fossil's discovery; after Bailey and Tryon, 2023, modified). The inset shows the excavation grid (in 2×2 m units), with the red circle marking the position of the burial, against the wall, in square F3, 11.46 m below datum, and, as can be seen in Plate Ia of Bergman and Stringer (1989), by the edge of the pit, 4 m away from the 1948 profile.

A cranium found on a ledge adjacent to a shaft at the bottom of the talus of reworked sediment that descends from the cave's collapsed entrance was also found at Manot (Hershkovitz et al., 2015). No sediment existed between the cranium's bone surface and the calcite crusts adhering to it, which implies that the fossil cannot correspond to a subsurface item eventually displaced upwards by burrowing. This evidence constrains the time of the cranium's entry in the cave to after sediment accumulation ceased, which, based on the basal age obtained for the flowstone capping Area C, is ~28 ka ago. The U-series age of ~55 ka that Hershkovitz et al. published for the cranium's crusts is an artefact of the correction factor used to account for detrital contamination; recalculation using the more appropriate isochron approach yields a stratigraphically consistent result of 33 ± 12 ka (2 σ) (Dirk L. Hoffmann, personal communication; Zilhão et al., 2015a).

With regard to the "whodunnit" question, the evidence from Manot is therefore as inconclusive as that from Ksar 'Akil, Bombrini, or Fumane. With current evidence, no human remains can be securely associated

with either the Protoaurignacian or the Ahmari.

3.2. Makers of the Bachokirian and the Ranisian

Building upon the genetic attribution to Moderns of undiagnostic bone fragments from levels 11 and I of the Bacho Kiro cave, in Bulgaria, the Bachokirian has been likened to the IUP of the Levant and interpreted as representing the arrival in the region of a singular biocultural entity that ultimately supplanted the indigenous population (Fewlass et al., 2020; Hublin, 2015; Hublin et al., 2020). Recall that, in this scenario, the personal ornaments of the Châtelperronian Neandertals, western Europe's last, would result from the influence that Moderns present to the east would have exerted over them during the ensuing prolonged period of continent-wide contemporaneity. As has been proposed by many (for a recent synthesis, see Demidenko and Škrdla, 2023), the other so-called "transitional" industries of intermediate regions of central Europe, e.g., the LRJ

(Lincombian-Ranisian-Jerzmanowician; henceforth, for simplicity, Ranisian) and the Bohunician, would have partaken in the process and been made by Moderns too.

The genomic analysis, however, revealed that the Bachokirians molecularly assigned to Moderns had had unmixed Neandertal ancestors no more than a minimum of two and a maximum of 17 generations back, i.e., no more than 40–340 years before their own time. Of particular interest is the male individual represented by the F6-620 molar and the AA7-338 bone fragment. Directly dated on the latter to $39,750 \pm 380$ BP (42,570–43,890 cal BP), this individual was found to have a most recent Neandertal ancestor two to six generations back, i.e., one that lived no earlier than ~ 44 ka ago. Since layer I of Bacho Kiro began forming ~ 44.6 ka cal BP at the latest (Talamo et al., 2023), such a Neandertal ancestor would have been alive at least five and perhaps as much as twenty centuries after the start date of the Bachokirian. Following the same reasoning, we can also conclude that another individual, the female CC7-2289, had a Neandertal ancestor who could have been alive up to 1200 years after the Bachokirian began.

Accepting these studies' assumptions and results, the makers of the Bachokirian could therefore have been the Neandertal ancestors of the sequenced individuals, the mixed Neandertal/Modern descendants of such ancestors, or both the ancestors and the descendants. Put another way, the Bachokirian could have been made all through the period during which distinct populations of the Lower Danube and adjacent regions exchanged their genes, and we lack the chronological resolution to empirically test the different possibilities. Thus, the conclusion that the Bachokirian is a modern human culture is entirely predicated on the *a priori* exclusion of Neandertals from the range of potential makers—the same rationale that, a quarter of a century ago, underpinned the interpretation of the Grotte du Renne's Châtelperronian jewellery and bone tools as intrusive, scavenged, or imitated Aurignacian items.

An additional hindrance for the notion that the Neandertal-associated Châtelperronian represents long-distance acculturation by Bachokirian Moderns is that, in stone tool production, the Châtelperronians used a full-blown Upper Palaeolithic technology (Bachelierie, 2011; Gravina et al., 2022), not the “transitional” methods derived from

Levallois that the Bachokirian is said to be based on. Moreover, the jewellery of the Bachokirian consists of tooth pendants, the same as in the Châtelperronian, and, in the putative source area of its putative Modern makers, the Levant, such types of personal ornaments are completely absent until much later (see below, Section 5.3.1., for a detailed discussion). In addition, the Neandertals' use of jewellery is documented in Europe since at least the Last Interglacial, and so the Châtelperronian is by no means a “first” requiring the postulation of an external stimulus. Thus, under Acculturation's theoretical premises, the Bachokirian would have to be considered as a by-product of west-east diffusion, and its makers would have to be considered as the acculturated, not the acculturators.

With regard to the Ranisian, the claim that it stands for the immigration of Moderns is grounded on the mtDNA-based classification of undiagnostic bone fragments from the eponymous site, the Ilsenhöhle, a collapsed cave in the eastern German town of Ranis (Mylopotamitaki et al., 2024). The remains come from a context that yielded lithic diagnostics dated by association to within the unmodelled age interval of 42.9–49.6 ka ago and were themselves directly dated to within that range. Based on the geographical distribution of the localities wherein the technocomplex has been identified, this evidence is claimed to have provided “demonstration that the [Ranisian] was produced by *H. sapiens*” and to have shown that “pioneer groups of *H. sapiens* expanded rapidly into the higher mid-latitudes, possibly as far as the modern day British Isles.” However, as the map purportedly illustrating these conclusions clearly shows, that distribution encompasses Belgium and the site of Spy, which yielded both lithic diagnostics of the Ranisian and a Neandertal adult skeleton, Spy I (Fig. 7). The latter has been reliably dated on the hydroxyproline molecule to 41.9–45.2 ka ago, while the even younger but also diagnostically Neandertal Fonds-de-Forêt femur, also from Belgium, has been likewise dated to 42.1–43.9 ka ago (Devièse et al., 2021; and see below, Section 5.3.1., for additional discussion of these specimens). Therefore, these Neandertals lived in Ranisian territory at least one to two millennia after the 46.0–47.5 ka ago interval modelled for the start of the technocomplex (Mylopotamitaki et al., 2024). Based on Mylopotamitaki et al.'s

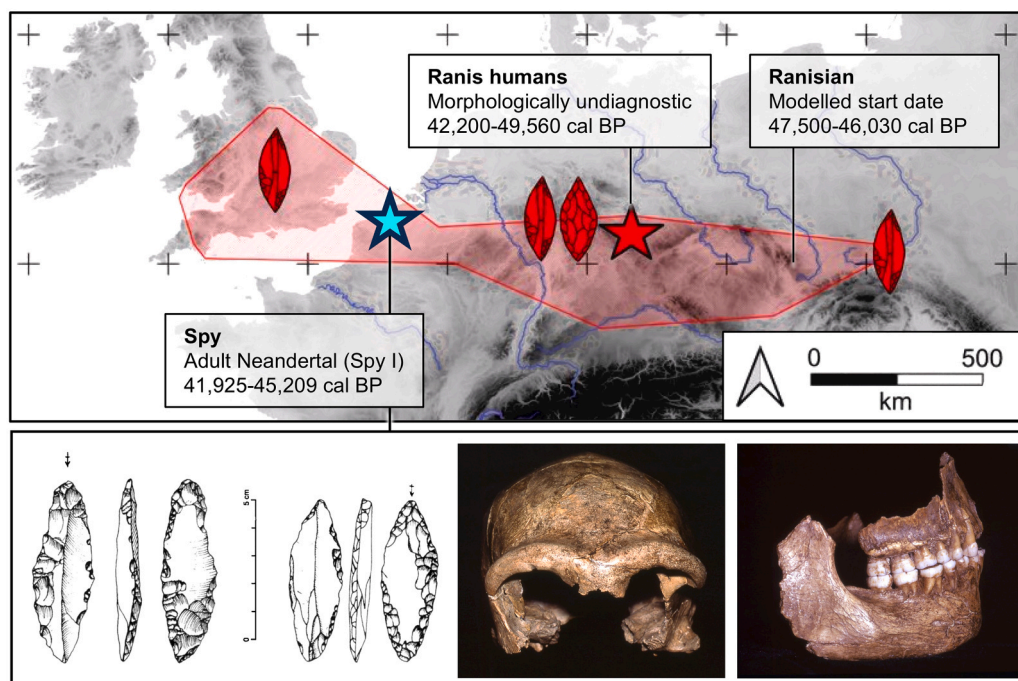


Fig. 7. The Ranisian. Top: the territorial range of the technocomplex as defined by Mylopotamitaki et al. (2024), which includes Belgium and the site of Spy. Bottom: Ranisian diagnostics from Spy (Jerzmanowice points; after Flas, 2002), and the Spy I adult Neandertal (photos courtesy of Erik Trinkaus), which has been directly dated by Devièse et al. (2021) to the same time range as the undiagnostic human bone fragments of Ranis genetically assigned to Moderns.

premises, we would thus have to conclude that the Ranisian was made by both Neandertals and Moderns.

As is the case with the Protoaurignacian and the Bachokirian, the Ranisian provides further empirical illustration of the fact that no one-to-one correspondence with physical type can be established for the technocomplexes of the Transition. In the revamped form derived from Bacho Kiro and Ranis, Acculturation is pulled back a few millennia, but the key logical issues remain the same: (a) human biology varied in a continuous space while material culture varied in a discrete space, which means that no one-to-one correspondence between the two domains can exist to begin with, and (b) the genomic evidence that the updated version of Acculturation relies upon allows for reasoning over time frames of a few generations while Archaeology and Human Palaeontology are based on dating methods whose resolution is one to two orders of magnitude poorer (i.e., millennial at best).

4. The logical inconsistencies of the dichotomic approach

Putting the Bachokirian and the Ranisian in the role that, in the 1980s–1990s, was assigned to the Protoaurignacian/Ahmarian, remains grounded in the assumption that the Neandertal/Modern dichotomy provides the foundation upon which to interpret all that happened through the early Upper Pleistocene prehistory of western Eurasia. The evidence reviewed above shows that the assumption is invalid and that it leads to narratives of the “post-hoc accommodative argument” type (Binford, 1981). In addition, such narratives often display significant levels of internal contradiction, or indulge in different types of logical fallacy, as we will now proceed to discuss.

4.1. When assigning fragmentary human remains to taxonomic entities

Geneticists are fully aware that admixture must have been the rule, not the exception: “it is striking that all four of the European individuals who overlapped in time with late Neandertals and from whom genome-wide data have been retrieved had close Neandertal relatives in their family histories,” suggesting that “mixing between Neandertals and the first modern humans that arrived in Europe was perhaps more common than is often assumed” (Hajdinjak et al., 2021; see also Peyrégne et al., 2022; Zeberg et al., 2024). This understanding of the genetic evidence is fully at odds with representations of the palaeoanthropological record as a by-product of the competitive interaction for space and resources between monolithic biocultural entities, namely those that ROA allows for in western Eurasia, where the remains must be either Neandertal or Modern. Moreover, the latter are palaeontological categories whose definition is based on the presence or frequency of morphological traits, which begs the question: In a world of gene flow and mosaic anatomies, can one reliably assign fragmentary remains to one or the other category?

Let us recall here the case of the Oase fossils. Among other non-Modern aspects, the maxillary third molars of Oase 2 are of a shape and size nowhere else to be found in the fossil record of *Homo*; in terms of size, they match the values for *A. afarensis* and are exceeded only by the mean values for other species of *Australopithecus* (Trinkaus, 2010). Had they been found in isolation; how would they have been classified? Would those teeth be said to represent an as-yet unidentified human species that descended from some Lower Pleistocene, if not earlier ancestor? We know that the correct answer is that these archaic teeth belonged to a human that, anatomically, was largely modern, and this is so because of the diagnostic, derived features of the individual’s cranium. The combination reflects the period’s complex evolutionary processes, and the shape and size of its upper third molars does not stand for the late persistence of a hitherto-unknown taxon.

Much the same can be said with regard to the dentition of the Lagar Velho child. Accepting that the Bombrini tooth is of Protoaurignacian or Aurignacian age, that child would have lived as much as ten millennia later. Yet, “the endostructural organization of the relatively voluminous

Lagar Velho 1 deciduous upper central incisor closely approaches the Neandertal condition, characterized by absolutely and relatively larger dentine volumes and a larger EDJ [enamel-dentine junction] surface” and “its deciduous lower lateral incisor has an intermediate position between Neandertals and extant humans” (Bayle et al., 2010). Had the Lagar Velho child’s deciduous incisors been found in isolation; might we be arguing that Neandertals persisted in Iberia until 28,000 years ago and that they were the makers of the regional Gravettian? Following the logic expounded for Bombrini, we might. However, because we have a complete skeleton, we know that the Lagar Velho child’s dentition is parsimoniously explained as reflecting the mixed ancestry of the population it belonged to. Under this interpretation, the child illustrates how the changes in dental tissue proportions observed in European populations across the Late Pleistocene affected different parts of the dentition in a diverse and chronologically uneven manner. In short, it illustrates that such changes do not correspond to the *en bloc* replacement of a tightly interrelated package of discrete features by another such package. As Bayle et al. put it, the “discrete dental morphological trait variation in early Upper Palaeolithic dentitions, and other morphological aspects (...) are not resolvable into a simple Neandertal versus modern human dichotomy,” and “these earlier Upper Palaeolithic modern humans are not simply older versions of extant humanity.”

The small size of the samples further complicates the dichotomous approach to the Transition’s fossil remains. For instance, the Bombrini deciduous lateral lower incisor is classified against a sample of eighteen Renaissance and Medieval Italians and five Neandertals. However, meaningful comparison must be reduced to an even smaller sample because the criteria assumed to be of diagnostic value relate to dental tissue proportions and so wear must be accounted for. The Bombrini specimen is in wear stage 4, but all of the Neandertals in Benazzi et al.’s sample are in stages 1/2 or 3. As, in the Italian sample, the ranges of variation in dental tissue proportions for wear stages 3 and 4 overlap significantly, the error introduced by merging both to make the comparison possible is negligible, the more so since interobserver differences play a significant role in the assignment (e.g., the Neandertal specimen from Abri Suard is deemed to be in stage 3 by Benazzi et al. 2015, and in stage 4/5 by Bayle et al. 2010). Doing so, we are left with two of the Neandertals and fifteen of the Italians in Benazzi et al.’s sample but, for additional context, we can extend the comparison to the two Upper Palaeolithic lower lateral deciduous incisors published by Bayle et al. (2010) and Crevecoeur et al. (2010): Lagar Velho 1 (wear stage 3/4), and La Madeleine 4 (wear stage 2/3) (Fig. 8).

When the comparison is based on the range of values rather than the average (which, given the size of the fossil samples, is an uninformative indicator) we clearly see, for both RET (Relative Enamel Thickness; the criterion that the Bombrini study considers as an effective taxonomic discriminator) and the proportion of the crown that is dentine and pulp, that (a) the early Neandertal and Italian values overlap, and (b) the Bombrini specimen is much closer to the Neandertal values than to the Upper Palaeolithic ones. Can we therefore exclude that the Bombrini lower deciduous incisor reflects the reverse of the Oase 2 and Lagar Velho 1 mosaics, i.e., that it belonged to a child who, despite the somewhat more modern-looking tissue proportions of one of its teeth, retained a Neandertal-like cranial gestalt? Put another way, if Oase 2 is a modern human with immediate Neandertal ancestors, can we exclude that the Bombrini tooth belonged to a Neandertal with immediate modern human ancestors?

The Bombrini study also illustrates two other aspects of how the Neandertal/Modern dichotomy hinders a proper understanding of the Transition. The study’s modern human comparative sample is entirely composed of specimens that are no more than a few centuries old, thus postdating Bombrini by almost 40,000 years. Furthermore, the comparisons excluded the late Neandertal and Upper Palaeolithic individuals for which endostructural data for the same tooth were readily available — the Spy VI, Lagar Velho 1, and La Madeleine 4 children. Thus, the study’s unstated assumptions would seem to be that (a) the

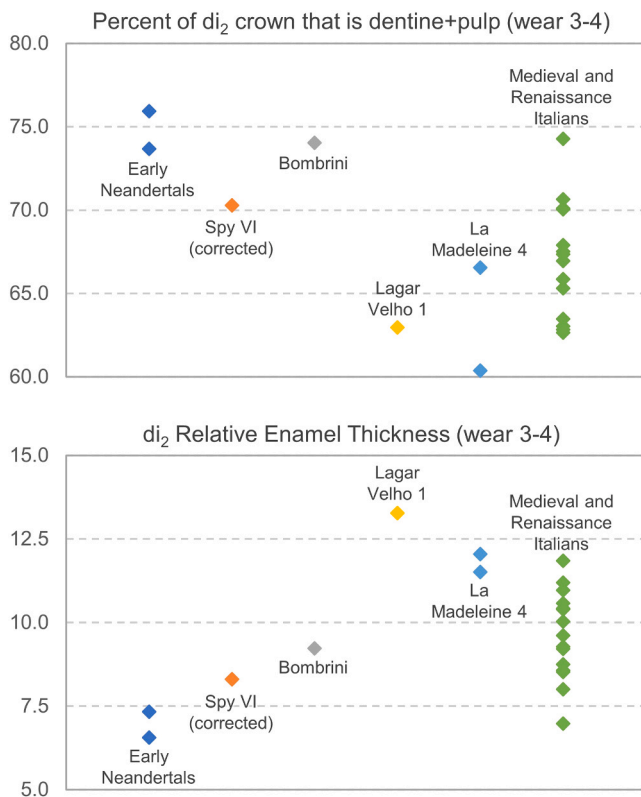


Fig. 8. The Bombrini fossil: dental tissue proportions. The Bombrini deciduous lower left lateral incisor compared with Neandertals, Upper Palaeolithic people, and recent humans. Data from Bayle et al. (2010), Crevecoeur et al. (2010), and Benazzi et al. (2015). Following Benazzi et al., to account for the difference in wear stage, the RET for Spy VI is plotted at 90 % of the observed value, and the percentage of the crown that is dentine and pulp is likewise corrected for an enamel volume decreased by 10 %.

condition observed in the Italian sample is representative of recent humans irrespective of space (i.e., worldwide) and of modern humans-as-a-species irrespective of time (i.e., whether the analysed teeth are 1000 or 100,000 years old), and (b) the Neandertal condition is likewise space-time invariable, i.e., Neandertals from e.g., 200,000 years ago are as good a standard as Neandertals from 50,000 years ago, and this irrespective of whether the remains come from Siberia, western Europe, or in between.

Yet, Bayle et al. (2010) conclude that, for many aspects of tissue proportions, the Lagar Velho 1 and La Madeleine 4 children are intermediate between the Neandertal and the extant human samples to which they were compared. The data provided by Bayle et al. and Benazzi et al. also suggest that a time trend may well exist within the Neandertal sample itself. For instance, with regard to lateral lower deciduous incisors, the earlier Neandertals feature less elevated RET values than the later ones: the lowest values are for the Abri Suard and Roc-de-Marsal 1 fossils, which are of Penultimate Glacial and Last Interglacial age, respectively, while the highest (9.23, essentially the same as Bombrini's 9.22) is for the Spy VI child, now securely dated on the hydroxyproline molecule to $41,700 \pm 2300$ BP (OxA-38790), i.e., 42.0–48.5 ka cal BP (Deviese et al., 2021). That the RET values of Bombrini and Spy VI are the same is the more remarkable because, if the former is indeed of Protoaurignacian or Early Aurignacian age, then the latter would be no more than five millennia older, i.e., in evolutionary terms, of broadly the same age.

True, the Spy VI tooth is in wear stage 1, a factor that, rather than chronology, could explain the difference. However, if, following Benazzi et al., we account for the fact that, in the comparison, Bombrini's value is underestimated by 10 % due to wear, it nonetheless remains closest to

Spy VI than to any other Palaeolithic specimen (Fig. 8). In fact, the difference between the two teeth is of the same order of magnitude as the difference between the left and right lateral deciduous incisors of La Madeleine 4. So: If found in isolation, would the Spy VI tooth be considered evidence that Moderns made the site's Mousterian and Ranisian stone tools? Or, conversely, shouldn't the Bombrini specimen perhaps be classified as Neandertal, not Modern?

These observations vindicate Smith's (2005) cautionary remarks on how small sample sizes limit our ability to distinguish between intra- and inter-taxonomic variation in the fossil record of the human lineage. They are especially relevant for fragmentary or isolated dental remains from the Transition, when, given the overlaps, the Neandertal vs. Modern dichotomy is, for such material, simply inoperable. Much the same point has been made with regard to the Kent's Cavern maxilla and the deciduous teeth from level E of Grotta del Cavallo, which, a decade ago, were claimed to constitute evidence for modern human presence in Europe prior to the Aurignacian: besides the issues of dating and stratigraphic association that plagued the claim, whether those remains can be assigned to moderns-as-a-species is also questionable (Zilhão, 2013). The latter concluded that, "for teeth from around the time of contact, secure classification in terms of the taxonomic categories of Human Palaeontology may be possible for large sets (e.g., the Grotte du Renne's) but not for isolated finds."

The evidence from Bombrini conforms to that conclusion, and so does the evidence from Manot. Sarig et al.'s (2021) discussion of the dental remains from Manot Area C argues that they display a "complex mixture of modern *H. sapiens* and Neandertal dental traits," explicitly considering the possibility that at least some "represent hybrid individuals, probably with variable genetic modern human and Neandertal contributions." Overall, Sarig et al.'s conclusion is that "a definite taxonomic interpretation of the populations represented by the Manot teeth is difficult based on the dental morphology only." But shouldn't the conclusion be instead that, here, taxonomic interpretation might well amount to reducing to one or the other pole of an imposed dichotomy individuals that in fact represent a continuum within a single, evolving population?

The conflicting reports on the affinities of two remains from Châtelperronian level X of the Grotte du Renne recently discovered among the unclassified material suggest that similar issues afflict the classification of fragmentary post-cranial elements. Henrion et al. (2023) assigned a hyoid's left great horn to the Neandertals "based on the taxonomic attribution of the dental remains and the taphonomic evidence," and this despite the lack of the "morphological or metric characteristics that allow us to distinguish it from those of our modern human sample." Gicqueau et al. (2023), however, assigned a perinatal illium to "an early modern human lineage whose morphology differs slightly from present-day humans" because it is only "slightly outside recent variability" and "clearly differs from the Neandertals."

The Neandertal sample from which the Grotte du Renne's illium is said to differ is made up of just two specimens, the illia of the Mezmaiskaya 1 and Le Moustier 2 individuals from Crimea and France, respectively. In and of itself, this fact renders statistically uninformative the mean used in the shape comparisons (and note that the Mezmaiskaya 1 specimen is damaged — the iliac spine is lacking, and the iliac crest features severe erosion, with exposure of the cancellous bone). Moreover, Gicqueau et al.'s PCA (Principal Components Analysis) fails to discriminate between the samples: distances between pairs of recent humans can be found that much exceed the distance between one Neandertal and the nearest recent human. Indeed, as Fig. 9 shows, removing the samples' identification labels makes it clear that the analysis lacks any discriminatory power whatsoever; the putative separateness of Mezmaiskaya 1 and Le Moustier 2 rests entirely on their prior classification as Neandertals, not on their possession of a morphology that readily distinguishes them from the specimens they are compared to. Based on this evidence, the implications-loaded conclusion that the new Grotte du Renne illium means that the level X human

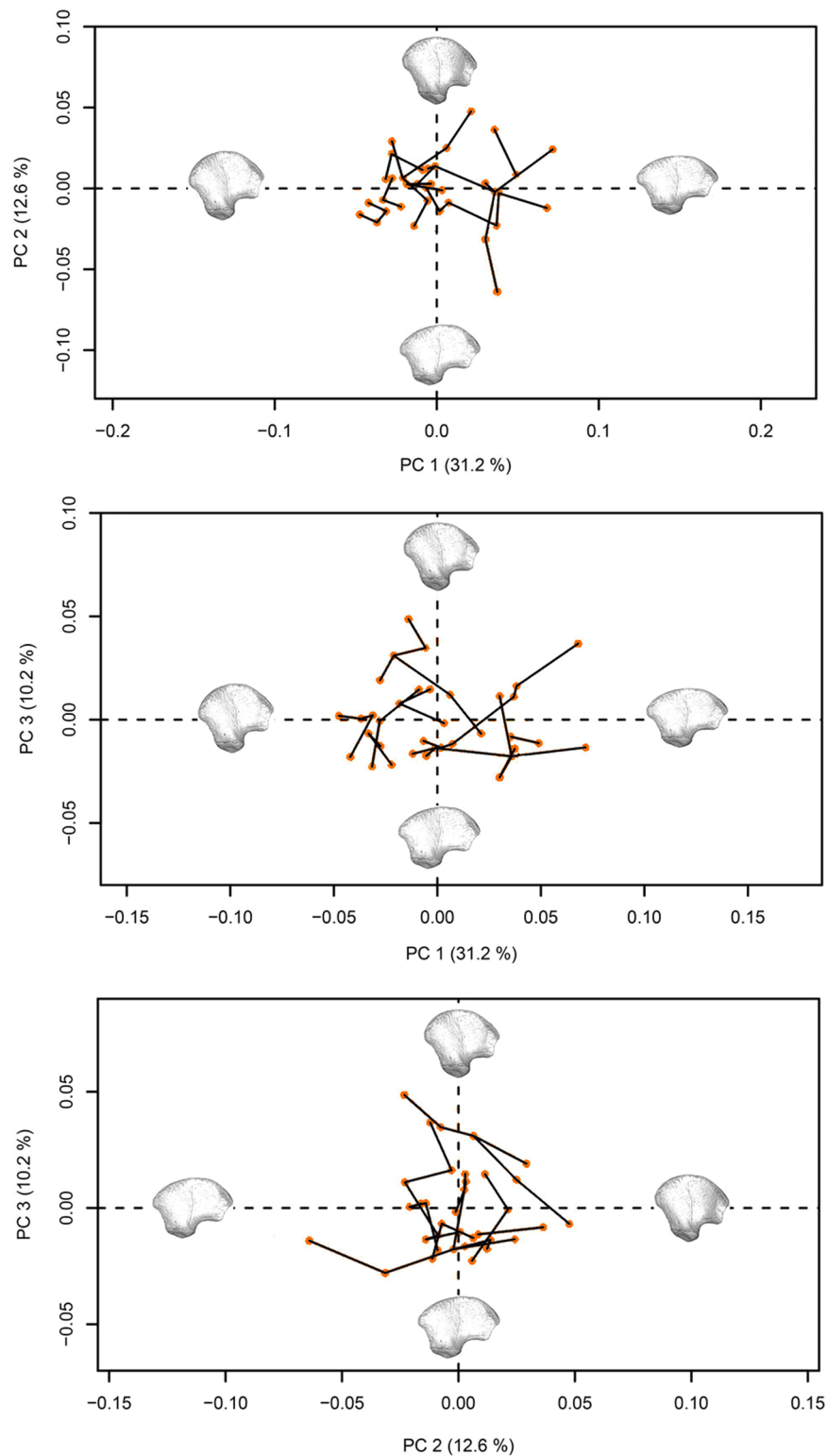


Fig. 9. Spot the Neandertals! The perinatal illia from Mezmaiskaya 1, Le Moustier 2, and layer X of the Grotte du Renne compared with those of 32 recent humans (after Gicqueau et al., 2023: Fig. 4, modified). The graph illustrates a PCA with neighbour joining computed with Procrustes distances; once the priors (i.e., the specimen labels plus the convex hull delimiting the space shape of recent humans) are dispensed with, as is done here, it becomes clear that the analysis is entirely unable to reveal the two Neandertals involved in the comparison.

remains include representatives of an early lineage of Moderns cannot be supported.

In short, what we can gather from these two Grotte du Renne studies is the following: in an ensemble made up of a large number of diagnostic Neandertal remains, a hyoid fragment is assigned to Neandertals despite

it being indistinguishable from that of Moderns, while an illium is assigned to Moderns despite falling outside their documented variation. This latter assignment gives more weight to the fact that the illium differs slightly from a sample of 2 (the bones in the Neandertal sample, one damaged) than to the fact that it lies outside the variation

represented by a sample of 32 (the recent human sample). Occam's Razor was heeded in the case of the hyoid, but not in the case of the illium.

4.2. When using “Modern” and “Neandertal” as genomic categories

A fundamental problem in the interpretation of the Transition's genomic data is the practice of framing it with recourse to categories derived from skeleton-based taxonomies. This approach is loaded *ab initio* with the conflicts inherent to the taking of concepts derived from Linnean fixism to interpret processes that unfolded under the laws of Darwinian evolution. The routine palaeoanthropological treatment of Neandertals and Moderns as invariant in space and time is but a readily apparent case in point.

When dealing with the genomic data, diagnosing species separateness should result from a population genetics enquiry into patterns of population structure, isolation by distance, and gene flow. Instead, the ontological reality of the species framework is taken for granted. Yet, when both present-day and fossil humans of the last half-a-million years are considered together, the morphological variation observed in the size and shape of the cranium — the principal criterion upon which Human Palaeontology bases current taxonomic distinctions — is fully within expectations derived from what can be seen within and between extant populations of *Pan troglodytes* (Lordkipanidze et al., 2013) (Fig. 10). This observation is even more relevant in light of Wood and Smith's (2022) cautionary note that “considering the ecology of hominins versus great apes and the fact that palaeospecies variation includes a time dimension, (...) variation within hominin palaeospecies was almost certainly greater than the variation we see in collections of extant great apes that capture variation across a couple of centuries, at most, and that were mostly collected from a restricted geographical location.”

Given the above, the null hypothesis in the study of late Middle and early Upper Pleistocene human genomes ought to be that of a single, evolving phylogenetic lineage whose spatially patterned variation is caused by population structure. If, instead, the species framework is adopted, inconsistency is bound to follow. A case in point is the study of

the human remains from the Bachokirian (Hajdinjak et al., 2021; Hublin et al., 2020). The case for calling them morphologically “modern” relies on the tissue proportions of a lower molar, the F6-620 specimen. The assignment is based on the tooth falling within the “recent *H. sapiens*” cloud of a PCA analysis of the EDJ carried out across three samples (fossil *H. sapiens*, recent *H. sapiens*, and Neandertal). Yet, the study's sample of fossil *H. sapiens* consists entirely of specimens of Last Interglacial or older age, such is also the age of 75 % of the Neandertal sample, the recent *H. sapiens* is entirely composed of Neolithic and clinical material from Europe, and there is much overlap between the clouds. A parsimonious reading of Hublin et al.'s graph is that the observed variability (a) was geographically structured and much higher in the Pleistocene than in the Holocene, (b) decreased over the last 100,000 years in significant manner, and (c) eventually converged to a pattern that is intermediate between the ancestral African and European conditions (Fig. 11). Accounting for change through time, the Bachokirian specimen simply illustrates that, perhaps unsurprisingly, the intermediate pattern already existed 45,000 years ago, half-way through that 100,000-year interval. On how the F6-620 molar compares with coeval populations in the region and its neighbourhood, Hublin et al.'s PCA is uninformative.

It is on the merits of the genetic data that the case for the modernity of the Bachokirian human remains must therefore rest, and the same applies to the undiagnostic, but genetically “modern” human bone fragments from Ranis (Mylopotamitaki et al., 2024). The rationale that appears to be followed stems from the premise that all the variation seen in the genomes of early Upper Pleistocene west Eurasian humans can be reduced to their belonging in one or the other of two groups, i.e., that genetically “modern” implies anatomical Modern-ness, and likewise for genetic and anatomical Neandertal-ness. This rationale rests on the two key observations that (a) genetically, living Eurasians are more closely related to an ancient African lineage than to >45,000-year-old Eurasian ones, and (b) when their skeletal remains are sufficiently complete, such >45,000-year-old, genetically sequenced fossil Eurasians are of the Neandertal phenotype. It is via this inferential path that undiagnostic skeletal remains of Eurasians are considered to be of anatomically

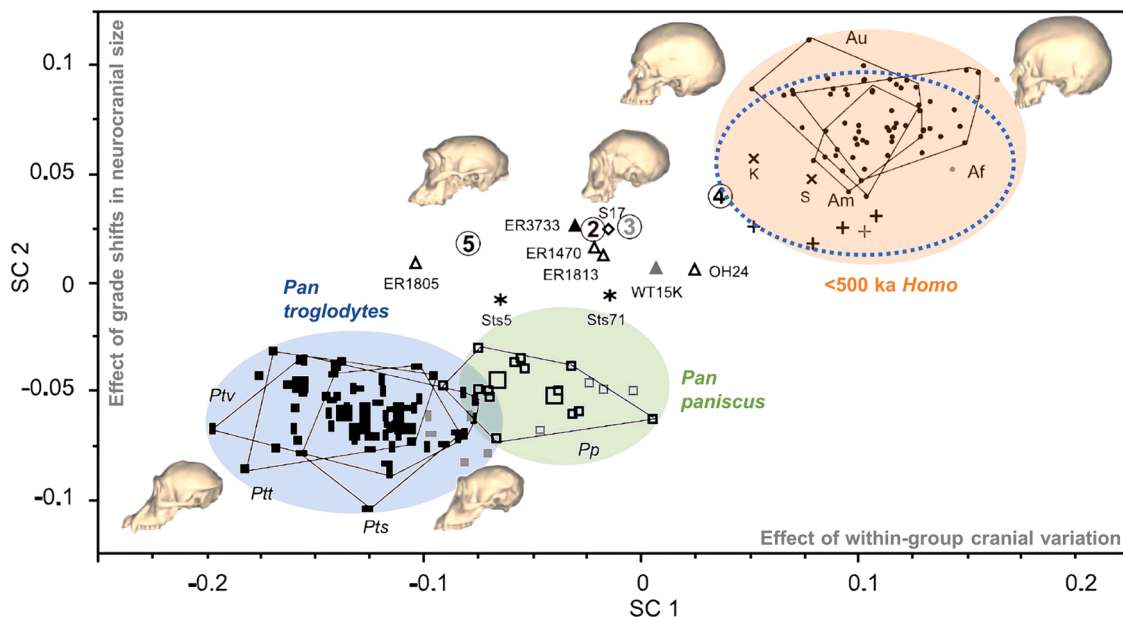


Fig. 10. Shape variation of human and chimpanzee crania. After Lordkipanidze et al. (2013), modified (the SC1 shape component captures within-group cranial variation from large-faced/prognathic to small-faced/orthognathic individuals; the SC2 shape component captures shape change associated with grade shifts in neurocranial size between taxa; circled numbers represent the five Dmanisi crania, dots represent recent humans, plus signs represent Neandertals, crosses represent the Middle Pleistocene Kabwe and Steinheim specimens; black symbols represent adult individuals, grey symbols represent subadult individuals). The added colour ellipses represent the morphological space occupied by *P. troglodytes*, *P. paniscus*, and <500 ka humans; the dotted line superimposed on the ellipse representing the latter is the contour of the *P. troglodytes*'s ellipse, showing how the illustrated variation is within expectations for a single species based on our closest extant relatives.

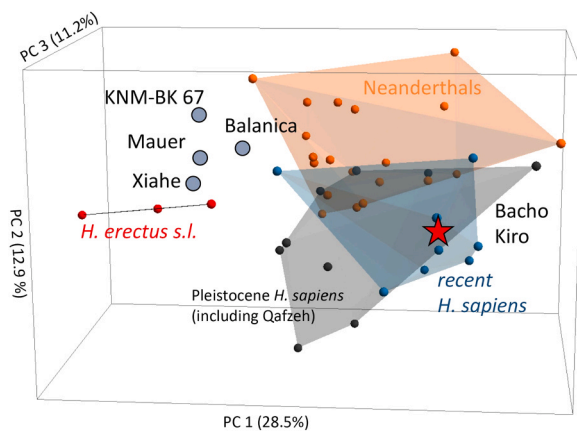


Fig. 11. The Bacho Kiro Cave second lower molar (F6–620). The tooth, indicated by the red star, is compared with recent and fossil humans in a PCA of the shape of the enamel-dentine junction ridge and cervix (after Hublin et al., 2020). Note the overlap and that (a) the study's sample of "Pleistocene *H. sapiens*" consists entirely of specimens of Last Interglacial or older age, (b) such is also the age of 75 % of the Neandertal sample, and (c) the "recent *H. sapiens*" sample is entirely composed of Neolithic and clinical material from Europe. The graph can therefore be parsimoniously read as indicating change through time and is mute on how the Bacho Kiro specimen compares with coeval remains.

modern humans even if nothing is known about their crania, mandibles, or dentitions provided that, genetically, such remains are closer to extant humans (and, hence, to the African lineage that the latter are posited to mostly derive from) than to genomically sequenced, skeletally diagnostic Neandertals.

Apart from the readily apparent circularity — geneticists taking the genetic Neandertal-ness of a few individuals to be representative of Neandertals as a whole because palaeontologists deem the latter to be a separate species, and palaeontologists then taking the geneticists' conclusions as support for the morphology-based proposition that Neandertals are distinct at species level — there are several problems with this reasoning:

- Except for a few traits with a simple genetic basis, such as eye or skin colour, differences in the genome do not translate into differences in phenotypes, especially in the case of features as complex as skeletal morphology (Ackermann et al., 2019), which may well be largely underpinned by the levels of strength and endurance required to thrive in the environments of western Eurasia with a Middle Palaeolithic technology (Churchill, 1998).
- Only three high-quality genomic sequences exist for the Neandertals, all representing individuals living in Eurasia's periglacial steppe-tundra belt (two from the Siberian cave sites of Denisova and Chagyrskaya, the other from the Croatian cave site of Vindija; Mafessoni et al., 2020).
- Lower quality sequences and partial genomic or mtDNA data have been obtained for other individuals, but, with a few exceptions, they all come from the same general ecogeographical area, i.e., from places in or north of the mountain barrier represented by the Cantabro-Pyrenean chain, the Alps, the Carpathians, and the Caucasus (Reilly et al., 2022).
- We have virtually no evidence concerning the DNA of the populations living across most of the Neandertal range, in those circum-Mediterranean areas where, given latitudinal constraints to ecosystem productivity and carrying capacity, human population numbers must have been significantly higher (during some climatic phases, up to two orders of magnitude higher; Tallavaara et al., 2015).

- The mtDNA of two Middle Pleistocene individuals, from Sima de los Huesos (Spain) and Hohlenstein-Stadel (Germany), differs from the mtDNA of Upper Pleistocene European Neandertals, indicating that the latter is of African origin, reflecting ancient gene flow from an early lineage related to modern humans (Posth et al., 2017).
- The Y-chromosomes of late Neandertals from Spy, Mezmaiskaya, and El Sidrón (Spain) are also of African origin, and, as with the Middle Pleistocene mtDNA data, reflect gene flow taking place between 100,000 and 370,000 years ago (Petr et al., 2020).
- Based on whole-genome sequence data from 2000 modern humans and the three Neandertals for which we have comparable, high-quality evidence, gene flow between Africans and Eurasians was recurrent and of significant magnitude all through the late Middle and early Upper Pleistocene (as much as 5–10 % ~200–250 ka ago; Li et al., 2024).

Geographical logic dictates that the "early lineage related to modern humans" from whom Upper Pleistocene Eurasian Neandertals got their mtDNA, Y-chromosomes (and, alongside, the other parts of their genomes that are estimated to represent African ancestry) is to be found >100,000 years ago in adjacent areas, namely the Levant and North Africa. Under the notion that a one-to-one correspondence exists between genetic and anatomical modernity, the fossils from this area and time range would therefore have to be deemed Modern, and it is as *Homo sapiens* in the strict ROA sense of the concept that much recent literature does refer to the late Middle and early Upper Pleistocene peoples of the Maghreb. To strongly drive the message home, it has even been suggested that the Aterian and Mousterian industries of the region be redefined as manifestations of the sub-Saharan Middle Stone Age rather than as, per tradition, akin to the Eurasian Middle Palaeolithic (Dibble et al., 2013). Yet, skeletally, the Maghreb fossils, which, so far, have yielded no aDNA, are anything but "modern."

With regard to the mandible, for instance, a major derived and uniquely modern human condition is the presence of a clear trigonum mentale, i.e., a "chin" of *mentum osseum* rank at least 4 or 5 (Dobson and Trinkaus, 2002). Yet, all the late Middle and early Upper Pleistocene mandibles from the Maghreb, going back to the Jebel Irhoud people of ~300,000 years ago, lack that feature (Bergmann et al., 2022; Hublin et al., 2017; Richter et al., 2017). A particularly large and robust individual, Dar-El-Soltan II 5, is more similar in mandibular shape to the Neandertals than to the Iberomaurusians of the regional Late Pleistocene that it is supposed to be ancestral to (Bergmann et al., 2022) (Fig. 12). The same happens in the Levant, where the relevant fossil is the Tabun C2 mandible, dated to the very end of the Middle Pleistocene and considered Modern by some and Neandertal by others; its affinities were thoroughly assessed by Stefan and Trinkaus (1998), who concluded that, despite aspects of the mandibular symphysis approaching the condition seen among the Qafzeh/Skhul people, most other discrete traits of the corpus and ramus as well as the proportions of the dentition align it with the Near Eastern Neandertals, otherwise represented in the same stratigraphic unit by the Tabun C1 partial skeleton and the Tabun C3 femur.

We could elaborate with respect to other parts of the skeleton, but as the mandible plays such a key role in differentiating Neandertals from Moderns, the above ought to represent sufficient support for the following conclusion: skeletally, the African source of the "modern" genes found in Europe's Upper Pleistocene Neandertals does not fit the "anatomically modern human" definition. That must be why Hublin et al. (2017) derive their "*Homo sapiens*" classification of the Maghreb fossils from the latter's (inferred) ancestor condition, not from their (actual) anatomy. Following that logic, however, we would have to say that Europe's Upper Pleistocene Neandertals are *Homo sapiens* too, given the African origins of their mtDNA and their Y-chromosome. More to the point, despite gene flow from Africa having resulted in the replacement of both uniparentally transmitted genetic markers, the anatomy of the Neandertals or pre-Neandertals of the late Middle Pleistocene did not as a result change from archaic to modern. Under Hublin's (1998)

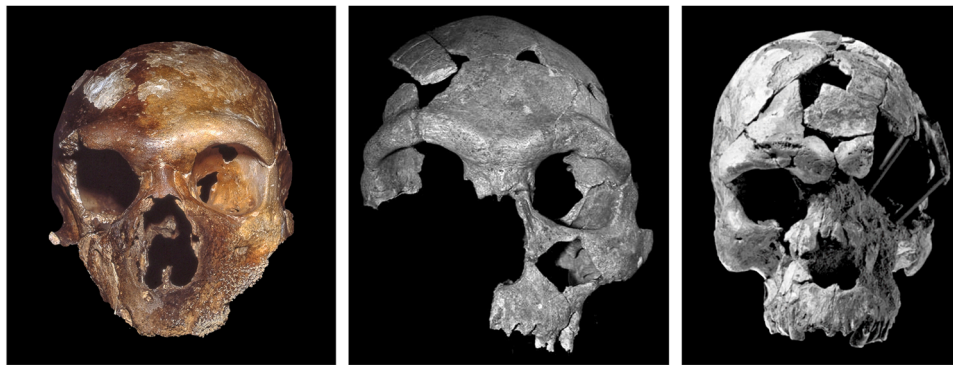


Fig. 12. Which is the odd one out? Late Middle and Early Upper Pleistocene crania from Europe, North Africa, and East Africa that have been taxonomically assigned to *Homo sapiens* and *Homo neanderthalensis*. Left to right: Guattari, Italy (courtesy Erik Trinkaus); Dar-Es-Soltan II 5, Morocco (after Harvati and Hublin, 2012); and Herto 1, Ethiopia (after White et al., 2003).

accretion model, it is the opposite that is supposed to have happened, i. e., despite this genetic turnover Eurasians would have continued to evolve in the direction of becoming even more Neandertal-like than before!

This evidence should suffice to put to rest the notion that genetic “modernity” necessarily implies skeletal “modernity.” A corollary is that the people of the Bachokirian, even though genetically “modern,” could have been anatomically “non-modern” — i. e., in that part of the world, Neandertal. Bear in mind that, given geographical proximity, the south-eastern Balkans must have experienced gene flow to and from the Levant and north-east Africa in a more frequent and more intensive manner than was the case with any other region of Europe. Thus, the Bachokirians could well have been skeletally Neandertal people who, genetically, were closer to Africans than to the Neandertals whose genomes we know well (those living at the extreme northern edge of Humankind’s range). Until such a time when the Bachokirian yields diagnostic parts of the human skeleton, we will not know for sure. Our prediction is that such remains will turn out to reveal a mosaic anatomy that is neither fully Neandertal nor fully Modern — like Oase 1, Oase 2, and Nazlet Khater, but perhaps with an even more significant retention of Neandertal, or generically archaic skeletal traits.

Likewise, can we exclude that the Ranis remains assigned to modern humans on the basis of their mtDNA could simply be of Neandertals whose genealogy included a Modern maternal ancestor? Pederzani et al. (2024) and Smith et al. (2024) have argued that the Ranis evidence stands for reoccupation of the steppe-tundra belt extending along the southern edge of the Fennoscandinavian ice sheet after a period of abandonment due to the prevalence of environmental conditions unsuitable for humans. If so, the protagonists of the process could well have been (a) in Germany and Poland, Neandertals coming in from regions to the south and east that, around 45–50 ka ago, had become genetically closer to neighbouring Near Eastern and North African populations, and (b) in northern France, Belgium and England, Neandertals coming in from south-west Europe, which was permanently settled throughout and featured hundreds of millennia of population continuity. In short: a pattern replicating, 30,000 years earlier, the mechanism via which the northern European plain was repopulated at the end of the Ice Age. Such a pattern might well explain why, at the time of the Ranisian, genetically distinct people sharing a common material culture and a common Neandertal gestalt could be found at opposite ends of the technocomplex’s range.

These considerations emphasise the importance of accounting for the large geographical and temporal gaps in the evidence we have at our disposal. A distinct possibility is that, once such gaps are filled, we will realise that “Neandertal” and “Modern” work as extreme poles of the morphological variation extant within and between regional populations of *Homo sapiens* (Fig. 12). That is what Wolpoff (1999) proposed for the early Upper Pleistocene peoples of the Mediterranean basin,

Arensburg and Belfer-Cohen (1998) have suggested for the interpretation of the Middle Palaeolithic human fossil record of the Levant, and the comparative analysis of the bony labyrinth across these fossil samples further supports (Coutinho-Nogueira et al., 2021).

Moreover, in western Europe itself, the recent study of a mandible from the Catalanian site of Banyoles poses a significant challenge to the coherence of the package of skeletal traits traditionally used to define the Neandertal gestalt (Harvati et al., 2024; Keeling et al., 2023). The fossil’s exact age is uncertain, but its dating excludes a Middle Pleistocene chronology and makes it older than 45–50 ka ago (the age of the encasing travertine), thereby placing it squarely in the time frame of western Europe’s “classic” Neandertals. Accordingly, the fossil’s *mentum osseum* is of rank 1, the most common in the Middle Pleistocene of Europe and present in 28 % of the 18 Neandertals scored by Dobson and Trinkaus (2002). In most other discrete traits of the mandible, however, the fossil is closer to recent humans than to the Neandertals and their Middle Pleistocene predecessors. To compare the three-dimensional geometric morphometric rendition of overall mandibular shape among recent human, Upper Palaeolithic, Neandertal, Near Eastern “early modern,” and Middle Pleistocene Europeans, Keeling et al. carried out a PCA analysis. If, in the comparison, we define Banyoles as Neandertal — as we should, based on *mentum osseum* rank, chronology, and region of provenience — the resulting pattern is one whereby Neandertals overlap with all the other groups in mandibular morphology, further undermining the “species” framework under which ROA, Acculturation, and many genomics experts continue to interpret recent human evolution (Fig. 13).

4.3. When discussing admixture and its evolutionary significance

The statistics underpinning genetic models of Upper Pleistocene population dynamics treat the “Neandertal genes” in fossil and present humans as a result of introgression, i. e., the exchange of genes in episodic manner and involving a minimal percentage of the donor genome. Yet, (a) the preceding examples illustrate how the more we know about the variability of early Upper Pleistocene populations of the Mediterranean Basin the more difficult it becomes to reduce them to a clear-cut Neandertal/Modern dichotomy, and (b) the ancient DNA evidence illustrates Middle or early Upper Pleistocene gene flow between Africa and Europe through the time range during which, under ROA, isolation is supposed to have driven the cladogenetic separation of the two putative species. We can see how downgrading the flow to a trickle may be required to keep the integrity of the ROA edifice, but doing so impacts the logical consistency of model outcomes. A case in point is the recent report on Koněprusy-Zlatý kůň 1, a Czech modern human cranium hydroxyproline-dated to $29,650 \pm 650$ BP (OxA-38022), i. e., to 32.2–35.3 ka cal BP (Prüfer et al., 2021).

To assess the significance of the fossil’s genomic data for Neandertal

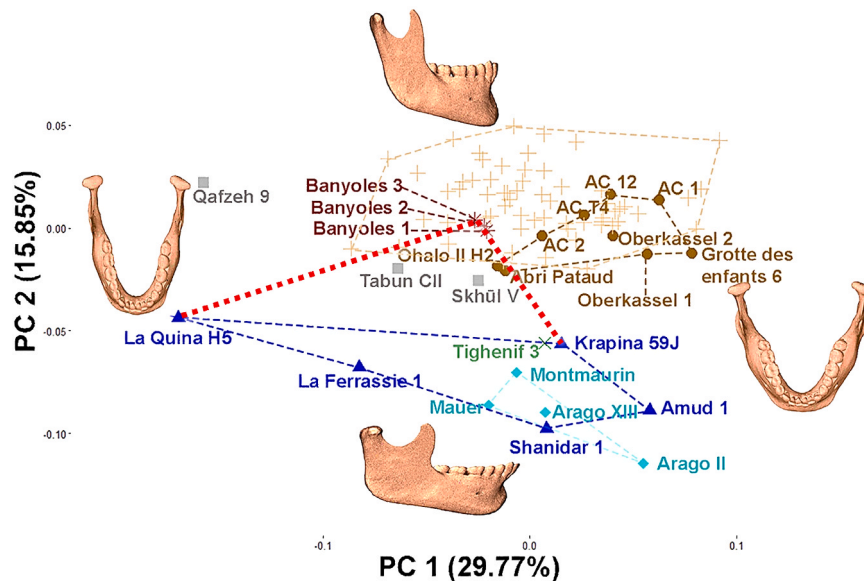


Fig. 13. The Banyoles mandible. The three reconstructions of the fossil shown in a plot of the first two principal components of a PCA of Procrustes landmarks (after Keeling et al., 2023, modified). If classified as Neandertal based on chronology, geographic provenience, and most morphological characteristics, the fossil would materialise the overlap in shape between the mandibles of all Upper Pleistocene people, including Neandertals, and recent humans (represented by the plus signs): in the features of shape captured by the analysis, variation decreases with time and samples tend to cluster as a function of geography and age.

ancestry and relatedness to later Eurasian populations, the Koněprusy-Zlatý kůn study assumes that “most of the Neandertal ancestry in present-day and ancient humans probably originates from a common admixture event with a group of Neandertals who were more closely related to European Neandertals than to a Neandertal from the Altai Mountains.” Based on the notion that the Neandertal genes found in present-day Europeans reflect such a single event, it is concluded that the fossil must be coeval with the Ust'-Ishim femur from western Siberia, which dates to ~45 ka ago and is said to be genetically and anatomically modern. The study also considers the possibility of a second admixture event, in which case the genomic modelling would make Koněprusy-Zlatý kůn 1 several millennia older than Ust'-Ishim. In their admixture graph, Prüfer et al. eventually settle for “a single gene flow event from Neandertals into the ancestor of all tested modern humans” and go on to discuss the significance of their fossil under this premise and as if its true age were at least ten millennia older than indicated by the direct dating work.

This *modus operandi* overlooks that such “introgression” events must have been numerous, as implied by evidence that Prüfer et al. do not question — e.g., the mtDNA and Y-chromosome of African origin seen among Europe's Upper Pleistocene Neandertals, or the interbreeding revealed by the Bacho Kiro and Oase fossils. In addition, the chronological basis of the admixture graph is inconsistent with the dating evidence itself. The Koněprusy-Zlatý kůn study blames “unremoved contamination” as an explanation for the discrepancy between the radiocarbon and genetic ages, but the laws of radioactive decay strongly object to that explanation. The study's hypothesis is that the hydroxyproline result is artificially young “due to the presence of trace exogenous contaminants derived from animal glue;” yet, for the posited underestimation of ten millennia or more to have been caused by unremoved modern carbon, the contaminant's percentage of the dated material would have to be >2 %, which hardly qualifies as “trace.”

Scerri et al.'s (2018) study of recent human evolution in Africa is another example of the logical issues raised by the paradigmatic understanding of Neandertals and Moderns as separate species (and see also Scerri and Will, 2023). Scerri et al. reject that the emergence of anatomical and behavioural modernity could have been the steamroller expansion of an originally small, geographically restricted speciated population, or the by-product of processes occurring within a single,

continent-wide panmictic population. The best fit for the data would instead be a story of interaction between “strongly subdivided (i.e., structured) populations, probably living across Africa, that were connected by sporadic gene flow,” forming “a set of interlinked groups whose connectivity changed through time” and that were “often semi-isolated for millennia by distance and/or ecological barriers.” Self-defined as “African multi-regionalism,” Scerri et al.'s (2018) model also contemplates the possibility of “hybridization between *H. sapiens* and more divergent hominins living in different regions.” With nuances, Meneganzin et al. (2022) have endorsed a similar view of the process (Fig. 14).

The geographical or ecological barriers that, in the world of Pleistocene hunter-gatherers, could conceivably have hampered biological and cultural interaction were e.g., large bodies of water, extensive deserts, impenetrable forests, or glaciated mountains. Such barriers, however, do not coincide with the boundaries of the continents as they are currently defined, and it should not be necessary to point out that in no way could the latter have been known to the people of the Palaeolithic and in some way operationalised by them for the purposes of inter-ethnic or reproductive exchanges. To take an example, for the people of northern Africa and the Lower Nile, isolation from the adjacent Levant, the Arabian Peninsula, and western Asia could not have been greater than with sub-Saharan Africa, which lies across a large desert belt that, through the Pleistocene, must have represented the most significant barrier to population interaction (Fig. 14). That such was indeed not the case is corroborated by the cultural traits shared across both shores of the Mediterranean basin (e.g., the basic similarity in stone tool technology seen through the Middle Palaeolithic) and the empirical finding that a signal of ancient admixture with the Neandertals can be detected in the genomes of extant northern African populations (Sánchez-Quinto et al., 2012).

Using a present-day thought category — “Africa” — to frame the process of recent human evolution, restricting it to have taken place within boundaries defined by modern-day geographers that are of no relevance for assessing the period's population dynamics, is, therefore, incongruous. But what if we also endow the Neandertals with population structure, as suggested by the differences between the Vindija and Denisova Neandertals and further supported by the recently published low-coverage genome of an individual from Grotte Mandrin nicknamed

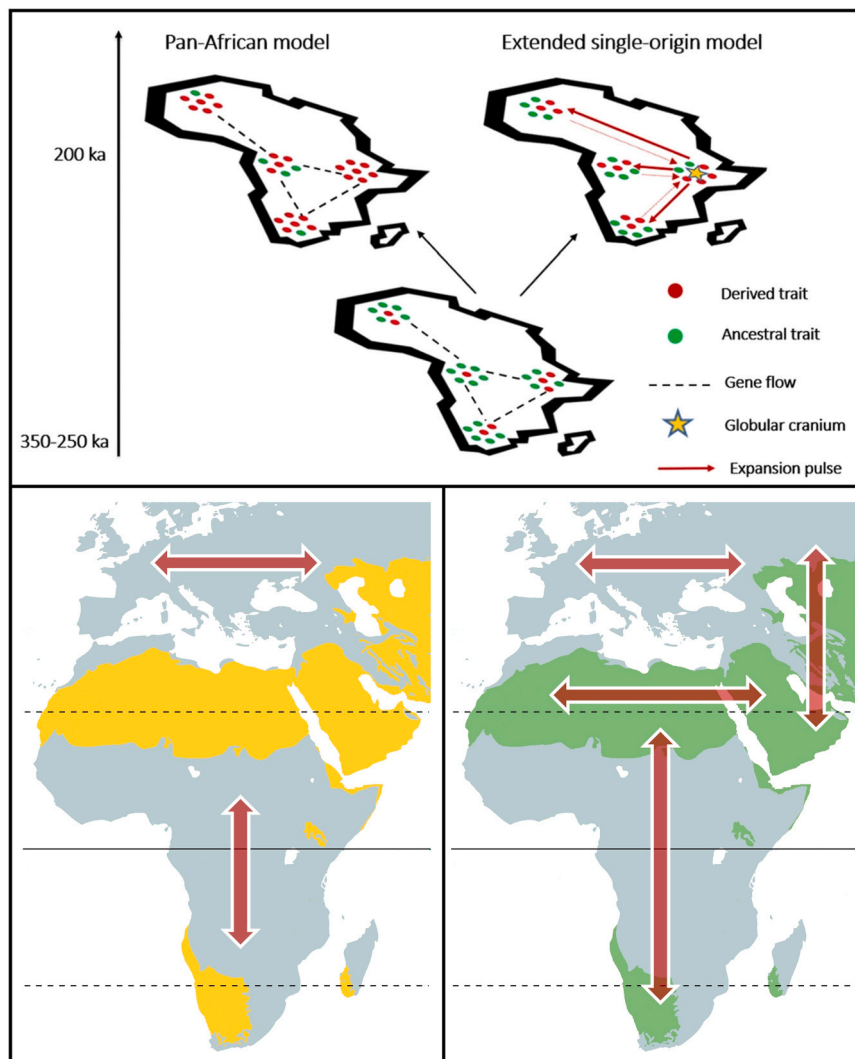


Fig. 14. Patterns of gene flow in modern human origins debates. Top: the two variants of ROA — pan-African (left) and extended (right) — considered by Meneganzin et al. (2022). Bottom: a model of intermittency in Middle and Upper Pleistocene inter-continental gene flow driven by the glacial/interglacial and stadial/interstadial rhythms of disappearance (left) and reappearance (right) of “Green Sahara” situations across the desert belt separating sub-Saharan Africa from western Eurasia.

“Thorin” (Prüfer et al., 2017, Slimak et al., 2024)? The answer is: liberating the mechanism of interaction between structured populations from artificial cartographic shackles, extending its domain of operation to the Old World as a whole, we end up with a spatially and temporally uneven process eventually unifying populations that, previously, due to isolation by distance, had developed along largely separate trajectories of inheritance (thereby building up the skeletal and genetic idiosyncrasies that allow us, whenever sufficiently separated by time or space, to sort them into discrete phenotypes). Put another way, we end up viewing the process under the lens of Assimilation and understanding why (a) an estimated 45 % of the specifically “Neandertal” part of Neandertal genomes remains extant, and (b) after >40,000 years, the percentage of “Neandertal” or “Denisovan” genes in, respectively, each present-day European or Papua New Guinean individual, can be as high as 4 % (Jacobs et al., 2019a; Prüfer et al., 2017; Reilly et al., 2022; Vespasiani et al., 2022). Under Assimilation and “divergence with gene flow,” such persistence patterns are to be expected (Ackermann et al., 2019): a special explanation — i.e., rare, if not unique introgression events — is necessary to account for them only if gene flow and admixture are treated as exceptional and anomalous.

5. The contradictions between model and evidence

In the preceding sections, we have discussed how submission to a Neandertal/Modern dichotomic framework inspires views of the Transition that, to remain within ROA and Acculturation, are driven to logical inconsistency and the fallacy of reification: rather than the actual individuals and the actual territories that individuals lived in, and across which culture and genes were exchanged, it is the categories of modern science, whether of palaeontological taxonomy or geographic description, that are taken to be the real thing. Likewise, the power that the ROA/Acculturation paradigm continues to hold over academia often conditions the interpretation of the empirical properties of the archaeological record, leading to representations of the data that we find to be at odds with the facts. Nowhere is this more apparent than in the narratives that the current trend to use the IUP as a proxy for Moderns-On-The-Move has given rise to, as we will endeavour to illustrate in the following.

Our case studies are the key sites in central Asia, the Levant, and southern and western Europe of relevance to assess the issues of primary concern: the validity, or lack thereof, of the IUP category; the putative relation of this entity with Moderns; and the chronology of the Transition with respect to its two components, namely, the emergence of the

Upper Palaeolithic and the rhythms of the Assimilation process. We will not address the evidence from Crimea and the Russian plains, which has been the object of recent reviews whose conclusions we agree with (Dinnis et al., 2021; Dinnis et al., 2019), and we will avoid the question of what it means to be a Denisovan, which is not directly relevant here. Likewise, we leave out the issue of whether the IUP has reached northern China, which is the matter of ongoing controversy (Carmignani et al., 2024; Yang et al., 2024a, 2024b) and is further complicated by the fact that what it means to be “anatomically modern” in East Asia is an unresolved issue (claims to such a status exist for fossils that date as far back as ~80 ka ago, and mosaic anatomies, including features that are fully modern, can be found in the crania of fossils as old as ~300 ka, such as the Hualongdong 6 skull; Dennell et al., 2020; Wu et al., 2021, 2023).

5.1. The antiquity of Moderns in Europe

The notion that modern humans, or their immediate ancestors, were in Europe during the late Middle Pleistocene and the earlier Upper Pleistocene goes back to the so-called Praesapiens Hypothesis (Trinkaus and Shipman, 1994; Vallois, 1954). Over the last decade, the notion has enjoyed renewed popularity. With regard to the Middle Pleistocene, the case rests upon the fossils from the cave site of Apidima, in Greece. However, their taxonomic assignment to either *Homo sapiens* (Harvati et al., 2019) or late *Homo erectus* with Neandertal traits (de Lumley et al., 2020) remains controversial, illustrating how such assignments are influenced by assumptions stemming from different models of how human evolution proceeded in Europe.

With regard to the Transition specifically, the renaissance of the Praesapiens Hypothesis was triggered by the demonstration that personal ornaments and cave art predate the Aurignacian by many millennia. Implicitly or explicitly, such instances of behavioural modernity have often been taken to implicate makers who, anatomically, were modern too, as putatively substantiated by the maxillary fragment from Kent's Cavern (England) and two deciduous teeth from Grotta del Cavallo (Italy) (Benazzi et al., 2011; Higham et al., 2011). The isolated teeth from Grotte Mandrin (France) and Roccia San Sebastiano (Italy) are recent additions to the list (Oxilia et al., 2022; Slimak et al., 2022).

The Kent's Cavern fossil has been directly dated — to $30,900 \pm 900$ BP (OxA-1621), a non-ultrafiltrated collagen result that Higham et al. (2011) dismiss as too young — but the teeth from Cavallo, Roccia San Sebastiano, and Mandrin have not. Thus, regardless of the issues discussed above concerning the taxonomic assignment of fragmentary remains, the key point here is that these fossils' putative pre-Aurignacian age relies entirely on their dubious association with either the dated samples or the material culture found in the same strata.

In the case of Kent's Cavern, White and Pettitt (2012) and Zilhão (2013) have shown that the age assignment is based on mistaking absolute depth for true age within a deposit that underwent significant post-depositional disturbance. A decade later, the claim that the fossil stands for a modern human presence in the British Isles at some point during the 41.5–44.2 ka interval has all but disappeared from the literature (but see Mylopotamitaki et al., 2024). With regard to the others, however, it remains widely accepted that the teeth are of Moderns, were retrieved *in situ*, and can reliably be taken as a proxy for the Moderns' pioneering, pre-Aurignacian and IUP-related settlement of Europe. Let us, therefore, take a closer look.

5.1.1. Grotte Mandrin

Grotte Mandrin is a site in the Rhône valley of France whose layer E, Bayesian-modelled to date to 51.7–56.8 ka ago, yielded a fragmentary upper right deciduous second molar (Man12 E 1300) upon which Slimak et al. (2022) hang the argument that the associated stone tool assemblage was made by Moderns. The specimen's published photos are of postage stamp size, hindering a proper assessment of its condition, but the description provided — “only small patches of enamel remain on the

crown and the dentine is smoothed, the dentine horns and crests being lowered and rounded, likely due to taphonomic alterations” — strongly suggests that it underwent weathering caused by geological (transport) or biological (digestion) agents.

Given its state of preservation, the caveats discussed above for the Bombrini specimen apply even more forcefully to the determination of the Mandrin tooth. Moreover, the latter's taxonomic assignment relies on an analysis of the EDJ, but most of the enamel is lacking, and the exposed dentine is eroded. Slimak et al.'s modelling of the fragment's original state assumes that the anatomical particulars of the dentitions of Neandertals and Moderns, including the EDJ, can be reduced to species-specific “templates,” which, as illustrated by the Oase fossils and the Lagar Velho child, is unwarranted. In these circumstances, there is simply no way that the “modernity” diagnosis can be considered conclusive, and, really, that is all one should need to say about the Mandrin layer E specimen. For the sake of completeness, however, one must also ask: Given the known instances of modern human remains found in Middle Palaeolithic deposits that, like the Staroselje child (Marks et al., 1997), turned out to be intrusive and date to the Holocene (including some, like the Riparo Mezzena material, that, initially, had been diagnosed as Neandertal; Talamo et al., 2016), is the tooth, even if truly Modern, an *in situ* find to begin with?

Slimak et al. fail to entertain, let alone discuss the possibility that the tooth could be intrusive, which is all the more remarkable because the site's original notoriety derived from the Bronze Age necropolis therein discovered in the 1960s (Giraud et al., 1998). Furthermore, when making extraordinary claims, solid evidence is required, and the data must be made available to the larger scientific community. This is not the case for Mandrin. Other than stratigraphic unit of assignment, Slimak et al. provide no exact provenience data for the find (e.g., grid unit, elevation, year of discovery), and they do not even let us know whether the tooth was retrieved during excavation, profile straightening, or sediment sieving. All we are given is positioning against a low-resolution stratigraphic profile that represents a span of 15 m along the sagittal axis of the site and an even lower-resolution plan lacking the designation of grid units. Moreover, in lieu of a proper description and adequate photographic documentation of the specimen's immediate context, we are given a scatterplot showing it at broadly the same elevation as the finds assigned to layer E in adjacent grid units, which tells us nothing about the findspot's stratigraphic integrity (or lack thereof). Based on comparison of this information with the partial plan provided by Slimak (2004: Pl. 152), we can nonetheless surmise that the fossil would seem to have been retrieved in the north-west corner of the external area of the site, ~6 m away from the dripline, in or close to the west wall of the excavation trench, at a depth of ~80 cm below ground surface. Slimak et al. (2022) omit, but Allentoft et al. (2024b) reveal, that, in 2014–2015, this external area yielded human skeletal remains directly dated by radiocarbon to the Copper and the Bronze Ages. Could the layer E tooth fragment derive, via post-depositional disturbance, from that Holocene necropolis? In our view, the possibility cannot be excluded.

Despite the find's potential intrusiveness and fragmentary, weathered condition, Slimak et al. (2022) venture that it documents an incursion of Near Eastern Moderns that, given the diagnostic Neandertal teeth and typically Mousterian stone tool assemblages retrieved both above and below, would have been extremely brief. However, numerous sites to the east, namely Fumane, in Italy, Vindija, in Croatia, or Kůlna, in the Czech Republic, show that, (a) prior to 50 ka ago, southern and eastern Europe were exclusively inhabited by Mousterian or Micoquian Neandertals, and (b) no micro-Levallois points of Mandrin layer E type have ever been found in those regions, even though they are easy to recognize and, thus, impossible to miss, even among the finds from old excavations (Benazzi et al., 2014; Deviese et al., 2017; Neruda and Nerudová, 2014; Peresani, 2012; Peresani et al., 2016). So, by what route and means would such Modern travellers have made their way into the Rhône valley? And how did such travellers manage to leave behind no breadcrumbs that might inform us on the path taken?

Given the unlikelihood of Slimak et al.'s narrative, one must consider alternatives, namely that the Mandrin tooth reflects travelling indeed, but perhaps of a different scope and much shorter length, i.e., an isolated fossil's downward migration of a few centimetres, from an overlying, more recent unit, rather than a whole population's westward migration

of several thousand kilometres, from the distant Levant. Since collagen preservation is good, as shown by the successful radiocarbon dating of bone samples from the site to as much as $47,000 \pm 2700$ BP (OxA-21698), rejecting the hypothesis that Man12 E 1300 is intrusive by submitting it to the dating test is entirely feasible. This is the more so

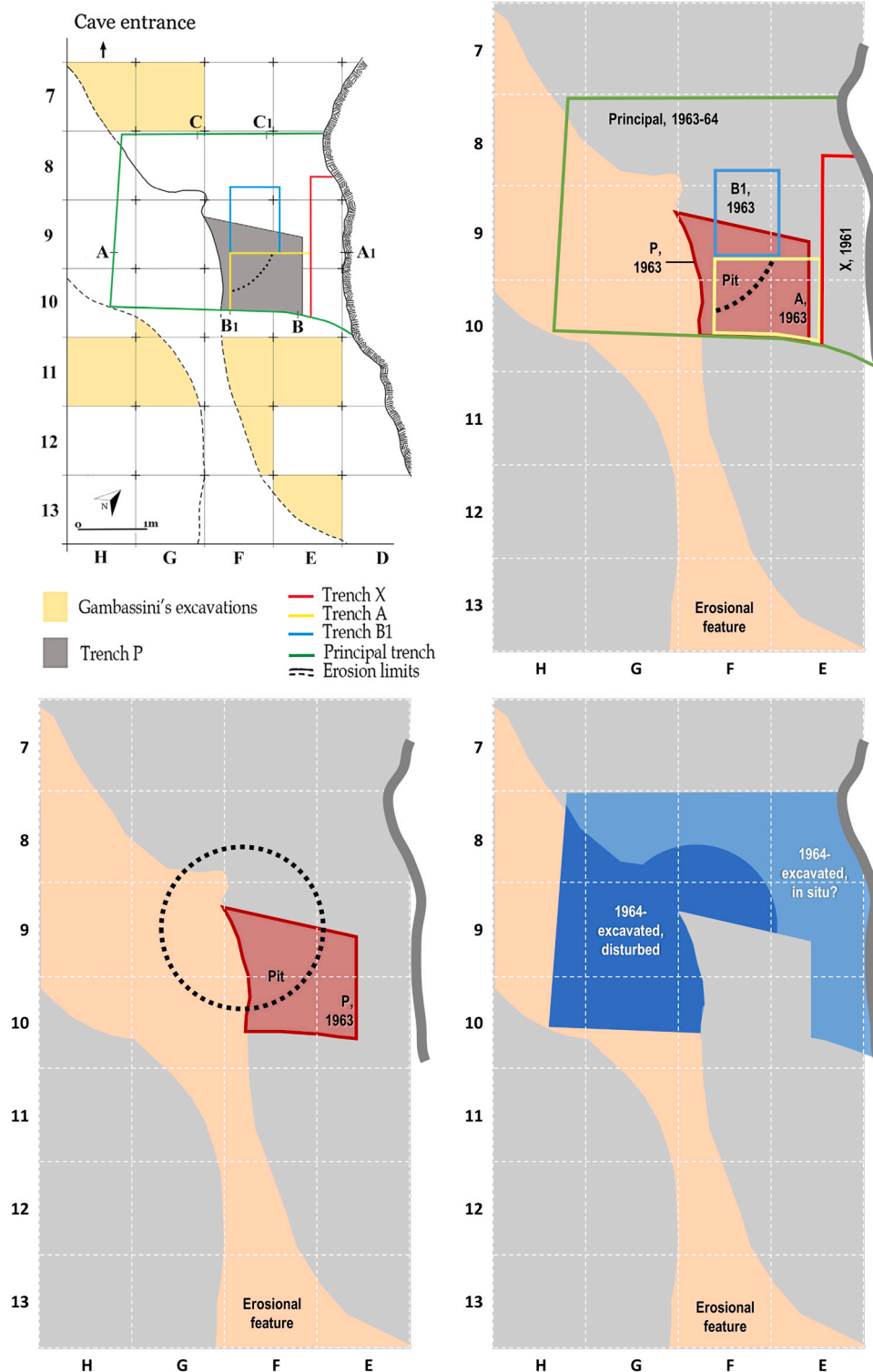


Fig. 15. Grotta del Cavallo: Palma di Cesnola's 1960s excavations in plane view. Top: Moroni et al.'s (2018) rendering of the progress of the 1963–64 work (left), and the same simplified for easier reading (right). Bottom left: Moroni et al.'s plan with only the P trench of 1963 and the complete outline, modelled as a circle, of the "pit" disturbance reaching the top of the Mousterian that, according to them, was identified that year. Bottom right: area that, based on Moroni et al., was brought down to the base of the Uluzzian in 1964. Per Moroni et al.'s own account, about half of the area excavated in 1964, when the Cavallo-B and -C teeth were found, corresponds to a deposit disturbed by the pit or by the erosional channel subsequently delimited by Gambassini's 1970s–1980s work.

since Fewlass et al. (2017) have demonstrated that collagen samples smaller than 0.2 mg can now be used to that effect. Surely, sacrificing such a small amount of dentine would be acceptable, given that the much more destructive sampling of the specimen for aDNA analysis was contemplated (per Parker et al. 2021, a mass of at least 50 mg would have been required; eventually, a pilot study of horse teeth revealed that, at Mandrin, the preservation of genetic material is poor and that is why no sampling of layer E's human tooth for aDNA was carried out).

The demonstration that Man12 E 1300 is not intrusive lies in the hands of the Mandrin team. It is only if such a demonstration is made that issues of taxonomy, if at all allowed by the fossil's state of preservation, become worthy of discussion. Until then, the tooth must be considered as of no relevance for the study of recent human evolution, much less as evidence that a group of Levantine Moderns went on an excursion to the Rhône valley some 54,000 years ago. Meanwhile, one must take due note that the spatial scattering of the fragments assigned to the "Thorin" Neandertal individual show that post-depositional displacement did occur at Mandrin, as might be expected given the deposit's texture and as the contradiction between the stratigraphic provenience of the remains and their direct dating otherwise corroborates — while Thorin "unambiguously belongs to the Level B2" (Fuchs et al., 2024), which Bayesian modelling constrains to the 42.3–45.1 ka ago interval (Sliimak et al., 2022), the direct, hydroxyproline results for three of his bones are all infinite, i.e., >50 ka ages (Sliimak et al., 2024).

5.1.2. Grotta del Cavallo

The Cavallo evidence consists of two deciduous teeth (Cavallo-B and -C) found during Palma di Cesnola's 1960s excavation of the site and in apparent association with stone tools typical of the Uluzzian (Palma di Cesnola, 1963, 1964, 1965, 1966; Palma di Cesnola and Messeri, 1967). As argued by Zilhão et al. (2015b), it is likely that both teeth come from the 1964 field season and the basal subdivision (unit E-III) of the Uluzzian sequence, composed of two layers, D and E. Based on a revision of the literature and the stone tool assemblages, Zilhão et al. also demonstrated the following:

- Layer D was mostly laid down in Protoaurignacian times but incorporates a mix of inherited or intrusive items of Uluzzian, Early Aurignacian, and Epigravettian age.
- The mix of diagnostics found among Palma di Cesnola's layer D assemblage accords well with Benazzi et al.' (2011) dating to the range of the Protoaurignacian (three), the Aurignacian I (one), or the Epigravettian (another), of five shell beads from layer D of Gambassini's 1979–1986 excavations (i.e., from areas of the cave with a presumably intact stratigraphy; cf. Fig. 15).
- Dufour bladelets, consistent with the Protoaurignacian but not with the Uluzzian, were found through the entire thickness of layer E, and, in the E-III spit that the Cavallo-B and -C teeth come from, they correspond to one-third of the 15 microliths classified by Palma di Cesnola (the 34 and 60 backed microliths mentioned by Moroni et al. 2018 for E-III and E-I/II, respectively, are for the combined total from Palma di Cesnola's and Gambassini's collections).
- Overall, the site's dating evidence is entirely consistent with the notion that the Uluzzian is coeval with the Châtelperronian and intermediate between the Mousterian and the Protoaurignacian.

Moreover, as Palma di Cesnola acknowledged, a massive disturbance feature, the so-called "pit," cut the Pleistocene deposit in the central part of the cave sampled by his trench, from the top, rich in finds of the Romanellian (a Tardiglacial industry), all the way down to the upper part of Mousterian layer F, >2.5 m below the surface. Based on this evidence, Zilhão et al. further argued that, whether of Neandertals or Moderns, the Cavallo teeth could be reliably associated with neither of the technocomplexes represented in layers D–E and ought to be left out of "whodunnit" debates.

Despite corroborating Zilhão et al.'s reconstruction of how the

excavation progressed through the years, 1963–1966, during which Palma di Cesnola excavated the Ulluzian deposit, Moroni et al. (2018) have since reasserted that the Cavallo fossils are *in situ* finds. Based on unpublished field notes, they argue that (a) the "pit" was recognised early on, from the fifth day of the 1963 excavation, and (b) as a result, and thus from the very beginning too, the disturbed areas were excavated separately from those judged to be intact. Based on this information, Moroni et al. further contend that the homogeneity of the Uluzzian assemblages is beyond question, the more so in the case of the finds from 1964, when the excavation targeted areas located towards the entrance, away from the area most affected by the pit disturbance, which would have been the SW corner of trench A of 1963. Specifically, Moroni et al. claim that the teeth come from squares E8, E9, F8, F9, or G8 of the grid set up in 1978–1980. This statement, however, would seem to represent inference rather than fact, as no supporting evidence is provided and other parts of layers D and E, namely along the cave wall, were explored in 1964 too.

Be that as it may, Moroni et al.'s own account of the progress of Palma di Cesnola's excavations leaves no doubt that the disturbances extended to those parts of the 1964 trench where they place the recovery of the E-III human teeth (Fig. 15). Their schematic rendering of the stratigraphy across Palma di Cesnola's trench, from the north-east cave wall to the south-west trench wall, coupled with their planimetric outline of the pit's boundaries, is entirely consistent with this conclusion (Fig. 16).

Under the premise that the reworked infilling was excavated separately from the very beginning, it stands to reason that the excavator would only have retained for analysis and publication the finds from intact areas; yet it is precisely among the published lithics that Zilhão et al., following Gioia (1987, 1990), identified Protoaurignacian and Aurignacian material all the way down to the E-III spits in which the Cavallo-B and -C teeth were found. Thus, the information in Moroni et al.'s field notes is no challenge to Zilhão et al.'s argument that, given the heterogeneity of the Uluzzian-labelled assemblages, it cannot be ascertained that the two teeth relate to the makers of the Uluzzian as opposed to the makers of the Protoaurignacian, the Aurignacian I, or the Epigravettian.

Clearly, Palma di Cesnola was aware of the problems posed by post-depositional disturbance and did his best to deal with them. However, no precise, error-proof delimitation of disturbed areas would have been possible in the context of an operation that (a) was carried out under the light of acetylene lamps, (b) proceeded by horizontal spits of arbitrary thickness, and (c) in the 1964 season alone, managed to remove some 6 m³ of sediment over the three weeks that it lasted (from the 9th to the 31st of July, according to the field notes cited by Moroni et al.). Moreover, the only profile photography available makes it readily apparent that, as Palma di Cesnola explicitly acknowledged, a clear separation existed neither between layers D and E nor between subunits of layer E. This observation is the more significant because it is likely that the photo in Fig. 16 concerns the stratigraphy observed in the north-west wall of the trench that Fig. 1 of Palma di Cesnola's 1964 report represents schematically — in his own words, the area featuring the "most complete and most intact stratigraphic series," in which the stratification could best be read (elsewhere in the trench, he reported the sequence to be either less complete or less intact). The comparison between photo and drawing also makes it clear that the latter's black, basin-shaped symbols are idealised; they do not represent true hearths, let alone intact ones. In this regard, it is important to remark that Palma di Cesnola and Messeri's (1967) reference to Cavallo-B coming from a *foyer* in the basal Uluzzian must be read in the context of the meaning that, in the 1960s archaeological literature, that French word was intended to convey — "occupation horizon," not "intact hearth feature" (for an extended discussion, see Zilhão et al., 2015c).

Layers D and E were rich in faunal remains. No data are available for Palma di Cesnola's excavations, but Boscato and Crezzini (2012) were able to determine to species 204 bones from a single spit that P.

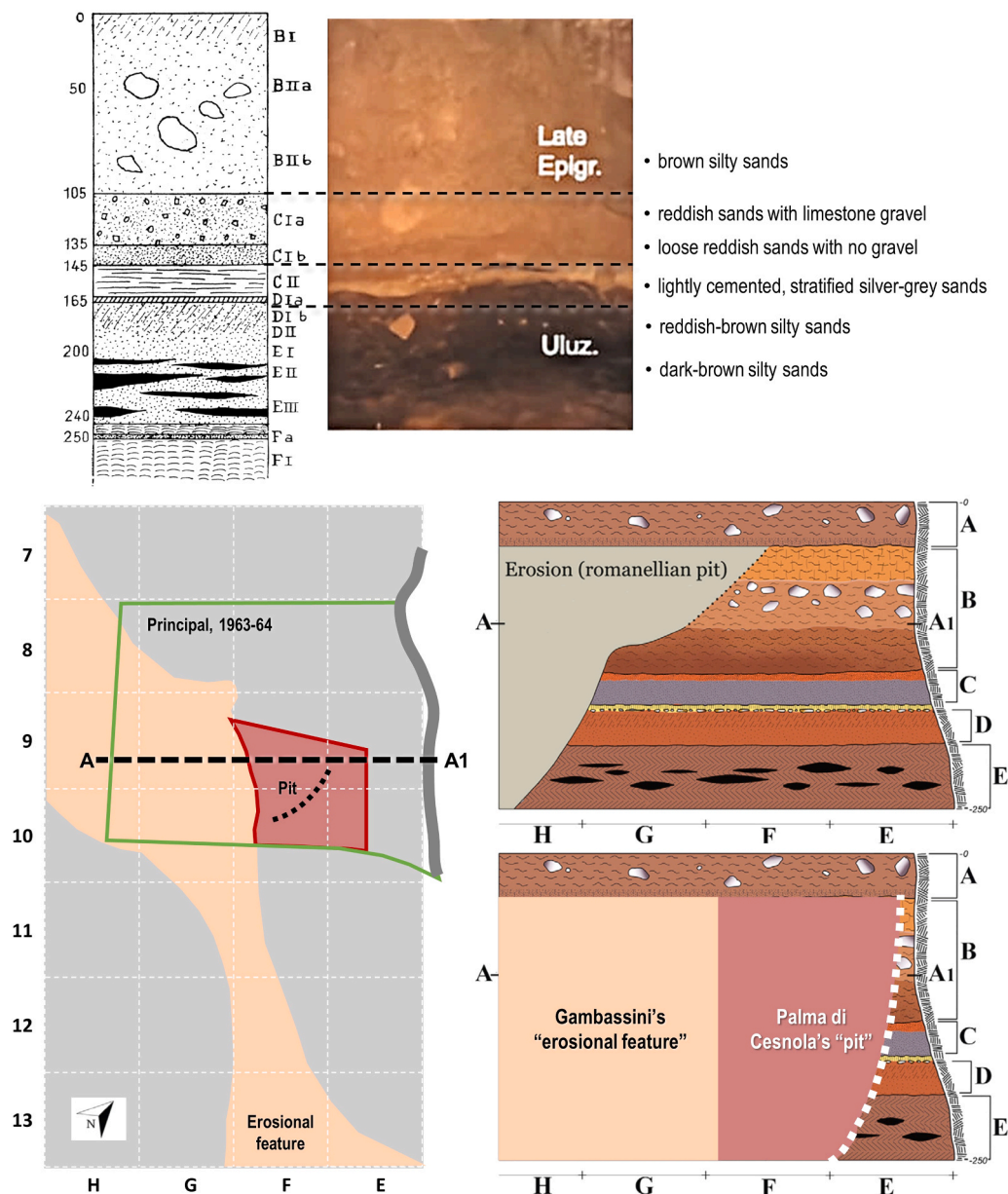


Fig. 16. Grotta del Cavallo: the stratigraphy of Palma di Cesnola's 1963-64 trench. Top: correlation between the stratigraphic scheme in Fig. 1 of Palma di Cesnola (1964) and the photo published by Benazzi et al. (2011). Bottom: Position of the A-A1 line along which Moroni et al. (2018) place their schematic rendering of the stratigraphy of the 1963-64 Principal Trench (left); their scheme (right, above) compared with the correct placing of the boundary between the reworked and *in situ* infillings (right, below) implied by their own planimetric rendering of the limits between the different trenches and Palma di Cesnola's reporting that the pit disturbance reached Mousterian layer F.

Gambassini excavated at the base of layer E, in 1986, over an area of ~1 m². Charcoal is also available: Palma di Cesnola (1969) reports on a conventional result (>31,000 BP; R-352), while Boscato and Crezzini (2012) inform that a project "is underway with the Oxford Radiocarbon Accelerator Unit using ABOx-SC techniques for dating." Thus, the homogeneity, or otherwise, of layer E of Palma di Cesnola's trench can easily be tested by dating samples of charcoal and animal bone retrieved alongside the two teeth. If all such samples return results consistent with the notion that Cavallo-B and -C must belong to the makers of the Uluzzian, the notion will become much harder to challenge. Conversely, if we were to obtain a diverse mix of ages comparable to that revealed by the dating of Gambassini's layer D ornamental shell samples, then the notion would be dead.

The test is entirely feasible, and one must wonder why Moroni et al.'s

team has so far not carried it out. The course so far taken instead has been that of dating samples from other parts of the Uluzzian deposit — those from Gambassini's work that Benazzi et al. (2011) reported on, and, more recently, those from a profile sampled in 2019 at the back end of the cave (Higham et al., 2024). From the observation that all samples from layer E of these areas yielded results consistent with the Uluzzian, the implication is derived that layer E must be devoid of intrusions across the intact areas of the site and, consequently, that Cavallo-B and -C are *in situ* finds indeed. It should go without saying that proving the stratigraphic integrity of layer E elsewhere in the cave in no way implies that the same is true of Palma di Cesnola's 1963-64 trench. Claiming otherwise is textbook fallacy.

Definitive clarification of these issues would come from the dating of bone or charcoal samples from the 1963-64 excavations themselves.

Hopefully, significant progress in that direction may nonetheless result from the forthcoming publication of a large series of radiocarbon dates for the site's Upper Palaeolithic sequence obtained in the context of work carried out in the entrance area of the site during the 1990s (Sarti and Martini, 2008; Martini, personal communication, July 4, 2024). This area lies adjacent to Palma di Cesnola's trench and, according to Moroni et al., remained largely unaffected by disturbance. We will see.

5.1.3. Roccia San Sebastiano

A recent addition to the corpus of putative Uluzzian fossils is RSS2, a deciduous lower molar retrieved at the top of the Cf stratigraphic unit of the Roccia San Sebastiano cave, in southern Italy (Oxilia et al., 2022). A radiocarbon age in the Uluzzian time range supports the fossil's cultural affinities. The dated sample comes from the t19 spit of grid unit F14, but the tooth comes from spit t16 of grid unit E16, which is ~2 m away and for which no dates are provided (if any have been obtained, as one would expect, they remain unpublished). Assignment to the Uluzzian is based on Collina et al.'s (2020) study of the Cf stone tools, which illustrates a mix of Uluzzian (e.g., lunates) and Aurignacian (e.g., a diverse range of retouched bladelets) material. Collina et al. further report that "twenty-two items were excluded from the study because they clearly pertained to an upper Gravettian level," and suggest that "this intrusive presence could be related to post-depositional processes." Based on the stratigraphy published by Aiello et al. (2018), such intrusive Gravettian items would have moved >1 m downward. Given the significant scale of such a post-depositional migration, we cannot exclude that RSS2 is as out of place as those Gravettian items, nor can we exclude that it relates to the Aurignacian rather than the Uluzzian component of the Cf palimpsest. Therefore, the tooth may well be Modern, but, as with the Cavallo remains, there can be no confidence that it belongs in the Uluzzian.

5.2. The use and abuse of the "IUP" concept

Slimak et al. (2022) argue that the industry of Mandrin layer E — which they assign to the regional Neronian, previously defined as a geographical facies of the Mousterian (Slimak, 2004, 2008) — compares well to the IUP of the Levant and use the comparison as ancillary support for their excursion narrative. They do so under the undemonstrated premise that the IUP was made by Moderns (the only conceivably associated fossil is Ksar 'Akil's Ethelruda, an edentulous, undiagnostic partial maxilla; Ewing, 1963). Otherwise, their argument raises issues of both definition and fact that warrant detailed examination, to which we now turn.

5.2.1. Issues of definition

Originally, the designation "Initial Upper Palaeolithic" had a precise meaning: it referred to the industry from level 4 of Boker Tachtit, a site in the Negev desert of Israel (Marks and Ferring, 1988; Marks and Kaufman, 1983; Marks and Volkman, 1983; Volkman, 1983). Here, a sequence of four occupation horizons separated by sterile deposits revealed how a Middle Palaeolithic, Levallois-based core reduction technique, in basal level 1, gave rise to a fully Upper Palaeolithic, prismatic core reduction technique, in uppermost level 4. In level 1, the system targeted the extraction of one or two points per core, and the cores have opposed platforms. In level 4, the cores are single platform, and the system targeted the extraction of blades; through the reduction process, naturally pointed blanks that are Levallois-like in shape but non-Levallois in mode of extraction were also produced. Two intermediate levels, 2 and 3, document the presence of the level 4 system alongside the level 1 Levallois method, which, by level 4 times, had been abandoned. The Levallois points in levels 1–3 often display elimination of the bulb by ventral retouch. This tool-type is the Emireh point, which is entirely lacking in level 4; its presence in level 1 supports continuity between the regional Middle Palaeolithic and the industry retrieved in levels 2–3, which we herein use as defining the Emiran *sensu stricto*.

Likewise, continuity between this Emiran and the IUP of level 4 is supported by the presence in the former of the Upper Palaeolithic-type reduction method that becomes exclusive in the latter.

Dating work carried out on samples retrieved in the context of the limited, 2013–2015 re-excavation of Boker Tachtit has established with significant precision the time of emergence of the IUP as defined by the lithics in level 4 (Boaretto et al., 2021). Charcoal from the latter's base provided two statistically identical maximum ages of $43,972 \pm 610$ BP (RTD-7739) and $44,314 \pm 634$ BP (RTD-7741), while charcoal retrieved in the level's main body, in direct association with the stone tools, dates the assemblage to $41,828 \pm 391$ BP (RTD-7736), i.e., to $44,068$ – $45,280$ cal BP. These results provide a *terminus ante quem* of ~45.3 ka for the Emiran in underlying levels 2 and 3 that, despite some problems with the ages obtained for samples in intermediate position, is consistent with the results for both a sterile deposit under level 2 (RTD-7740; $46,095 \pm 808$ BP, i.e., $46,372$ – $50,512$ cal BP) and for a large fire pit in level 1 (SMU-259; $46,930 \pm 2420$ BP, i.e., $45,851$ – $54,980$ cal BP; Marks, 1983).

Boker Tachtit is the only site where the Emiran and the IUP appear in a stratified sequence, the different occupation horizons are well separated, and the industrial diagnosis is supported by extensive refitting, with numerous core reconstructions. However, the clear-cut picture of the Transition in the Levant that Boker Tachtit afforded has since been muddled by attempts at reconciling it with the Ksar 'Akil sequence, where the emergence of the Upper Palaeolithic can be followed across the deposit comprised between 10 and 15 m below surface (Ohnuma and Bergman, 1990): in Phase I, corresponding to levels XXI–XXV, there is, according to Azoury (1986), a specialised Levallois blade technology combined with Upper Palaeolithic retouched tools; in Phase II, corresponding to levels XIII–XX, the stone tool assemblages are of Ahmarian affinities. Ohnuma & Bergman, however, convincingly argued that most of Azoury's material corresponds in fact to prismatic cores and to points produced in the context of their reduction for the extraction of blades. The small percentage of cores prepared for the extraction of all three types of Levallois blanks (flakes, points, and blades; 1–5 %, depending on the specific level) nonetheless demonstrates that the method is represented in Phase I.

Phase I of Ksar 'Akil would thus seem to be a good match for levels 2–3 of Boker Tachtit — as indeed suggested by an Emireh point found in level XXIV, in close association with Ethelruda (Ewing, 1947, 1963). Recently, however, it has become commonplace to subsume these assemblages with that from Boker Tachtit level 4 in an "IUP" redefined as "a general descriptor for all early Upper Palaeolithic assemblages from the eastern Mediterranean and Near East that contained mainly Upper Palaeolithic tool forms made on blades produced by a technology combining elements of Levallois (flat core faces, hard hammer, platform faceting, etc.) with more typical prismatic core exploitation" (Kuhn and Zwyns, 2014). Since, the redefinition has been extended even more broadly to encompass any and all contexts, regardless of their technological or typological specificities, that fall in the time frame during which Moderns would have sprung from the Near East westward into Europe and eastward as far as the Altai (Goder-Goldberger and Malinsky-Buller, 2022). In this latter sense, the "IUP" is no more than a label that simply reflects how its user perceives recent human evolution; it conveys no meaning in terms of the actual features of the stone tool assemblages that it is applied to, or in terms of the relationship that such assemblages bear with the Middle and the Upper Palaeolithic as traditionally defined, i.e., with respect to lithic technology.

Whenever we read "IUP," it is therefore important to know what exactly is meant in each case.

5.2.2. Mandrin vs. the Levant

Intent on strengthening the case that Mandrin layer E represents the activity of Modern pioneers, Slimak et al. (2022) stress that "the Neronian lithic industries do not represent here a 'IUP *sensu lato*', but rather an IUP *sensu stricto* or Ksar 'Akil like IUP." In a companion paper, Slimak

(2023) reiterates this position. Ksâr 'Akil, however, is not fit to serve as a standard. Per Williams and Bergman (2010), besides the well-known curatorial problems from which the collections are known to suffer (e.g., selective discard, scattering across different institutions, post-excavation museum mixing due to manipulation by multiple researchers, deficient records, ambiguous datum points), major issues of provenience and stratigraphic integrity arise out of how the site was excavated: in horizontal spits of arbitrary thickness that cut across the natural stratification (Fig. 6).

As pointed out by Zilhão et al. (2015a), these shortcomings suffice to explain the discrepant age models produced by the two projects that have tried to date the Ksâr 'Akil sequence based on ornamental (Douka et al., 2013) and alimentary (Bosch et al., 2015) shell samples (Fig. 17). Taken at face value, these teams' results bear out a total lack of age-depth correlation and indicate that we should expect each of the layers in the XV–XXV sequence to contain a mix of Ahmarian and Emiran material in proportions that are unknown and unknowable because (a) ages in the Ahmarian range were obtained for all dated marine shell beads from layers XXI–XXV, (b) items of Levallois debitage are present in Ahmarian layers XV–XX, and (c) El-Wad points, diagnostic of the Ahmarian, exist in Emiran layer XXII (Ohnuma and Bergman, 1990).

Thus, even though amenable to interpretation in terms of trends and long-term change, the Ksâr 'Akil sequence lacks the resolution required for meaningful comparison with assemblages representing discrete units of technological behaviour. That is probably why an industry like that in Boker Tachtit's level 4 has gone unrecognised at Ksâr 'Akil. Usage of the site by bearers of that technology may well have taken place, and the remains left behind may well have been found somewhere at the elevation of layers XXI–XXIII, above Emireh point-bearing layer XXIV. If so, however, they must now be indistinguishably included among the mix making up the generic Phase I collection.

Slimak et al.'s (2022) use of the "IUP" of Ksâr 'Akil to assess the significance of Mandrin level E is inappropriate also in that it introduces a blatant inconsistency in their rationale. If, per Clarke (1978), the IUP is defined as a technocomplex with specific traits and defined temporal boundaries, then it stands to reason that its manifestations at the point of origin must be earlier than or, minimally, coeval with its manifestations elsewhere. Yet, at Ksâr 'Akil, no Phase I sample dates beyond 44 ka ago, while the age of Mandrin layer E lies in the 51.7–56.8 ka ago interval; therefore, ~52 ka is the youngest Mandrin layer E can be, and the discrepancy remains when more strictly defining the IUP as a Boker Tachtit level 4 industry, as the latter's maximum age is ~45 ka. Thus, under Slimak et al.'s premises, the IUP would have existed at the point of arrival seven or eight millennia earlier, if not more, than at the point of origin! The argument might be salvaged if one took the Neronian to be coeval with Emiran levels 2–3 of Boker Tachtit, but that too implies a stretch, given the age — no earlier than 50.5 ka — obtained for the sterile layer below level 2 of the Negev site. This result makes the start of the Emiran at Boker Tachtit at least two millennia younger than the start of the Neronian at Mandrin (Fig. 18).

For the sake of the argument, let us nonetheless pretend that Mandrin layer E is coeval with levels 2–3 of Boker Tachtit, and that these assemblages are representative of the two regions' stone tool technologies. At Boker Tachtit, as shown by the refits, reduction proceeded according to the rules of the Levallois concept and was geared towards the extraction of points from opposed platform cores, but (a) the process did not necessarily end with the extraction of the point (thence, blade blanks were often produced), and (b) alongside, as illustrated by a significant number of cores, blade extraction was carried out by means of single platform, prismatic core reduction. It is not the appearance of the latter, however, that represents a major break with tradition. As discussed by Marks and Ferring (1988), a tendency to favour the production of blades including by means of the prismatic method is found in the Levant since the middle of the Middle Pleistocene. This tendency has typological implications, namely with regard to the significant numbers of end-scrapers, burins, and other retouched tools of the so-called "Upper

OxCal v4.4.4 Bronk Ramsey (2021); r:5 Marine data from Heaton et al (2020)

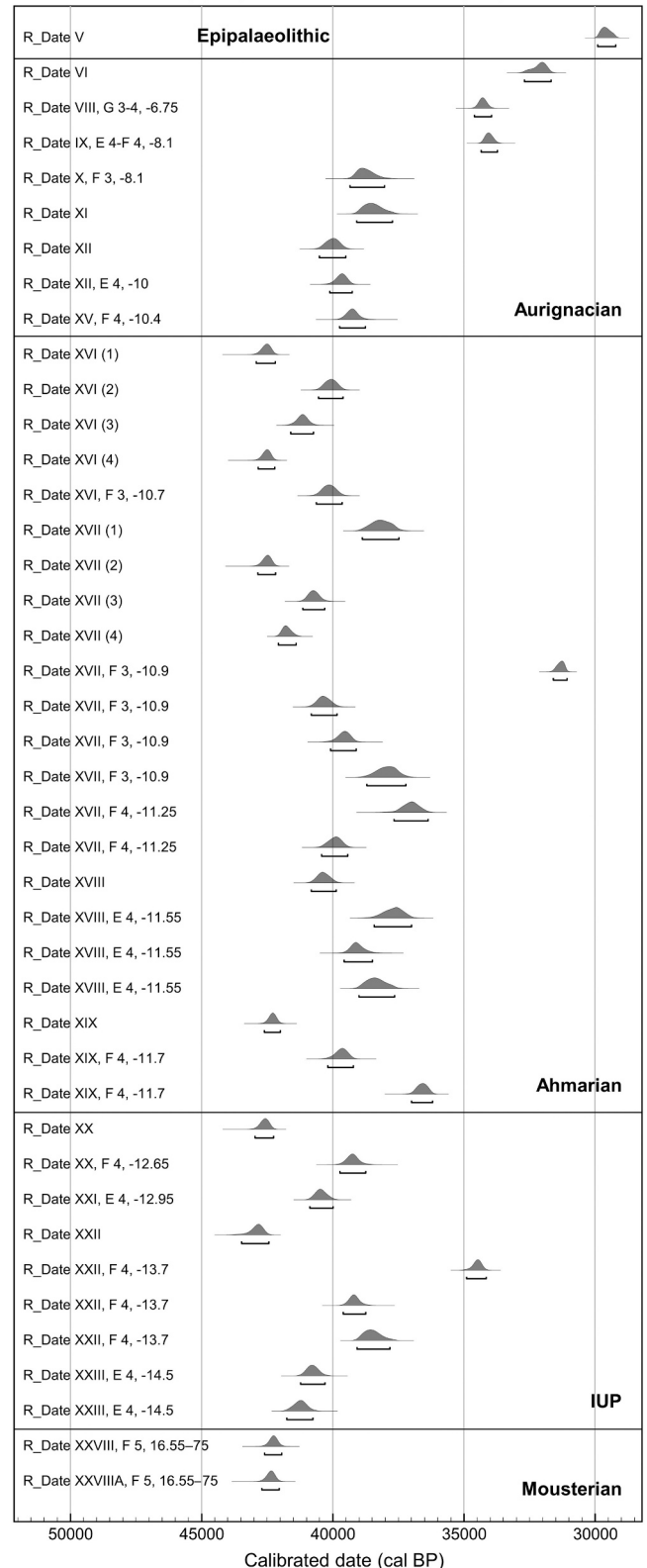


Fig. 17. Ksâr 'Akil: the chronology. The site's AMS radiocarbon dating results for samples of ornamental and alimentary mollusc taxa. Data from Douka et al. (2013) and Bosch et al. (2015).

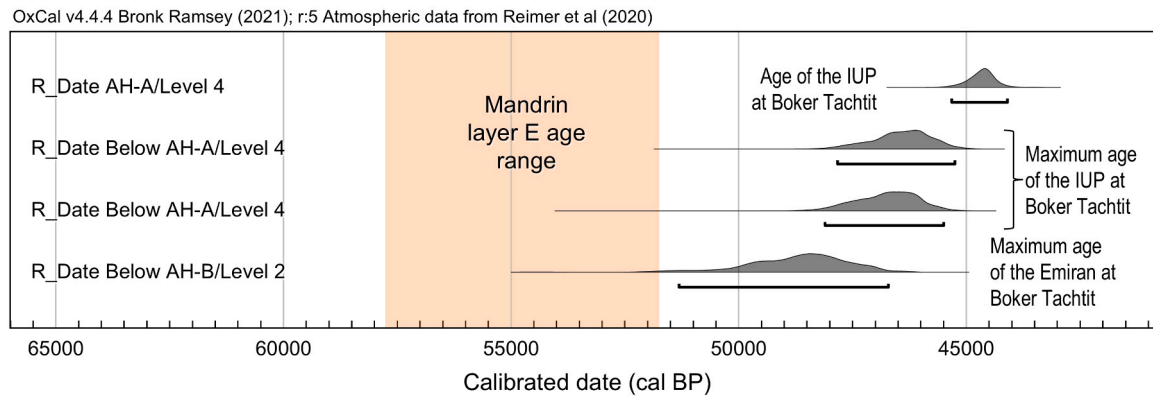


Fig. 18. Palaeolithic time-travelling? The chronology of the Emiran-to-IUP sequence of Boker Tachtit (after the dates in Boaretto et al., 2021) compared with the time span given by Slimak et al. (2022) for the age of the Neronian in layer E of Grotte Mandrin. The colour band denotes the time interval that dating constrains the deposition of Mandrin layer E to. Did Mandrin's putative IUP-like modern humans leave the Levant for the Rhône valley millennia after having arrived at their destination?

Palaeolithic group" that are regularly found in the regional Middle Palaeolithic, including in level 1 of Boker Tachtit. The break, embodied in the industry from the latter's level 4, resides in that, at the corresponding point in time, the Levallois method has already been definitively abandoned.

When looked at in context, there is therefore nothing to suggest that the IUP of Boker Tachtit stands for a break with the preceding Emiran amenable to interpretation in demic terms (e.g., immigration from somewhere else in the region, let alone replacement of one human type by another). This is the more relevant because, in the 50–60 ka ago interval, the Levant's only known fossils are the Neandertals from Amud (Rink et al., 2001; Valladas et al., 1999). Likewise, the Neronian from layer E of Mandrin represents no technological break with the preceding Mousterian. Slimak et al. (2022) and Metz et al. (2023) emphasise the role played in the Mandrin assemblage by the production of points, and note the latter's small size, but both observations can be parsimoniously explained in terms of site function and raw material economy. Moreover, as these authors put it, the points conform to "the strict definition of symmetrical Levallois and Levallois-like points whose shape is the deliberate outcome of flaking technologies geared towards their production" (Slimak et al., 2022). Given that the points are 882 out of a total of 2477 lithics >2 cm, it stands to reason that the remaining two-thirds of the layer E material must correspond for the most part to flakes, blades, and bladelets generated in the context of the point-producing system. In fact, therefore, the Neronian is a Levallois industry, not an IUP-like (*sensu* Boker Tachtit level 4), or Emiran-like (*sensu* Boker Tachtit levels 2–3) industry.

Mandrin layer E's production system is also fully within expectations for the European Middle Palaeolithic. The occurrence of Levallois points in large numbers is, for instance, a well-known feature of the period in northern France, where it can be found as far back as ~180 ka ago at the site of Therdonne (Goval et al., 2016). In this region, such point production schemes can coexist with blade and bladelet prismatic core reduction methods — much as is the case in the Emiran. Examples are (a) Rencourt-lès-Bapaume, a site dated to the very end of MIS (Marine Isotope Stage) 5a (Goval and Hérison, 2006; Goval et al., 2016), (b) Balver Höhle, in Germany, which yielded no less than 47 cores documenting early MIS 3 prismatic, unidirectional, Upper Palaeolithic-like bladelet production (Pastoors and Tafelmaier, 2010), or (c) Bau de l'Aubiesier, where such bladelet production dates to MIS 5d (Carmignani and Soressi, 2023). Not only is such prismatic reduction absent in the Neronian, but it is also the case that, based on Slimak (2004), the composition of the retouched tool kit further substantiates that the industry of Mandrin layer E otherwise fits the European pattern: besides the points, it is almost entirely made up of sidescrapers, notches, and denticulates, in contrast to the significant role played by the "Upper

Palaeolithic group" in the Levant.

Finally, when retouched, the Levallois points of Mandrin layer E conform not to the Emireh but to the so-called Soyons type, which Slimak (2004, 2008) defined as the index fossil of the Neronian. Yet, were the latter to stand for the geographical extension of a coeval Levantine industry, one would expect to see the same index fossil in both, the more so if the process underpinning the emergence of the Neronian is understood as immigration rather than diffusion. For instance, a legitimate argument in favour of the involvement of demic processes in the genesis of the Protoaurignacian is that its Krems point is typologically equivalent to what, in the Ahmarian, is called an El Wad point. It is striking, therefore, that no known instances of the Emireh point exist in Europe, while the only other place where the Soyons point has so far been identified lies not to the east but to the west, in the Middle Palaeolithic of Mediterranean Spain (Eixea, 2018).

This pattern is the more notable since, as Yaroshevich et al. (2021) have convincingly argued on the basis of the material from Boker Tachtit, the Emireh point is a highly standardised tool: the points' size, thinness at the tip, hafting-related features, and impact breaks show that they were designed for mounting on high-velocity projectiles. So, how did groups originating in the Levant lose the know-how to make such an effective tool within the time frame of one generation, or even a few generations, only to reinvent themselves as Soyons point-making Neronians upon settling in western Europe? Slimak et al. provide no explanation for why that would have happened. We contend that it did not.

5.2.3. The nature of the Bachokirian

According to Hublin et al. (2020), the so-called Bachokirian technocomplex, as defined by the artefacts retrieved in levels 11 (1970s excavations) and I (2015–18 excavations) of the eponymous site, fits in the IUP as defined *sensu lato*. In their own words, the different manifestations of the IUP would (a) be "characterized by blades and tool types typical of the Upper Palaeolithic, but with some Levallois forms and faceted platforms that are reminiscent of the preceding Middle Palaeolithic and African Middle Stone Age," (b) "span Eurasia from central Europe to Mongolia," (c) "occur before the appearance of Upper Palaeolithic assemblages characterized by bladelet production," and (d) "arguably have their origin in southwest Asia."

The key point of Hublin et al.'s definition concerns chronology. Based on the IntCal20 calibration curve, the results reported by Fewlass et al. (2020) for layer I of the new excavations fall in the range of 42.5–45.9 ka ago (95 % probability interval), and so the accumulation of the Bachokirian deposit may indeed be construed as coeval with that of level 4 of Boker Tachtit (which falls in the 44.1–45.3 ka ago interval). Yet, the latter's lithics are in a different league from the Bachokirian's,

which, as argued by Teyssandier (2007, 2024) and acknowledged by Tsanova (2023), reflect, for the blade component, a Levallois system based on the reduction of broad flaking surfaces. As a result, and in marked contrast with the slender blades produced at Boker Tachtit, the blanks of the Bachokirian are “heavy” — large, wide, and thick (up to 15 mm-thick), with platforms that are carefully faceted and likewise thick. A detailed comparison is hindered by the fact that Tsanova’s metric data for the blades of Bacho Kiro layer I include a significant proportion of bladelets that either were produced differently — “on the edge of a blank, on an anvil using bipolar shaping, by thinning of flake-scar ridges on thicker flakes and blades prior to their removal” — or are accidental by-products of the reduction process (as none is retouched, or bears use wear).

The technological contrast between the Bachokirian and the Emiran and IUP assemblages from Boker Tachtit is even starker if only the points are considered: at Boker Tachtit, their average thickness is <5 mm, while the typical Bachokirian point is twice as thick and always consists not of the natural point that the Boker Tachtit reduction system is designed to preferentially produce but of a blade or laminar flake blank whose sides were modified to converge by retouch (Teyssandier, 2007, 2024). Put another way, these Bachokirian items are not Levallois points akin to the blanks that the Emireh points of the Levant are made on; typologically, they are Mousterian points, as indeed originally classified by Tsanova and Bordes (2003) (Fig. 19).

In fact, the Bachokirian is a fully Middle Palaeolithic industry based on robust laminar blanks extracted from mostly single-platform Levallois cores. The break it represents with the flake-based Mousterian that stratigraphically underlies it at the eponymous site is parsimoniously explained by the corresponding break in raw material economy — from locally available, poor-quality, mostly volcanic rocks to high-quality flint from sources located 90–180 km away. Prior to the emergence of the need to reconcile the Bachokirian with the IUP concept, as required for paradigmatic consistency with the RAO view of recent human

evolution, previous assessments of this material agreed: “From the standpoint of technical tradition, this industry seems to us to belong in the Middle Palaeolithic (...) No longer can we therefore consider layer 11 of Bacho Kiro as an aspect of the diffusion of the Aurignacian in Europe, but rather as evidence of the gradual transformations that, everywhere in Europe, seem to stem from the Mousterian substrate” (Tsanova and Bordes, 2003).

5.3. Go West?

5.3.1. Acculturation 2.0

The bone tools retrieved in Bacho Kiro layers I/11 (three awls and two *lissoirs*, plus a few non-standardised items with bevelling, wear on the tip, or evidence of use as intermediate pieces) are in the range of what has for a long time been known for the Middle Palaeolithic and also for the Châtelperronian (d’Errico et al., 2003; Banks and d’Errico, 2019; Soressi et al., 2013; Julien et al., 2019). It is only in the realm of personal ornaments that, regionally, the Bachokirian is truly novel. The 1970s work yielded a spindle-shaped bone pendant, grooved at the narrow end, and two perforated teeth (Kozłowski, 1982). The recent work recovered two beads (bone and sandstone), plus eighteen pendants, mostly cave bear teeth pierced or modified by scraping, grooving, or gouging (Martisius et al., 2022).

For Hublin et al. (2020), “the earlier age of the Bacho Kiro Cave material supports the notion that these specific behavioural novelties seen in declining Neandertal populations resulted from contacts with migrant *H. sapiens*.” Martisius et al. (2022) agree: “IUP populations likely influenced the local groups with whom they interacted. Shortly after this migration into Europe, various forms of osseous material culture developed in different regions such as the awls and personal ornaments found further west in Europe, including animal teeth pendants from Châtelperronian contexts with strikingly similar manufacturing methods.”

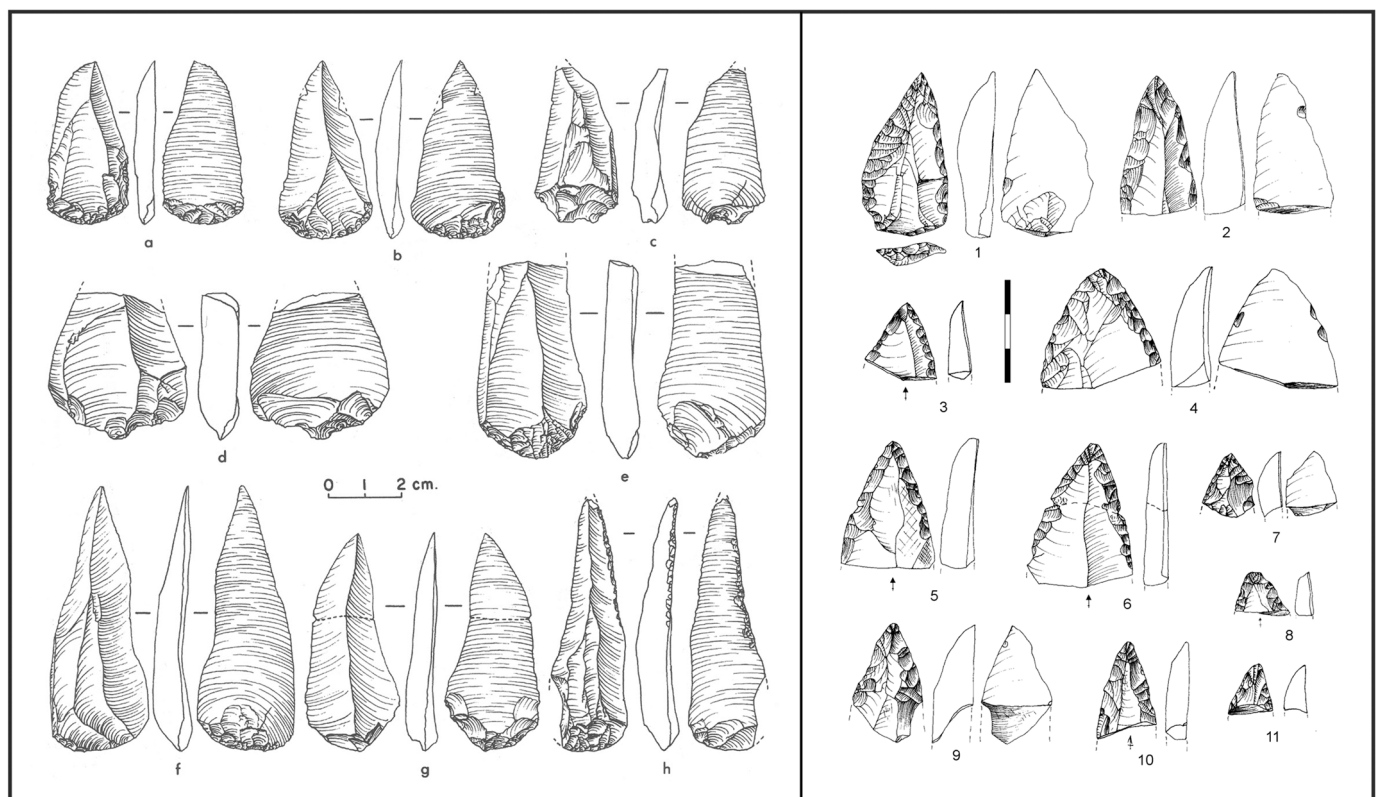


Fig. 19. Points: Boker Tachtit vs. Bacho Kiro. Emireh points from level 2 of Boker Tachtit (left, after Marks and Kaufman, 1983), and Mousterian points from Bacho Kiro level 11 (right, after Tsanova and Bordes, 2003).

As discussed above, these restatements of Acculturation require that the jewellery of the Bachokirian be conceived as rooted in a pre-existent personal ornament tradition — the Levantine IUP's, as represented in Phase I of Ksâr 'Akil and layers F-I of Üçağızlı (Kuhn et al., 2009; Kuhn et al., 2001; Stiner et al., 2013). However:

- The Üçağızlı vulture talon that Martisius et al. include in the jewellery kit of the IUP comes in fact from the site's Ahmarian layer B, which, based on the dates reported by Kuhn et al., post-dates the Bachokirian by some five to ten millennia.
- The jewellery retrieved in those two Levantine contexts consists entirely of shell beads made of small size taxa, mostly *Tritia (Nassarius) gibbosula*, plus some *Columbella rustica*.

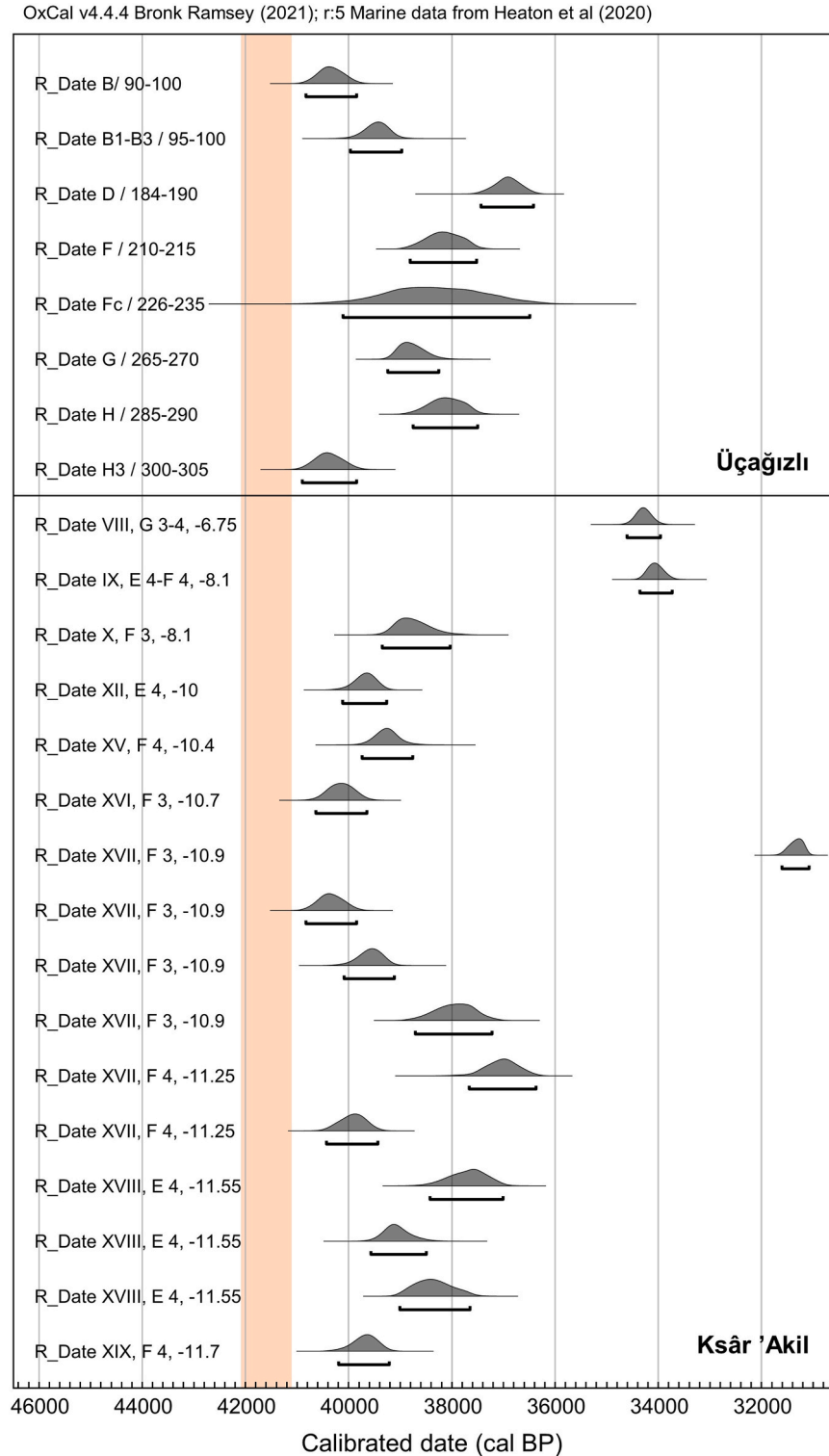


Fig. 20. Dating the Levantine tradition of beadworks made from marine shell. Ages obtained for ornamental molluscs in the IUP and Ahmarian levels of Üçağızlı and Ksâr 'Akil (after the dates in Douka 2013 and Douka et al. 2013). All results post-date the older boundary for the start of the Protoaurignacian in Europe (indicated by the colour band and after Banks et al., 2013b, herein updated under IntCal20).

- The direct dating of such beads returned in all cases ages younger than 41.5 ka (Douka, 2013; Douka et al., 2013), i.e., in the time range of the Ahmarian (Fig. 20).
- That intrusive material is present in Üçağızlı's layers F–I is otherwise indicated by the two populations of charcoal dates obtained for them, one in the range of the Ahmarian — between $33,874 \pm 271$ BP (AA-68963) and $36,915 \pm 335$ BP (AA-68962) — and another in a range that, at the older end, is consistent with the age of Boker Tachtit level 4 — between $38,900 \pm 1100$ BP (AA-27995) and $41,400 \pm 1100$ BP (AA-37625).
- Whether the IUP of the Levant featured any jewellery at all is therefore entirely contingent upon the notion that the perforated *Glycymeris* shells found in levels XXI–XXV of Ksâr 'Akil are ornamental (as Stiner et al. contend), but the tradition they would putatively represent (a) goes back to the Last Interglacial, (b) spans the northern shores of the Mediterranean, from the Israeli site of Qafzeh in the east (Bar-Yosef Mayer et al., 2009, 2020) to the Spanish site of Cueva de los Aviones in the west (Hoffmann et al., 2018a; Zilhão et al., 2010), and (c) is associated with both Moderns and Neandertals.
- Even if, besides the Ksâr 'Akil *Glycymeris* valves, some of the small gastropod beads are also accepted as part of the material culture represented by the lithic assemblages found alongside, the contrast with the Bacho Kiro pendants, entirely made of stone, bone, or tooth, remains stark.
- Martisius et al. explain the contrast in the choice of the ornaments' blanks (shell vs. stone/tooth) as "likely reflective of the locally available raw materials," which is contradicted by the fact that bovids, cervids, and carnivores, both small and large, are well represented in the faunal assemblages that the beads from both Ksâr 'Akil and Üçağızlı are associated with.
- The Bachokirian is coeval with, not earlier than the Châtelperronian, as the older end of the former's modelled duration lies at 44.5–44.6 ka (with IntCal20), while the older end for the latter's start date has been modelled to lie at 45.0 ka (in the Grotte du Renne, with IntCal13) or 45.3 ka (in south-west France and Cantabrian Spain as a whole, with IntCal20) (Bard et al., 2020; Discamps et al., 2015; Higham et al., 2014; Talamo et al., 2023).

Thus, what the similarities between the personal ornaments of the Châtelperronian and the Bachokirian illustrate is the existence, some 45 ka ago, of a pan-European tradition that had roots neither in the Levant nor in Africa. If such a shared cultural trait came about as a result not of convergent developments but of the operation of an exchange network, then the latter did not extend to the Near East (Zilhão, 2006c, 2007). Diffusion and migration could have been among the mechanisms that made the tradition function, but: Can we tell? And, if so, in which direction?

The first element of response to these questions lies in something that Acculturation 2.0 models fail to consider: the time depth in central and western Europe, going back to the Last Interglacial, of the practice of modifying animal body parts (e.g., raptor talons) for symbolic purposes (Frayer et al., 2020; Radović et al., 2015). Most recently, such antiquity has been illustrated by the engraved giant deer phalanx from Einhornhöhle (Germany), directly dated to $47,800 \pm 2800$ / -2100 BP (KIA-55192), i.e., to >47.5 ka cal BP, in agreement with the age obtained for associated samples of bone and charcoal (Leder et al., 2021). The numerous and varied items of body ornamentation found in the Châtelperronian of the Grotte du Renne are only slightly later. Despite the uncertain context and lack of dating, the ivory ring from Trou Magrite (Belgium) and the ivory disc from the Ilsehöhle (Germany) compare well with items in the Grotte du Renne's collection (Zilhão, 2007). Thus, the regional visibility of the practice ~45 ka ago is parsimoniously rooted in the Einhornhöhle find — there is no need to look elsewhere. It is likewise with the bone tools of the Châtelperronian, which, at the Grotte du Renne, include, besides the *lissoirs*, 30 ivory

sagaies and 54 bone awls. Many of the latter are ochred and one third of them bear marks of functional or symbolic significance (Julien et al., 2019). The Grotte du Renne's is a typically Upper Palaeolithic bone tool assemblage that lies in stark contrast with the Bachokirian's, which is poorer, simpler, and fully within the range of the European Middle Palaeolithic.

The notion that the Châtelperronian owes its genesis to influence from the Bachokirian is also at odds with the little we can tell based on the reliable genetic and chronological evidence available for the broadly coeval Neandertal populations of Europe. At Vindija, for instance, the Vi208 morphologically Neandertal parietal is now dated on the hydroxyproline molecule to $42,700 \pm 1600$ BP (OxA-X-2689–09), which is statistically the same as the result of $42,450 \pm 450$ BP (ETH-86772) obtained for the oldest of the Bacho Kiro bone fragments that has been genetically assigned to Moderns (Devièse et al., 2017; Fewlass et al., 2020; Hublin et al., 2020). If Bachokirian Moderns were involved in the emergence of the Châtelperronian, whether as makers or as long-distance acculturators, one should expect the corresponding diffusion/migration signal to be observed in intermediate areas along the so-called "Danube Corridor" (Conard and Bolus, 2003). Yet, at Vindija, halfway between Bacho Kiro and the Grotte du Renne, there is no evidence, whether genetical or cultural (e.g., personal ornaments, lithics), of the nearby presence of migrating populations of Moderns.

Based on the hydroxyproline date obtained for the Vi33-19 fragment ($44,300 \pm 1200$ BP, OxA-X-2717–11; Devièse et al., 2017), the Vindija specimens that yielded the Neandertal genome (Vi33-16, Vi33-19, Vi33-25, and Vi33-26; Green et al., 2010; Prüfer et al., 2017) are a couple of millennia earlier than Vi208. Morphologically, however, the site's Neandertals form a single, homogeneous population that, in several cranial features, is intermediate between the region's Last Interglacial people, as represented by the Krapina fossils, and the Cro-Magnon people of the Gravettian. This pattern can be seen in the context of Neandertal/Modern admixture at the time of contact in Central Europe (Smith et al., 2005), or as a by-product of small amounts of modern human biological influence (Karavanić and Smith, 2013). However, no "modern humans" were genetically detected among the immediate ancestors of any of the Vindija individuals, and whatever "modern" influence their morphology reflects did not fundamentally change their gestalt, which remained recognisably Neandertal. This evidence suggests that the "modern influence" envisaged by Karavanić & Smith relates not to short-term historical events (immigration) but to long-term evolutionary processes: under Assimilation, the limited and uneven inter-continental gene flow that, per Li et al. (2024), was in operation across the late Middle and early Upper Pleistocene of the Old World, thereby maintaining the unity of the human species while allowing for the emergence and persistence of geographically distinct morphotypical and genotypical variants.

This interpretation of the Vindija evidence is fully consistent with the little we can say for certain about the biology and dating of coeval Neandertals further to the west. Two specimens, both adult and from Belgium, are, based on their hydroxyproline dating, coeval with Vindija Vi208: the Fonds-de-Forêt isolated femur and the Spy I individual (Devièse et al., 2021). In each case, two statistically identical determinations have been obtained: OxA-38322 and OxA-X-2767–13 for Fonds-de-Forêt, OxA-X-2762–21 and OxA-X-2778–15 for Spy I. This allows us to derive the specimens' ages from the corresponding averages: $39,081 \pm 697$ BP ($42,121$ – $43,876$ cal BP) for the former, and $39,900 \pm 1393$ BP ($41,925$ – $45,209$ cal BP) for the latter. We lack high-quality genomic data for these Neandertals, but we know that, morphologically, that is what they are, as otherwise corroborated by the complete mtDNA genome of the Fonds-de-Forêt specimen. This individual post-dates the 44.5–44.6 ka onset of the Bachokirian by at least six centuries. Thus, if the emergence of the Châtelperronian at the Grotte du Renne had been triggered by the arrival in western Europe of Moderns of whatever cultural variety (e.g., Bachokirian, or Ranisian), one would expect some contribution from the immigrants to be detected in

the biology of the late Neandertals from Belgium, no more than ~300 km to the north. Yet, no evidence exists that Moderns dating to only a few generations back are among those Neandertals' immediate ancestors, as would have to be the case under the mechanisms of neighbour-with-neighbour contact envisaged by Hublin et al. (2020) and Martisius et al. (2022).

5.3.2. François Bordes 2.0

Could it be that, unlike their eastern counterparts, western Europe's Neandertals refused to mix with the newcomers, limiting their exchanges with them to memes, not genes? Such is the gist of Djakovic et al.'s (2022) "Overlap Hypothesis" for the Transition in south-west France and Cantabrian Spain. Based on Optimal Linear Estimate modelling, they find that Moderns set foot in that part of the world 1400–2900 years before the Neandertals disappeared and conclude that (a) "the early stages of the Upper Palaeolithic of this region may have involved the proximal co-existence of different human groups, likely irrespective of their biological classification," and (b) "the initial Upper Palaeolithic in this region likely involved a period of co-existence between Neandertals and *Homo sapiens*."

The first point of logic we need to make here is that the two conclusions above cannot both be correct: if the two groups were distinct regardless of their biological classification, then their distinction was cultural; if such culturally distinct groups document the co-existence between Neandertals and *Homo sapiens*, then they were not distinct "irrespective of their biological classification." In fact, even though acknowledging that taking the Châtelperronian and the Protoaurignacian as proxies for biological entities is fraught with uncertainty, that is exactly what Djakovic et al.'s modelling does. We have already seen why the assumption is unsound and will not press that point further; for the sake of the argument, let us nonetheless proceed under the premise that it is justified.

It was in the notion that people more readily exchange their genes than their culture that François Bordes sought a theoretical basis for his view of industrial variability in the Mousterian of south-west France (Bordes, 1973). Only such a predisposition could explain that distinct cultural entities persisted alongside in the region for tens of millennia. In its original form, Acculturation reversed the Bordesian argument to posit that Neandertals acquired body ornamentation while remaining forever wary of catching the genes of the people that they got the idea from. Djakovic et al.'s Overlap Hypothesis is a return to Bordes, in that they acknowledge the possibility of gene exchange across the boundaries of cultural entities that maintain their identity and separateness through the period of coexistence. For that to be possible, however, the exchange must be modelled as limited and the boundary as stable and well defined. For Bordes, such a boundary was behavioural and between sympatric entities. Rather than restating the same for a two-actor scenario where the Neandertals would have played the role of Astérix's "Irreducible Gauls," Djakovic et al. argue instead for a boundary that would have been geographical and entities that would have been allopatric: "The oldest calibrated age ranges from well-dated Protoaurignacian assemblages initially form a cluster at the southern and northern limits of France and Spain respectively, overlapping with dates produced for Châtelperronian assemblages in the central-northern parts of France [which] may indicate that the chronological overlap may have been geographically structured, with the Protoaurignacian following a south to north pattern of appearance."

Is there a parsimonious, alternative interpretation of Djakovic et al.'s data? To explore the possibility, we took their dataset and ran under OxCal (Bronk Ramsey, 2009; Reimer et al., 2020) the radiocarbon dates used in Djakovic et al.'s Optimal Linear Estimation modelling. Our goal was to investigate the impact on their long-term overlap outcome of (a) the selection of results to be used, and (b) the assumption that the associated stratigraphic labels are reliable and a true reflection of the samples' relative ages. We did not consider the three results that Djakovic et al. themselves removed from the dataset due to uncertainty in

(a) sample provenience, namely OxA-X-2694-17, $38,900 \pm 1000$ BP, from Isturitz level 5a, which, per Normand et al. (2007), contains inherited material, or (b) sample definition, namely two Trou de la Mère Clochette results (OxA-19621, $33,750 \pm 350$ BP, and OxA-19622, $35,460 \pm 250$ BP) on "Protoaurignacian split-based points" whose classification and stratigraphic association are, per Teyssandier and Zilhão (2018), questionable. Besides, we also excluded the EVA-11 result for the Châtelperronian of the French site of Les Cottés, as it is accounted for in the weighted average that Djakovic et al. calculated together with OxA-V-2381-53 (another, statistically identical age for the same sample).

In Model 1, the 52 dates (27 from the Châtelperronian, and 25 from the Protoaurignacian) were run as forming two contiguous phases. This model had a poor agreement index because of the failure to accommodate the five oldest Protoaurignacian results (four from Isturitz and one from Labeko Koba) with the most recent Châtelperronian results (two from level VIII of the Grotte du Renne).

In Model 2 (Fig. 21), we excluded the two problematic Châtelperronian results and added another from layer VIII of the Grotte du Renne that Djakovic et al. had left out (EVA-53, $36,230 \pm 435$ BP). This time we obtained a good agreement index ($A_{\text{model}} = 85.4\%$), but with two results slightly below the 60 % threshold: EVA-5/OxA-V-2381-51 ($42,360 \pm 370$ BP) for Les Cottés, the oldest Châtelperronian result ($A = 58.3\%$); and OxA-23435 ($37,500 \pm 900$ BP) for level C4d1j' of Isturitz, the oldest Protoaurignacian result ($A = 55.4\%$). However, the values for those results do not invalidate the model, because of its overall agreement index, the more so since another result for Isturitz — OxA-23436, $37,400 \pm 900$ BP, for a sample from level C4d1j' — is essentially the same as OxA-23435 and did cross the threshold.

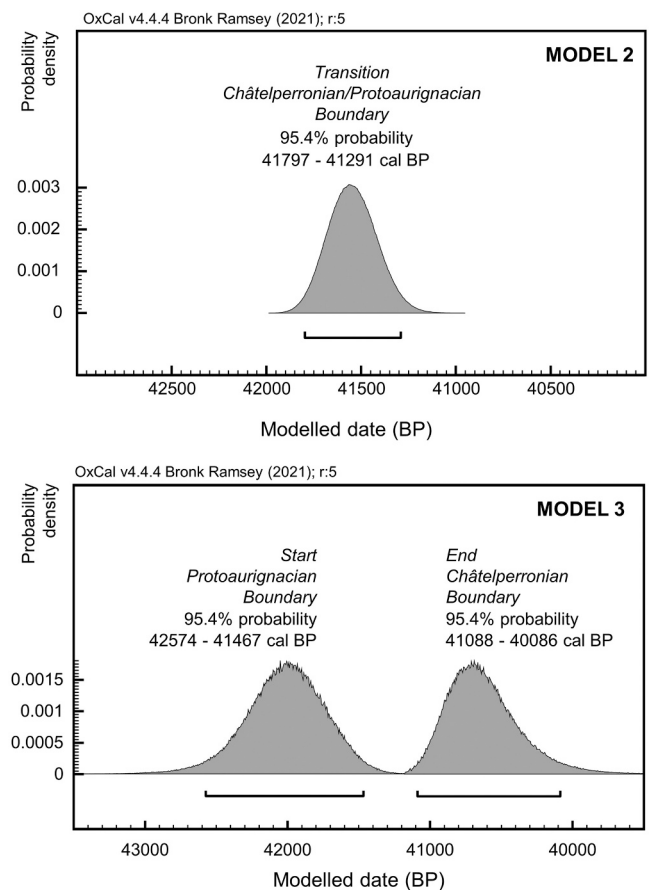


Fig. 21. Timing of the Châtelperronian/Protoaurignacian transition in south-western Europe. Models 2 (top) and 3 (bottom) (see text), based on Djakovic et al.'s (2022) set of radiocarbon dates.

In Model 3 (Fig. 21), to account for the possibility that the anomalies in Model 1 reflected stratigraphic uncertainty, we ran again the latter's set of results but, this time, defining the two phases as overlapping rather than contiguous. Doing so accounts for the presence in the dataset of items that could be intrusive or inherited (i.e., out of place due to post-depositional disturbance or *décapage* errors), thereby acknowledging the fuzziness of stratigraphic interfaces that, in cave or rock-shelter sites, is a hallmark of all continuous successions. Indeed, at Les Cottés, the Châtelperronian directly overlies a Mousterian deposit, and, at the Grotte du Renne, layer VIII is in direct contact with overlying Protoaurignacian layer VII. Model 3 had an excellent agreement index ($A_{\text{model}} = 106.3\%$) and no individual results deemed anomalous.

In both Model 2 and Model 3, in agreement with Banks et al. (2013b) and as Zilhão and d'Errico (1999) had inferred from their analysis of the then-available dataset, the replacement of the Châtelperronian by the Protoaurignacian happens ~ 41.5 ka: specifically, within the 41,291–41,797 interval, in the case of Model 2; no later than 40,086 and no earlier than 42,574 years ago, in the case of Model 3. Thus, when one properly accounts for the uncertainty in the integrity of individual stratigraphic units that is inherent to any continuous sequence, Djakovic et al.'s data are entirely amenable to an understanding of the Châtelperronian and the Protoaurignacian as two consecutive rungs of the regional chrono-stratigraphic ladder (as otherwise demonstrated by the numerous sequences where both are represented and in which the former invariably underlies the latter).

The second point of logic raised by Djakovic et al.'s study is that they modelled emergence and extinction based on the earliest results for the Protoaurignacian and the latest results for the Châtelperronian. They then ran those results under the Optimal Linear Estimation rationale that (a) the last appearance date is likely to be earlier than the actual disappearance, and (b) the first appearance date is likely to be later than the actual appearance. Given this rationale and the composition of the dataset, their conclusion is an affirmation of the consequent — even if you ignore the potential impact of site formation processes, a significant overlap outcome is entirely contained in the premises of the approach. Consider, for instance that, at the Grotte du Renne, the youngest date for the Châtelperronian ($35,380 \pm 390$ BP; EVA-54) is statistically the same as the oldest date for the Protoaurignacian ($34,810 \pm 210$ BP; EVA-95). No modelling is required to see that, positing Djakovic et al.'s priors, co-occurrence of the two cultures in the cave's surroundings for an extended period of time is going to be the posterior. Yet signs of such a coexistence are nowhere to be found in the stratigraphic units that the samples come from: layer VII yielded no Châtelperronian finds to speak of (if any, the numbers are so low that *décapage* error parsimoniously explains them), and ditto for layer VIII and the Protoaurignacian (Caron et al., 2011).

Doubtless, different narratives of what happened in south-west France during the Transition may be put together that, depending on the assumptions used in the modelling and on the criteria underpinning the selection of samples, will be consistent with the space/time occurrence points. We contend, however, that neither Djakovic et al.'s nor any others are worthy of consideration until and unless the null hypothesis is falsified. That hypothesis must be that, in the Franco-Cantabrian region, the Protoaurignacian and the Châtelperronian are, at the scale that the resolution of both dating methods and stratigraphic successions lets us work with, consecutive, not coeval.

Last but not least, a precondition for the Bayesian modelling of dating results is that either stratigraphic provenience or the accuracy of the measurements be taken for granted: if we go for the former, then we are allowed to interpret outliers as a by-product of error in the latter; if we go for the latter, then we are allowed to interpret outliers as a by-product of error in the provenience information (Pettitt and Zilhão, 2015). In our models above, we assumed accuracy so as to be able to identify potential problems with provenience. However, as illustrated by the redating of the Neandertals from Vindija and Belgium (Deviese et al., 2017, 2021), some of the younger-than-expected results for the

Châtelperronian that one finds in the literature, even those most recently obtained on ultrafiltrated bulk collagen, may well be minimum ages only. This caveat applies even more forcefully to the Neandertal remains from St.-Césaire and Grotte du Renne, whose rather young radiocarbon ages significantly impact Djakovic et al.'s pattern of Neandertal extinction in the north long post-dating the emergence of the Protoaurignacian in the south. That pattern could therefore be an artefact of error not only in the modelling but also in the age measurements.

5.3.3. *Sympatry in Iberia?*

In Eurasia's westernmost finisterra, the focus of Transition debates has been the so-called Ebro Frontier model, which hypothesises a long period of allopatric separation whereby the Châtelperronian, the Protoaurignacian, and the Early Aurignacian would have succeeded each other in northern Spain, while, in the peninsula's south-west, the Mousterian would have persisted all along, until the regional emergence, 37.0–37.4 ka ago, of the Evolved Aurignacian (Wood et al., 2013; Zilhão, 1993, 2000, 2009a, 2021, 2022; Zilhão et al., 2011a, 2017, 2021b). However, based on the Spanish rock-shelter of Bajondillo (Málaga) and the Portuguese cave site of Lapa do Picareiro (Alcanena), and following up on a hypothesis originally put forth on the back of data from Gorham's Cave, in Gibraltar (Finlayson et al., 2006; Zilhão and Pettitt, 2006), a scenario of Bordesian, millennia-long coexistence is implied by recent claims that Early Aurignacian Moderns were present in south-west Iberia alongside the last of the Neandertals (Benedetti et al., 2019; Cortés-Sánchez et al., 2019; Haws et al., 2021b; Haws et al., 2020). The claim that the assemblage from Level 1 of Cueva Millán (Burgos) stands for the presence in the Central Meseta, as early as 42.9–44.8 ka, of an IUP-like industry, dubbed the Arlanzian (Sánchez-Yustos et al., 2024), brings additional complexity to the picture.

Cueva Millán features a 1 m-thick, homogeneous but pedogenically weathered deposit whose accumulation occurred during the Middle Palaeolithic, as shown by the luminescence dating of the sediment. The deposit does include components of Upper Palaeolithic age (stone tools and radiocarbon-dated bone), but the lithic assemblage is otherwise typically Mousterian, and those components are not restricted to Level 1: bladelets and bladelet cores are present as far down as the base of Level 2, 60 cm below the surface. In fact, the "Arlanzian" from Cueva Millán is but a chimeric construction. Like El Castillo's "Transitional Aurignacian" (see Section 2.1. above), it results from the misinterpretation as cultural process of a mundane geological one, namely, the post-depositional intrusion of Upper Palaeolithic items discarded on the surface of a previously formed Middle Palaeolithic surface. Likewise, at Bajondillo, the claim for a very early Aurignacian derives from the content of level Bj/13–12, which underlies Evolved Aurignacian level Bj/11. A few non-diagnostic Upper Palaeolithic-like lithics were found in Bj/12–13, where most of the stone tool assemblage is, however, of unambiguous Middle Palaeolithic affinities. Therefore, the parsimonious interpretation of the Bajondillo data is that the ages in the range of 43–45 ka ago obtained for Bj/13–12 relate to the level's Middle Palaeolithic component (Anderson et al., 2019; de la Peña, 2019; Zilhão, 2006b, 2021).

At Picareiro, the claim for an Aurignacian earlier-than-hitherto thought raises much the same modelling issues that invalidate Djakovic et al.'s application of the Bayesian approach to the Transition in south-west France. The relevant part of Picareiro's potent Upper Pleistocene infilling consists of five lithological units — from top to bottom, levels FF, GG, HH, II, and JJ-upper (Haws et al., 2020, 2021a). The latter is Middle Palaeolithic, FF is Aurignacian, and GG, HH and II form the depositional ensemble (henceforth, GG-II) that yielded the very small, fragmentary and heavily scattered flint assemblage defining the site's first Aurignacian occupation: in total, 42 items (mostly bladelet fragments, chippage, and shatter, but including one carinated scraper/core), corresponding to a finds density of $1/\text{m}^2$ ($2/\text{m}^3$). Treated as a single unit for the purposes of characterising the stone tool assemblage, GG-II was

however separated into distinct phases for the age modelling. Haws et al.'s conclusion that level II provides a start date — no later than 38.1–41.1 ka ago — for the site's Aurignacian follows from this inconsistency and is not supported when the dataset is run under the right premises, which are:

- GG-II is a single phase, as otherwise follows from [Benedetti et al.'s \(2019\)](#) geological description of the ensemble as a “hardpan” where HH is “an uncemented lens of muddy éboulis in between the firmly cemented levels GG and II.”

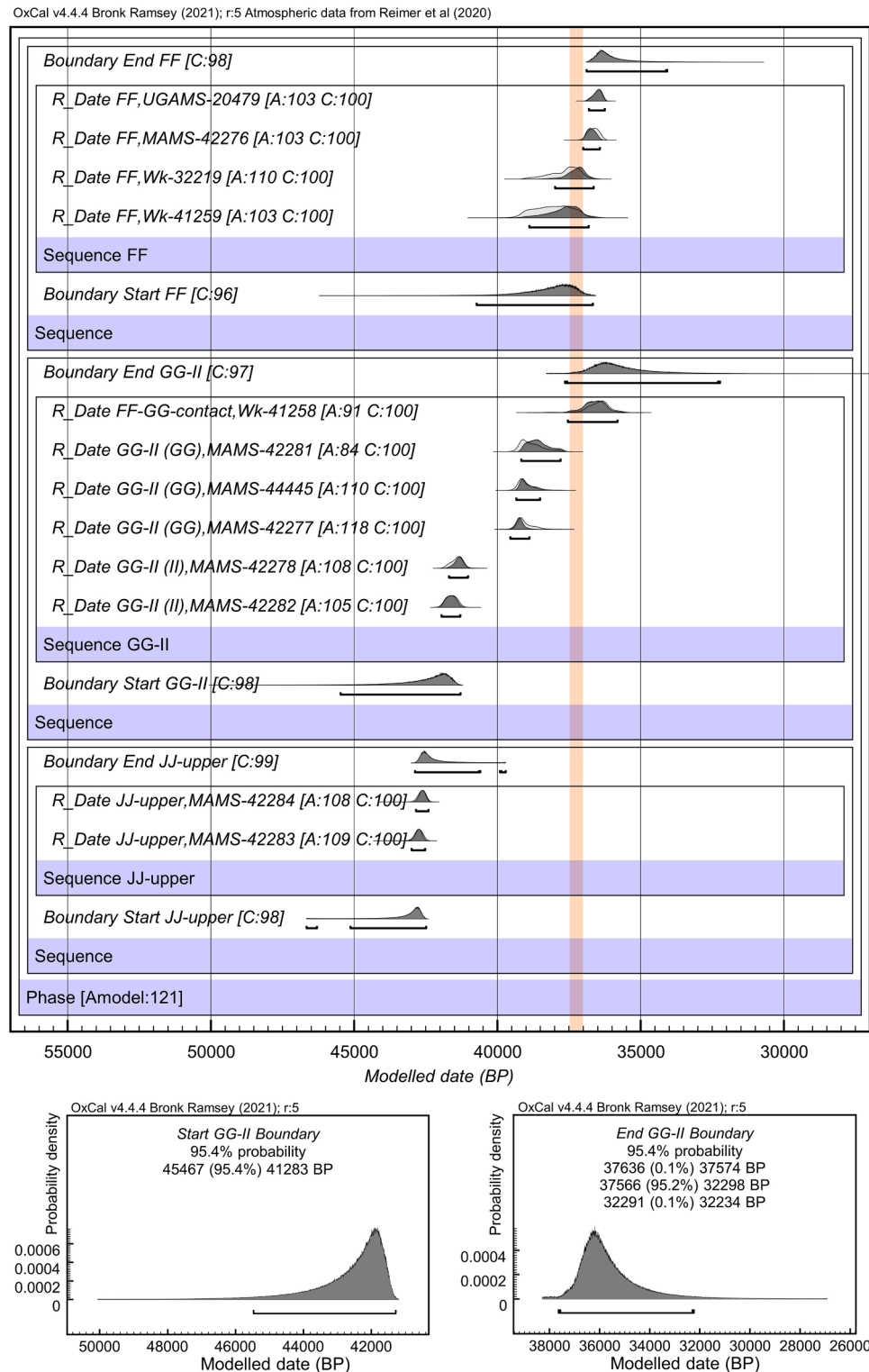


Fig. 22. Lapa do Picareiro: modelled chronology of the Transition levels. The time of deposition of the Aurignacian lithics retrieved in the GG-II stratigraphic ensemble implies no extended overlap with the region's late Mousterian and is entirely consistent with the chronology of the replacement of the Mousterian by the Evolved Aurignacian in south-western Iberia (indicated, after [Zilhão 2021, 2022](#), and [Zilhão et al. 2017](#), by the vertical colour band). Data from [Benedetti et al. \(2019\)](#) and [Haws et al. \(2020\)](#).

- The span of the three archaeological units of analysis (JJ-upper/sterile, GG-II/lowermost Aurignacian, FF/uppermost Aurignacian) is allowed to overlap so that boundary indistinctiveness (acknowledged by the excavators and implied by some contradictory information on the stratigraphic provenience of the samples) and the possibility of vertical displacement (implied by the openwork nature of the accumulation) can be properly accounted for.

Running the Picareiro ages as three overlapping sequences ($A_{\text{model}} =$

121.3) constrains the Aurignacian in GG-II to the interval comprised between 41.3–45.5 and 32.2–37.6 ka ago (Fig. 22). This is entirely consistent with the lithics representing Evolved Aurignacian activity, which those boundaries constrain to **within** that interval, not to **all through** it. Moreover, Bayesian modelling of the radiocarbon and OSL ages obtained at Gruta do Caldeirão (Tomar), some 25 km north-east of Picareiro, has set a *terminus post quem* (38.6–38.9 ka ago) for the end of the regional Mousterian that is fully consistent with its persistence until as late as elsewhere in south-west Iberia (i.e., until 37.0–37.4 ka ago;

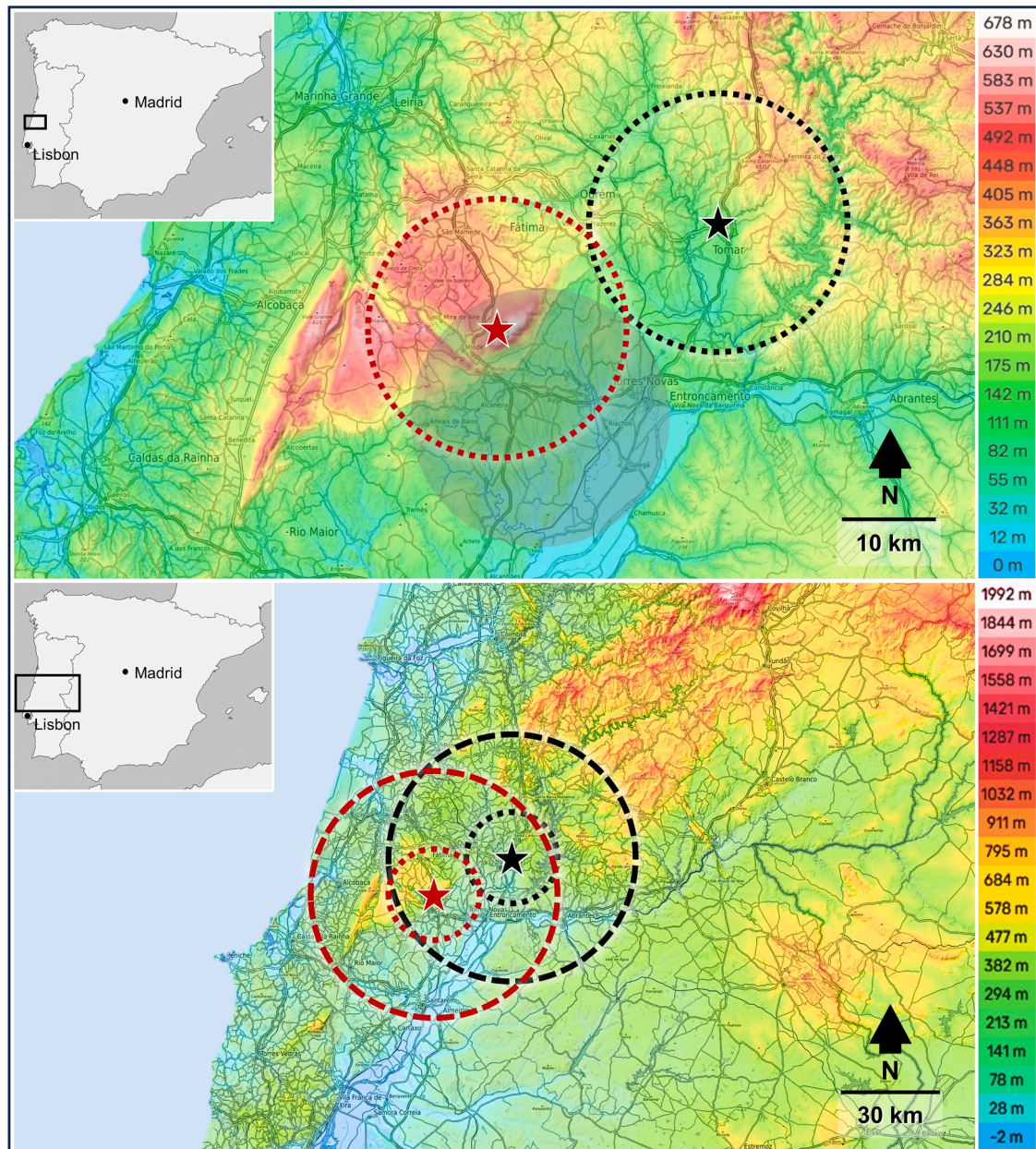


Fig. 23. Long-term Mousterian/Aurignacian sympatry in central Portugal? The rectangles in the inserts denote the location in Iberia of the mapped areas (source: <https://pt-pt.topographic-map.com/map-6nmzs/Portugal/>). The red star is Lapa do Picareiro (Aurignacian), the black star is Gruta do Caldeirão (Late Mousterian). The grey circle denotes the ~600 km² subsistence territory of a Middle Palaeolithic family, reconstructed after the mapping of Sr in the regional soils, compared to the high-resolution, LA-MC-ICP-MS (laser ablation multicollector inductively coupled plasma mass spectrometry) analysis of the variation in the Sr content of the enamel (formed between ages 3.5–6.5 and 8.5–14.5 years post-natal) of two Neandertal teeth from nearby Gruta da Oliveira, dated to ~93 ka ago (Linscott et al., 2023). The circumferences of matching colour bound subsistence (dotted lines) and reproductive (dashed lines) territories centred on the sites that, for subsistence, are of the same size as the grey circle, and, for reproduction, are modelled after Wobst (1974) with the following parameters: (a) the size of the minimum band is 25 and the attendant population density, as derived from the Oliveira data, is 0.04/km²; (b) the maximum band (the reproductive unit) is of the smallest possible size (i.e., it brings together seven minimum bands). Given that spatial and demographic constraints must have remained much the same during the Transition, regional, millennia-long sympatry between Aurignacian Moderns and Mousterian Neandertals is not a realistic scenario.

Zilhão et al., 2021a). Therefore, if the Picareiro Aurignacian were as early as Haws et al. claim, it would have coexisted for a significant amount of time with the region's latest Mousterian. But would such a coexistence be at all possible under the territorial constraints posed by (a) the demography of hunter-gatherer populations and (b) the mutual avoidance behaviour required to maintain the self-identification and fundamental separateness implied by long-term sympatry?

In the Portuguese case, this question can be answered based on direct archaeological evidence. At Gruta da Oliveira (Torres Novas), high-resolution analyses of the strontium content of human tooth enamel have allowed reliable estimation of the size of the subsistence territory of a band of early Middle Palaeolithic Neandertals living in the same area of Central Portugal as Caldeirão and Picareiro: ~600 km² (Linscott et al., 2023). Assuming a band size of 25, the evidence from Oliveira translates into a population density of 0.04/km². Bearing in mind the requirements for the proper functioning, allowing for survival over the long term, of mate-exchange systems, these numbers imply reproductive territories one order of magnitude larger: between ~4400 km² and ~12,000 km² for maximum band compositions of, respectively, seven and nineteen minimum bands, the range returned by Wobst's (1974) simulations.

There is no reason to suppose that things would have been significantly different during the Transition. Therefore, in central Portugal, coeval, but culturally segregated Mousterian and Aurignacian entities would have overlapped extensively in space as much as in time, even if the maximum bands were of the smallest possible size (Fig. 23). Mutual avoidance would not have been feasible, even in a scenario of alternating use of the same sites. In such a scenario, the slow sedimentation rates characteristic of caves would lead to the formation of "transitional" palimpsests (of e.g., 10 cm in thickness, minimally representing one thousand years) commingling the remains left behind by the different entities. Yet, there is no evidence that *in situ* remains of Aurignacian activity are subsumed in the latest Mousterian deposit of Caldeirão, and ditto for Mousterian activity in the Aurignacian deposit of Picareiro. We might posit that such apparent invisibility is simply due to a random lack of diagnostics. In the case of Picareiro, for instance, use of the site by the Caldeirão Mousterians could be represented in GG-II by human-modified bones reflecting on-site processing of hunted game with expedient tools. In that case, however, whether the dated bone samples from GG-II relate to either the Aurignacian or the Mousterian would be impossible to ascertain.

The truth is that, in south-west Iberia, there is no way of reconciling with fact or theory the notion of an extended, millennia-long regional coexistence between immigrating Moderns and autochthonous Neandertals. Either the late persisting Mousterian of southern Spain and Portugal is an artefact of dating error, or the region's putative Early Aurignacian is an artefact of interpretation error. With current evidence, it must be the latter.

5.3.4. And in Italy too?

Based on a large set of radiocarbon and luminescence ages from nine major Transition sites spanning the Italian peninsula from the very north to the very south, Higham et al. (2024) have claimed that (a) Neandertals disappeared from southern Italy before the arrival of modern humans, putatively represented by the Uluzzian, (b) the Uluzzian began earlier in the south than in the north, (c) the reverse is the case with the Protoaurignacian, and (d) the Uluzzian and the Protoaurignacian overlapped in time, suggesting that they were made by culturally different, albeit largely contemporary groups of modern humans.

However, Higham et al.'s title — "Chronometric data and stratigraphic evidence support discontinuity between Neanderthals and early *Homo sapiens* in the Italian Peninsula" — is at odds with their own paleogeographic maps, which are purported to illustrate the spatio-temporal dimensions of the process. The maps are derived from KDE (Kernel Density Estimate) modelling of the set of dates for each technocomplex (KDE is a statistical tool that dispenses with the uniformity in

distribution assumed by the Bayesian methods implemented in OxCal; Bronk Ramsey, 2017). Instead of Neandertals represented by the Mousterian disappearing from southern Italy prior to the arrival of Moderns represented by the Uluzzian, the maps indicate presence of the latter since 45 ka ago and persistence of the former until 40 ka ago. Moreover, the three entities (Mousterian, Uluzzian, and Protoaurignacian) are shown to have coexisted in southern Campania all through the 41–42 ka interval.

Setting aside both the discrepancy between title and content and Higham et al.'s questionable associations between technocomplexes and human types (see above and Zilhão et al. 2015b, 2015c), is this sympatry scenario any more consistent than that proposed by Haws et al. for Iberia? To investigate the issue, we ran Higham et al.'s KDE models for the Mousterian, the Uluzzian, and the Aurignacian of Italy (unmodified, except for the correction of two errors in the assignment of dating results, which concern levels A3-A4 of Fumane, included in the Mousterian by Higham et al. but that, per Peresani et al. 2016, are Uluzzian, and layer D of Cavallo, which is Aurignacian, but Higham et al. included in the Uluzzian). Our results are shown in Fig. 24. They clearly bear out two key conclusions. Firstly, that the Uluzzian is tightly constrained to the 41–44 ka ago interval. Secondly, that the overlaps between Mousterian and Uluzzian and between Uluzzian and Aurignacian can be explained entirely by the intrinsic uncertainty of the age measurements, as intimated by the marked reduction that said overlaps undergo when the luminescence ages (whose standard deviations in the dataset are, on average, 6 % of the mean) are excluded and only the radiocarbon ages (whose standard deviations in the dataset are, on average, 2 % of the mean) are considered.

The dating of the Italian Transition is therefore entirely in agreement with the notion that Mousterian, Uluzzian, and Protoaurignacian are consecutive rungs of the regional chronostratigraphic ladder, one that ran in parallel with south-western France's. Higham et al.'s study thus provides a useful cautionary tale with respect to the kinds of questions that we can legitimately ask and hope to answer. The resolution of this period's site stratigraphies and radiometric chronologies lets us deal with issues of process and long-term change, but it is inadequate to address issues of short-term history. Pretending that modelling will allow us to overcome the intrinsic limitations of the record is delusional.

5.4. Go East?

If, in Europe, the drive to make modern humans as early as the data conceivably might allow them to be leads to inconsistency with respect to the data, the logic of the interpretations, or both, could it be the same with the opposite arrow of the dispersal, that which putatively IUP Moderns in central Asia and eastern Siberia as early as 45 ka ago? As most recently summarised by Zwyns (2021), the argument to that effect is supported, on the technological side of things, by similarities between the IUP *sensu lato* and the assemblages from several open-air sites. Whether such similarities are real, and stand for diffusion, migration, or convergence is something that needs to be addressed only if the dating of those assemblages is secure to begin with. In the following, therefore, dating is the issue that, on a site-by-site basis, we will largely limit ourselves to.

5.4.1. Kara-Bom

In the stratigraphic succession observed at this open-air Altai site, the stratigraphic units of interest are found in grid units D-N (Cyrillic Д-Н)/1–9 of Trenches 1 (excavated 1980–1991) and 4 (excavated 1992–1993). The deposit containing the archaeology of interest is a colluvium of aeolian dust and sandy loam containing rock debris derived from the cliff that it leans against. Adjacent to the rock face, the stratification presents a significant dip, which gradually diminishes over a distance of ~11 m until the bedding becomes nearly horizontal and only the underlying Middle Palaeolithic units are represented. In Goebel et al.'s (1993) description of the 1991 profile, the relevant deposit is

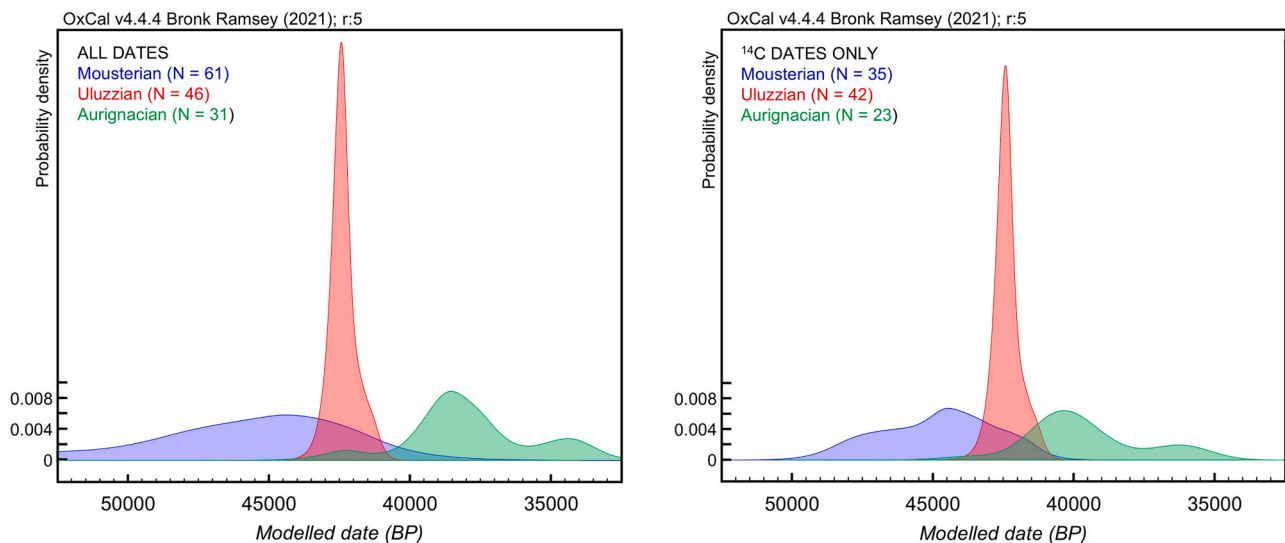


Fig. 24. Modelling the Transition in Italy. The KDE model plot of Higham et al.'s (2024) complete dataset (left), compared with that obtained when using only the radiocarbon ages (right). Note how excluding the less precise luminescence ages substantially reduces the overlap between the Mousterian and the Uluzzian and aligns the start date of the Protoaurignacian with the 41.5 ka mark seen everywhere across Europe. The extended left tail of the Aurignacian distribution reflect the former's duration and Higham et al.'s inclusion in the latter of results from both Protoaurignacian and Early Aurignacian contexts. These distributions suggest that the Mousterian, the Uluzzian, and the Protoaurignacian are consecutive cultural phases and that, rather than reflecting actual settlement history, the observed overlaps result from the inherent uncertainties of the dating methods.

lithological unit 4, wherein “four stratigraphically separate early Upper Palaeolithic components” were recognised: from top to bottom, II-d, II-c, II-b, and II-a (Fig. 25). In Derevianko and Rybin's (2003) subsequent rendering of the sequence, II-b and II-a correspond to Occupation Horizons (OH) 5 and 6, found within lithological stratum 6 of an updated geological description of the same profile; higher-up, Goebel et al.'s components II-d and II-c correspond, respectively, to Derevianko & Rybin's OH3 and OH4 horizons, found within their lithological stratum 5.

There is no question that the illustrated lithic assemblages from stratum 6 were produced in the framework of a fully Upper Palaeolithic technology; the numerous refit sets document the volumetric reduction of cores and the complete absence of the Levallois method, otherwise well represented lower down in the Middle Palaeolithic part of the succession (Derevianko and Rybin, 2003; Slavinsky et al., 2016; Zwyns et al., 2012). The refitting work, however, also revealed that the deposit has a complex formation history. Rather than the four horizons previously identified, Slavinski et al. have shown that only two can be differentiated, an upper “UP1” and a lower “UP2.” Putting together all the stratigraphic and planimetric information available, it becomes readily apparent that (a) both horizons reproduce the downslope, sagittal, roughly north-to-south dip away from the cliff face that characterises the sedimentary body, (b) the dip is of $\sim 25^\circ$ across its entire extent in the case of UP1 and of $5\text{--}10^\circ$ in the case of UP2, (c) along the other axis of the stratification, UP2 is nearly horizontal, and (d) the vertical scattering of the items that go into the refit sets is quite significant in the case of UP1 (up to 50 cm), but less so in the case of UP2 (15–20 cm).

This site formation framework sheds much light on the significance of the radiocarbon dating results that Goebel et al. obtained on samples taken in 1991 along the I (Cyrillic И) line of the grid (at the interface between Trench 1 and the adjacent, subsequently excavated Trench 4) (Fig. 25). Projecting Slavinski et al.'s clusters of refit links onto the stratigraphy recorded by Goebel et al. reveals that:

- The uppermost sample, GX-17592 ($38,080 \pm 910$ BP) is out of stratigraphic order.

- Two results in the range of 39 ka cal BP (GX-17594, and GX-17595), plus another in the range of 35 ka cal BP (GX-17593), are from samples that correlate well with the cluster that defines horizon UP1.
- The lowermost, statistically identical results of ~ 46 ka cal BP (GX-17596, and GX-17597), which have been assumed to provide an age for the site's IUP, come from samples in a fire feature lying unambiguously **below** the cluster of refit links that defines the UP2 horizon.
- The small 10 cm-deep depression in the south-west corner of square L8 — dug from a *décapage* surface lying at ~ 322 cm below datum, and containing 88 g of red powder, a flat pebble with pigment stains, and three pendants — lies at the base of the UP1 cluster of refit links, well **above** the UP2 cluster.

With regard to UP1, GX-17592 indicates the presence of inherited material among the charcoal fragments found in stratum 5. This is to be expected given (a) the significant post-depositional disturbance of the upper part of the stratification, especially near the back, against the rock face, as acknowledged by Derevianko and Rybin, and (b) Slavinski et al.'s finding that the artefacts in horizons OH1–OH2 refit within UP1. That the charcoal content of UP1 is heterogeneous is further illustrated by GX-17593, which is statistically younger than GX-17594 and GX-17595. In addition, elevation-wise, the artefacts defining Derevianko and Rybin's OH4 plot between Slavinski et al.'s UP1 and UP2 clusters of refit links, not within UP1's, which further hinders any attempt at correlating the natural stratigraphy with the archaeological stratigraphy.

It must also be borne in mind that refitting material found within the same thickness of deposit, or even on the same surface, does not necessarily demonstrate the contemporaneity of the activity documented by the refit sets, let alone that they were produced in the context of a single occupation event. In François Bordes' classic example, if, in a hypothetical Australian junkyard, two clusters of refit links can be established, one bringing together different car parts, another bringing together flaked stone tools, it does not follow that past Aboriginal people possessed the levels of technology and socio-economic organisation required for the industrial production of motor vehicles (Bordes, 1980). Likewise, the technological homogeneity of the finds making up the UP2 refit sets needs not imply that everything else in stratum 6 must reflect

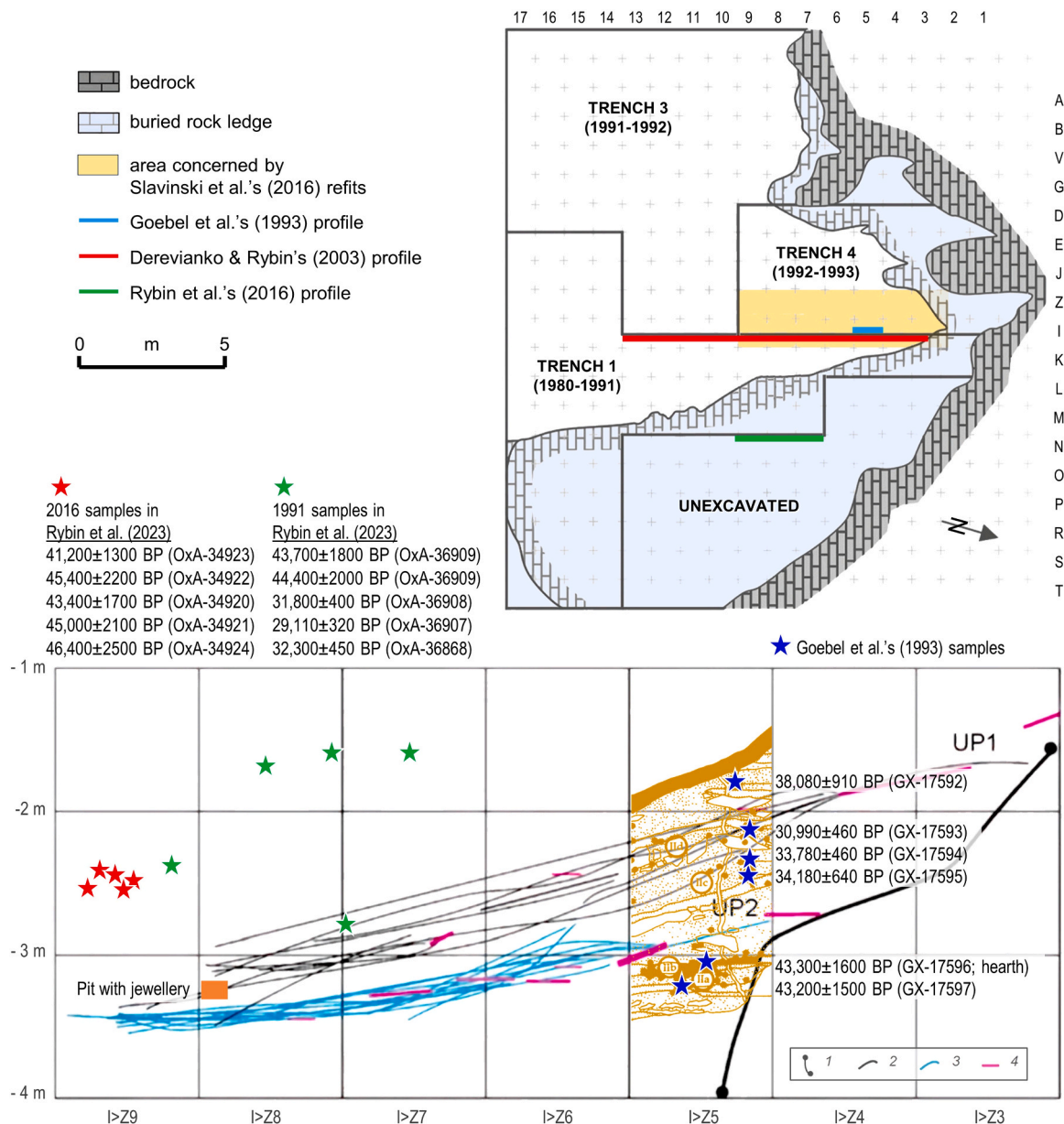


Fig. 25. Kara-Bom: archaeological stratigraphy and dating. Site plan and excavation grid (after Rybin et al., 2023, modified), with positioning of the jewellery kit and of Goebel et al.'s (1993) samples onto (a) the latter's Z>I stratigraphic profile and (b) the distribution in columns Z and I of Slavinsky et al.'s (2016) UP1 and UP2 clusters of refit links (caption: "1. vertical profile of rock along line Z; 2. distribution of artifacts made from various groups of raw materials in UP1; 3. distribution of artifacts made from various groups of raw materials of UP2; 4. distribution of combustion structures").

coeval, similar activity.

According to Slavinski et al., "the technique of subprismatic bidirectional detachment of medium sized and large laminar blanks was determinative for the industries of both horizons." If anything, this continuity in technology suggests that both horizons are close in time and that the significantly earlier age obtained for the hearth feature that Goebel et al. excavated below UP2 is but a *terminus post quem* for the overlying scatters of refitted stone tools. What exactly does that hearth stand for? The answer may lie in the stone tools found in basal stratum 6 that did not make it into the UP2 refit sets (which, for UP1 and UP2 combined, involve no more than 294 artefacts out of a total of 2010). Until information is provided on what such material looks like, we will not be able to know. What we do know — not unexpectedly, given the deposit's colluvial nature and periglacial context — is that the commingling of charcoal of at least three different ages is demonstrated in stratum 5, and, so, that there is every reason to expect stratum 6 to also

be heterogeneous in content.

The new results reported by Rybin et al. (2023) do not change the picture. Five are on piece-plotted bones from the 1991 excavation, which Rybin et al. plot against Derevianko and Rybin's décapage plan for grid units Z-M (Cyrillic 3-M)/7-9. The finds in the latter, however, "were recovered from the lower portion of lithological layer 6 consisting of grey sand and loam impregnated with gravel and schist plates," and "the difference in relative levels of the finds within this layer is not more than 38 cm: from -352 cm (from zero datum) in the south-western corner of the study area to -314 cm in the unit's north-eastern corner; the average levels vary from -316 to -340 cm, which corresponds to the general dip of the excavation unit's floor." Yet the 1991 samples that Rybin et al. dated come from between 1.0 m and 1.5 m above that plan's elevations. With regard to the five 2016 bone samples taken in the M>N (Cyrillic M>H) profile, they come from a deposit that lies on a rock ledge forming a terrace in the eastern side of the Trench 1 excavation, where,

as Rybin et al. (2023) do acknowledge, “lithological Layers 1–6, containing UP assemblages, [and] the underlying sediments with MP assemblages, were not found.” Accounting for the significant dip to west of the deposit lying on the ledge (well apparent in the photo of the 1991 excavations published by Belousova et al., 2020) does not change the fact that those samples come from well above the deposit that yielded the site’s UP assemblages. Yet, they are statistically the same as the two charcoal dates reported by Goebel et al. for the sediments found below Slavinski et al.’s UP2 cluster of refit links (Fig. 26).

The meaning of these observations is self-evident to us: an animal bone component of Middle Palaeolithic age, dating in the range of 40–55 ka ago, is scattered through Kara-Bom’s post-Middle Palaeolithic deposit. That each of the units differentiated in the latter contains inherited material of a diverse chronology is otherwise corroborated by GX-

17592, Goebel et al.’s stratigraphically anomalous charcoal result. Such background noise probably reflects the gradual incorporation of remains derived by erosion from soils and natural thanatocoenoses originally formed upslope to the east — ones that gradually gravitated, or were washed down, all through the accumulation of the aeolian material forming lithological strata 1–6 of Derevianko and Rybin’s layout. These conclusions are fully consistent with the fact that, except for the tool dated to $29,110 \pm 320$ BP (OxA-36907), none of Rybin et al.’s other bone samples bear cut marks or are otherwise humanly modified.

To sum up: the stone tool assemblages in the UP1 and UP2 horizons of Kara-Bom are technologically similar and fully Upper Palaeolithic in nature. Based on the charcoal ages associated with UP1, they are likely to date to the time range of the Early Aurignacian of western Eurasia,

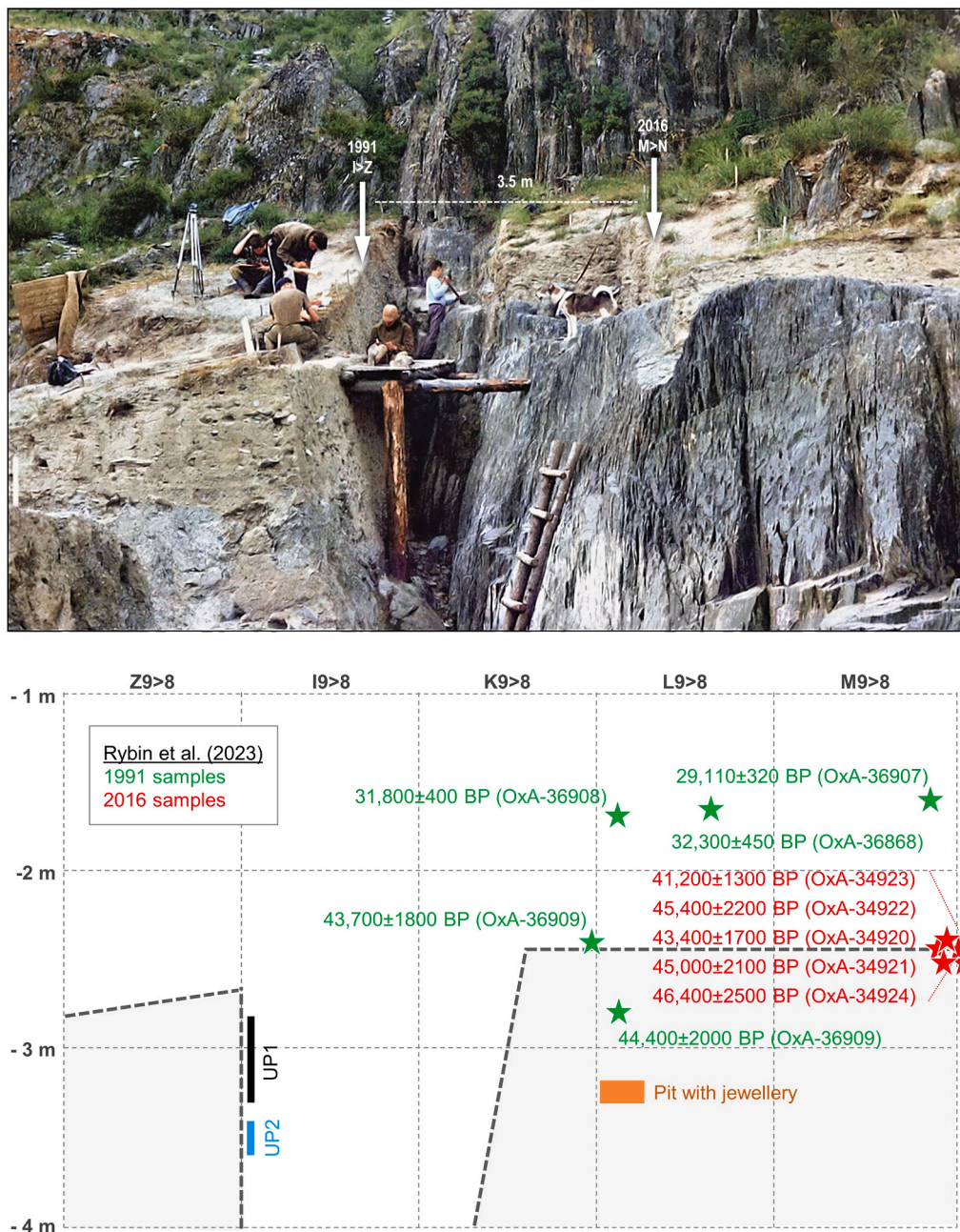


Fig. 26. Kara-Bom: stratigraphic distribution of the OxA bone dates. Top: frontal view of the rock face and the excavation trench (after Belousova et al., 2020, modified); the profiles from 1991 (Goebel et al., 1993; Derevianko and Rybin, 2003) and 2016 (Rybin et al., 2023) are indicated. Bottom: projection of the positions of the pit with the jewellery and of Rybin et al.’s (2023) samples across a schematic east-west section running along the separation between rows 8 and 9 of the grid.

~39 ka ago. Albeit widely quoted on the basis of Goebel et al.'s results, the ~46 ka horizon for the regional emergence of this technology is in fact a *terminus post quem*. Otherwise, Rybin et al.'s Bayesian model is a good example of how a statistically robust methodology can be misapplied. By claiming to date a deposit based on the age of samples that, even though not collected in it, are posited to relate to it, they effectively engage in circular reasoning, affirming the consequent and proving nothing that they had not assumed to begin with. Finally, the stratigraphic relationship between the clusters of refit links and the symbolic artefacts in the small depression found in grid unit L8 vindicates Zilhão's (2007) proposition that it be seen as a cache related to the upper, not the lower find horizon.

5.4.2. Tolbor

At this extensive Mongolian site, unit 3c of the Tolbor 16 locality is claimed to document an Upper Palaeolithic occupation dated to within the 41.2–46.7 ka cal BP interval (Zwyns et al., 2019). The claim is based on Bayesian modelling of the radiocarbon ages obtained from the bone fragments (in total, 19 unidentifiable and >20 mm, plus 49 from sieving and <20 mm) therein associated with an 825-strong stone tool assemblage (362-strong, excluding the <20 mm sieve finds). However:

- Unit 3c is a solifluction lobe: “With a few exceptions, most of the samples from unit 3 show particle size distribution curves (...) consistent with reworking (...) or soil development (...). Although loess is the parent material, the dominant depositional process within unit 3 seems to be sheet erosion.”
- The preservation of the bones is extremely poor, and no cut marks or other evidence of human modification could be observed: “When bones are preserved, they are fragmented, and the cortical surface is missing.”
- The luminescence dating of unit 3c sediment yielded ages of 26.6 ± 2.6 ka (quartz OSL) and 35.3 ± 3.2 ka (pIR-IRSL290 polymineral OSL). When the estimates obtained for the same sample do not agree, the site's luminescence study argues that the quartz age should be retained. For unit 3c, doing so implies deposition no earlier than 31.8 ka, 10–15 millennia later than indicated by the radiocarbon-dated bone samples (even if we posit that the polymineral estimate should be preferred, a deposition age in the 28.9–41.7 ka interval, also much later than indicated by the radiocarbon ages, is nonetheless implied).

Zwyns et al.'s reasoning would seem to be that (a) the OSL results date the sediments' last exposure to light and therefore a remobilisation event, and (b) the time of deposition of the displaced human occupation remains found within the sediments must predate that event and be given by the age of the bones. The latter's poor preservation, however, is not due to chemical processes, given the good collagen content implied by the successful dating of 32 % (6 out of 19) of the >20 mm bone fragments from unit 3c, and the fact that 23 out of 24 samples submitted to ZooMS analysis could be taxonomically identified. Moreover, even if rarely so, bone fragments are also found in units that contain no lithics. Given this, the parsimonious interpretation of the bones' poor physical condition is that they were subject to processes of mechanical weathering, ones that do not seem to have affected the lithics. These observations contradict the notion that the bones must relate to the human activity represented by the artefacts, and, in any case, co-occurrence in a reworked deposit is no proof of contemporaneity.

Further evidence that the bone component of unit 3c's soliflucted lobes cannot be taken as a proxy for human activity is provided by the infinite date obtained for basal level 7 of Pit 1 (AA-93134, >45,400 BP; Zwyns et al., 2014). Zwyns et al. (2019) refer to the bone sample that this result derives from as follows: “its association with the archaeology was not clear.” Therefore, either the rationale that the dated bones must all be associated with the archaeology is invalid, or, if the sample was associated with the archaeology, then the soliflucted accumulations'

faunal content is at least in part made up of residual material derived from the erosion of earlier deposits. AA-93134 therefore corroborates that Tolbor 16's radiocarbon ages provide no more than *termini post quem* for the Upper Palaeolithic stone tools found alongside the dated bone samples.

The same is the case elsewhere at Tolbor. For instance, at Tolbor 4, Occupation Horizons OH5 and OH6 yielded an assemblage like that in unit 3c of Tolbor 16, which lies <10 km downstream (Derevianko et al., 2013; Zwyns et al., 2014). On ostrich eggshell, the Tolbor 4 dates are $31,210 \pm 410$ BP (AA-93140) and $35,230 \pm 680$ BP (AA-93141) for OH5 and OH6, respectively; on bone, the corresponding results are >41,050 BP (AA-79326) and $37,400 \pm 2600$ BP (AA-79314). These bone dates are stratigraphically inverted and corroborate the residuality of the poorly preserved faunal assemblage apparently associated with the lithics. The ostrich eggshell dates are stratigraphically consistent, but the older one is four to six millennia younger than the ~45 ka time horizon for the emergence of the IUP at Boker Tachtit.

Another example is Tolbor-21 (Rigaud et al., 2023; Rybin et al., 2020), where the surface condition of the faunal remains is unambiguously described as follows: “The frequency of cracking (26 % of NR) and exfoliation (42 % of NR) are consistent with a slow embedding of the bone assemblage. This finds an interesting echo in the high impact of the root etching observable on 62 % of the remains, attesting a protracted exposure of the remains to vegetal activity. In consequence, most of the cortical surface of bones is usually destroyed; indeed, 52 % of the remains have lost more than 75 % of their cortical surfaces.” The contemporaneity of these fragmentary and heavily weathered remains (and, hence, of the dated samples) with the Upper Palaeolithic stone tools and symbolic artefacts of the site's AH (Archaeological Horizon) 4 is, therefore, undemonstrated. This is the more so given the nature — “continually accreting low- to moderate-energy slope deposits” — of the encasing sediment (Rybin et al., 2020). At best, thus, the dated bones from AH4 of Tolbor-21 can only provide a *terminus post quem* of 41–42 ka cal BP for the human occupation that left the artefacts behind.

5.4.3. Kamenka

Like Kara-Bom, Kamenka, an open-air site in the Transbaikal region of Siberia, is a slope deposit. Here, layer 6 of the stratigraphic succession is the unit of interest. It yielded two archaeological horizons at a depth of 7–9 m below surface. Based on the advanced stage of weathering of the small number of faunal remains and the wide scattering of the rare artefacts, the upper horizon, Complex B, is considered to be in derived position. The lower horizon, Complex A, is reported to contain hearth features tightly associated with clusters of faunal remains, lithic artefacts, and bone tools (awls, retouchers, and a decorated “whistle”); i.e., Complex A does contain reliable indicators of on-site, well-preserved human activity (Germonpré and Lbova, 1996; Zwyns, 2021; Zwyns and Lbova, 2019).

The stone tools found in Complex A look unambiguously Upper Palaeolithic; production is based on the same core reduction techniques documented by the Kara-Bom refits. It is from this observation and the age of the stratigraphically associated, AMS-dated bone samples that a claim is derived for Complex A to represent evidence for IUP-like assemblages to be found that far to the east as early as ~45 ka. The argument is predicated on the notion that the artefacts, the features, and the faunal remains are coeval, and, therefore, that the dates are a reliable measure of the age of the human activity. This assumption, however, does not stand up to scrutiny, as it overlooks the fact, well documented by Germonpré and Lbova, that Complex A's faunal assemblage consists of two components. One, formed of remains of horse and Mongolian gazelle, represents 90 % of the NISP, is relatively fresh, and bears cut marks and other evidence of human modification. The other, representing 10 % of the NISP, is weathered, bears no evidence of human modification, includes carnivore-gnawed specimens, and, alongside horse and gazelle, is mostly comprised of taxa not found among the fresh material, namely: bison, woolly rhino, giant deer,

mountain sheep, camel, and an extinct antelope.

This second component of Kamenka's Complex A fauna is, therefore, residual: environmental background material that the deposit incorporated penecontemporaneously with the human activity, for which it provides no more than a *terminus post quem*. Yet, out of the four AMS dates that Zwyns & Lbova take as reliable, two — OxA-12116 ($39,290 \pm 350$ BP), and OxA-12117 ($41,350 \pm 450$ BP) — are on such residual material, specifically, on giant deer bones: a fragment of humerus, and a shed antler (Hughes et al., 2006). A third date (Vasiliev et al., 2002), AA-26,743 ($40,500 \pm 3800$ BP), is on a bone unidentified to taxon and comes with an uncertainty interval too large for practical use in the assessment of the age of Complex A. According to Hughes et al., the fourth date — GrA-5435 ($37,350 \pm 310/-490$ BP) — comes from a cut-marked tibia of gazelle, probably the bone photographically illustrated in Germonpré and Lbova's Fig. 8, as that is the only such tibia that the latter identified in the assemblage.

Assuming the reliability of the zooarchaeologist's classification of the mark, GrA-5435 would be the only dated sample from Kamenka that one can securely associate with human activity. Whether such activity relates in turn to the artefact assemblage depends on whether the latter is homogeneous and reflects a single episode — and that, as we have seen in the case of Kara-Bom, is assuming a lot. Such an assumption provides the best scenario for the Upper Palaeolithic in Complex A to be of an early age — albeit one no older than the Ahmari/Protoaurignacian. Thus, at Kamenka, what is of the same age as the IUP of the Near East, perhaps even older, is not “modern humans” bearing a comparable material culture but a giant deer fauna that significantly preceded any human presence at the site.

5.4.4. Tolbaga

Another Transbaikalian example of the site formation issues raised by the Siberian open-air sites is Tolbaga (Izuho et al., 2019). Here, two distinct cultural layers have been recognised within the topsoil and another two, layers 3 and 4, within the underlying, ~60 cm-thick, muddy gravel that overlies another soil horizon. Most of the finds come from layer 4 and, according to Izuho et al., they provide a good illustration of the region's earliest Upper Palaeolithic, characterised by “blade-based lithic toolkits with Levallois elements, rich osseous tools produced through systematic procedures, and mobile art such as pendants or sculptures (...), found alongside stone-lined dwellings, stone-lined hearths, and storage pits.”

Layer 4 of Tolbaga yielded no less than 12 dates on ultrafiltered bone collagen, none of which would seem to bear cut marks or other evidence of human modification, even though many such bones have reportedly been identified in the faunal assemblage. Most of these layer 4 results fall in the 36–42 ka cal BP range, but one is as young as $24,070 \pm 150$ BP (UCIAMS-143239; $27,841-28,630$ cal BP), and another is as old as $43,900 \pm 1800$ BP (UCIAMS-143220; $43,276-49,939$ cal BP). As the succession formed via colluvial slope wash with intermittent soil formation, residuality issues must be of import here as much as at Kara-Bom, Kamenka, and Tolbor. There is therefore every reason to dismiss as background noise the single sample from the archaeological horizon that dates in the 45–50 ka cal BP range.

5.5. Denisova

Having clarified the overall Eurasian context, we are now in a position to assess the evidence from Denisova, a key Altai site where the preservation of aDNA is excellent and samples therefrom contributed major breakthroughs to the palaeogenetics of the Upper Pleistocene. While the Siberian localities we just reviewed are all open-air sites, Denisova is a cave in the study of which it is especially important to bear in mind the lessons of Turner et al.'s (2013) taphonomic revision of Palaeolithic Siberia's faunal assemblages.

Turner et al.'s key conclusion was that, whenever evidence of hyaena denning exists in a cave site, the association between artefacts and bones

ought to be considered suspect by default because of the species' burrowing behaviour: if, alongside solifluction, frost-wedging, and the other disturbance processes that ubiquitously affect cave deposits formed under periglacial conditions, hyaena burrowing is found to be a significant contributor to syn- and post-depositional disturbance, then the presumption that individual stratigraphic units must be homogeneous in content is therefore even less warranted than usually. This caveat is the more important to consider when assessing cultural change through the Middle and early Upper Palaeolithic of Siberia because both predate the regional extinction of hyaenas and because it applies to open-air sites as well. At Kara-Bom, for instance, Turner et al. found evidence that hyaenas had been involved in the accumulation of the faunal assemblage. This factor may additionally explain the issues of sample association that afflict that site's dating record.

Regrettably, Turner et al.'s advice has seldom been heeded. Denisova, where hyaenas were highly active, is a major case in point. Significant post-depositional disturbance is corroborated by Morley et al.'s (2019) soil micromorphological work, which, as argued by Kuzmin and Keates (2020) and d'Errico et al. (2024), suffices to explain the patently inconsistent dating results obtained for the site (Douka et al., 2019; Jacobs et al., 2019b; Reich et al., 2010). In fact, the Bayes-derived chronological frameworks such results have been forced into are only as good as the underlying assumptions, which, in our view and as we now proceed to argue, are questionable.

5.5.1. Stratigraphy and dating

Given the issues with stratigraphic integrity, the bottom line at Denisova is that dating by association is not possible: only comparative typology, supplemented by the direct dating of diagnostic human remains and of artefacts made on bone or tooth, is amenable to providing reliable age estimates. A clear-cut illustration of the problems is provided by the discrepancy between the direct dating results obtained for bone fragments genetically assigned to the so-called Denisovan population and the ages obtained for samples with which those fossils were found in stratigraphic association. Based on the number of mutations observed in their mitochondrial genomes, all of the site's Denisovan individuals have been dated to >51.6 ka ago, which agrees with the >49.9 ka ago radiocarbon age for a bone representing the first generation offspring of an episode of Neandertal/Denisovan interbreeding (Douka et al., 2019; Slon et al., 2018). Yet the remains of such individuals were retrieved in levels for which ages up to at least 30,000 years younger have been obtained on both bone and charcoal samples. For instance, the Denisova 4 fossil (the upper permanent molar of an adult Denisovan male) comes from level 11.1 of the South Chamber, where a charcoal sample collected at the same elevation <2 m away is as young as $19,990 \pm 61$ BP (Essel et al., 2023) (Fig. 27).

In addition, the site's Pleistocene sequence is exposed in three different chambers; the trenches therein excavated are not contiguous, their lateral correlation is not straightforward, and problems exist even within a single trench. Take for instance the stratigraphic G>D (Cyrillic Г>Д)/6–5 profile of the South Chamber. Fig. 28, where the compared images are taken from Jacobs et al. (2019b), leaves no doubt that the two photos record the same profile — as it remained after the 2003 excavations, on one hand, and after its 2016 sampling, on the other. Yet the deposit that OSL samples 1–3 of 2012 and 1–3 of 2016 are reported to provide an age for is designated level 11 in the “after 2003” photo and associated drawing but said to be the provenience of the OSL samples from level 12 in the 2016 photo. Given that all the remains genetically assigned to either Neandertals or Denisovans were excavated between 1984 and 2012, and seven out of eight come with either a level 11 (five) or level 12 (two) label (Douka et al., 2019), one cannot but wonder about their reported association with the ages published post-2016 for samples carrying the same level labels, i.e., “11” and “12” (and much the same applies to the site's directly dated animal tooth pendants): Do the finds and the samples come indeed from the same stratigraphic units, or do they simply carry the same labels, ones whose stratigraphic meaning

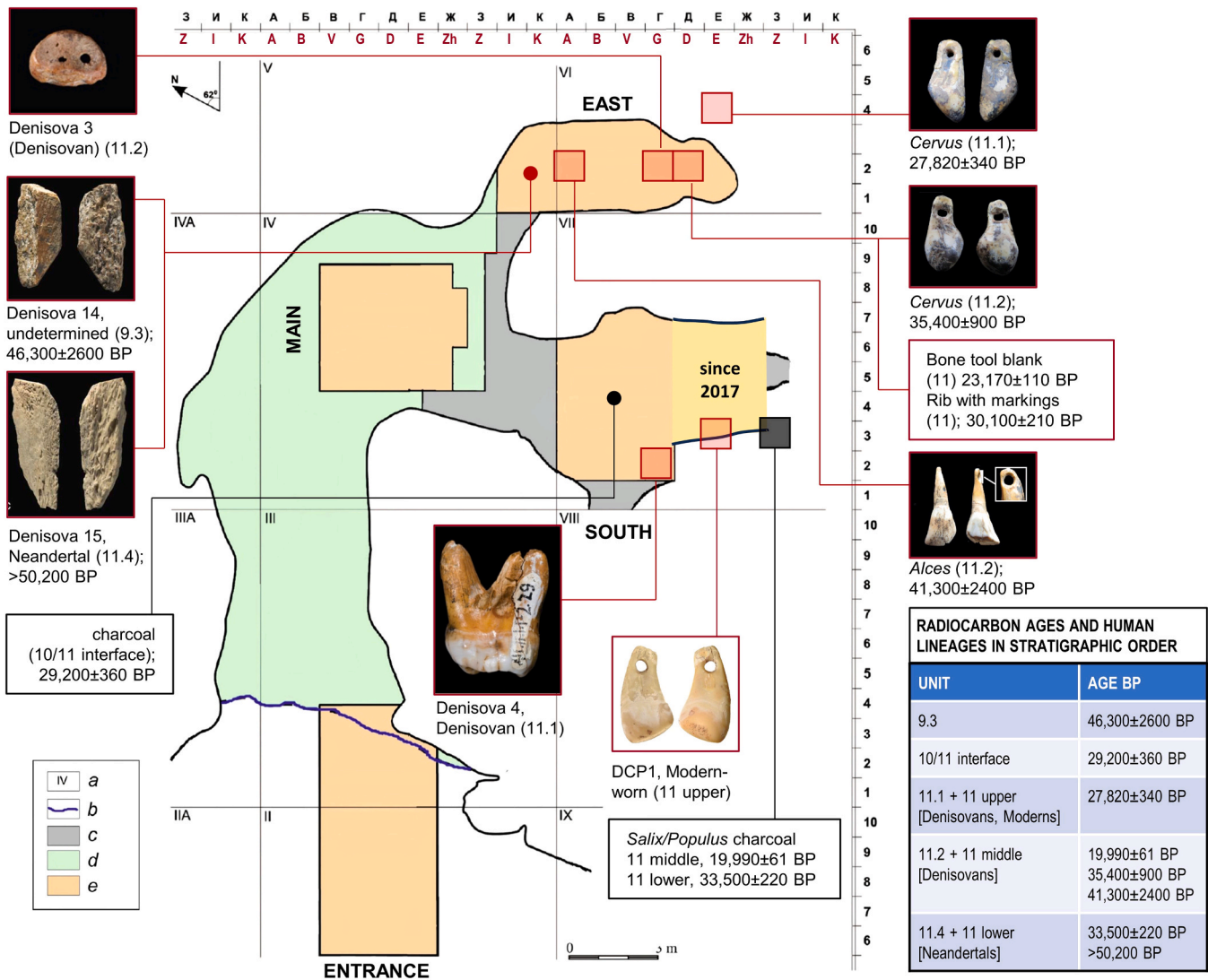


Fig. 27. Denisova Cave: site plan and spatial distributions. Provenience of (a) the human remains that have been directly dated or have provided genetic evidence allowing assignment to (or relation with) a specific human lineage, (b) the stratigraphically provenanced and directly dated animal tooth pendants and bone tools, and (c) the charcoal dates for the South Chamber (caption: a. sector number; b. dripline; c. Holocene surface; d. top of exposed Pleistocene deposit; e. excavation trenches). The area excavated in the South Chamber since 2017 has been added. After Douka et al. (2019) and Essel et al. (2023), modified.

changed through time, as the excavation of the site progressed?

Using comparative typology, we can nonetheless conclude that the stone tools from basal level 11 of Derevianko and Shunkov's (2003) monograph point to a human occupation of the site taking place in the range suggested by (a) the charcoal dates associated with Kara-Bom's UP1 refit cluster, (b) the cut-marked gazelle bone from Kamenka, and (c) most of the dates for layer 4 of Tolbaga. That range is the 39–42 ka ago interval during which the Early Aurignacian and the Ahmarian/Protoaurignacian are to be found in Europe and the Near East. With regard to the pendants and the bone tools, however, Douka et al. (2019), based on direct dating results, have argued that, at Denisova, the production of such types of artefacts began 43–49 ka ago and may well have been the work of neither Neandertals nor Moderns but of Denisovans. An alternative interpretation is Zilhão's (2007) argument, based on Derevianko and Shunkov's (2003) rendering of the site's stratigraphic layout, that (a) "a major discontinuity separates (...) layer 11 of Denisova from the immediately overlying (...) level 9," that (b) "the contact between the two is significantly disturbed," and, therefore, that, (c) "because the range of ornaments from level 11 is identical to that found in both level 9 and the pockets containing level 9 lithics that penetrated deeply into level 11 (...), their association with the IUP is questionable."

The implication of this reasoning was that most, if not all the pendants and bone tools from Derevianko and Shunkov's (2003) level 11 are of a later Upper Palaeolithic age — probably in the range suggested by the artefacts in their level 9, i.e., in the range of the Gravettian of Europe and western Russia.

In making their case, Douka et al. would seem to have overlooked the significance of the charcoal ages that they also obtained for the 2016 excavation of "level 11" of the Main Chamber. They report that the samples come from freshly excavated profiles (mostly from the south-east wall of the 2016 excavation trench) and "from locations that were deemed during excavation to be undisturbed." The 14 determinations made on 10 different samples using a range of pretreatment techniques, including the more robust ABOx-SC method, are consistent and therefore can be used to define the time span during which the deposit was laid down: between 32,530 ± 260 BP (OxA-34721) and 36,300 ± 900 BP (OxA-X-2695–23), i.e., within the 36–42 ka cal BP interval. Against this background, any older dates for artefacts and bone samples must reflect residuality, the more so if the stratigraphic integrity of the area of the cave (or the part of the deposit) that they come from cannot be ascertained. That residuality is an issue here is otherwise demonstrated by the faunal dates for subunit 11.4 listed in Douka et al.'s set of 2016

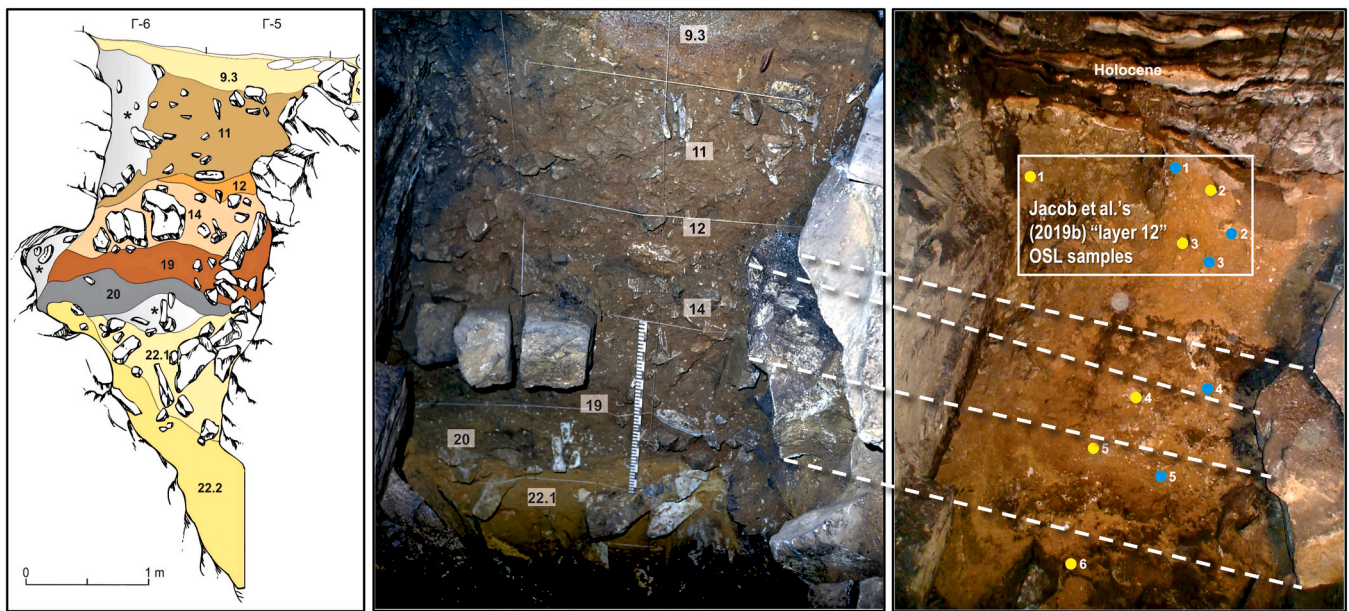


Fig. 28. Denisova Cave: The G>D/5–6 profile of the South Chamber. Left: drawing, after the 2003 excavation. Middle: photo, after the 2003 excavation. Right: photo, in 2016, after sampling for OSL dating (the blue dots correspond to samples collected in 2012, the yellow dots to samples collected in 2016). After [Jacobs et al. \(2019b\)](#), modified. The dashed lines indicate points common to both photos, added to facilitate the comparison. The rectangle in the 2016 photo bounds the area containing the samples that Supplementary Table 12 of Jacobs et al. places in layer 12, at an elevation that is consistent with their assignment of samples 4 and 5 to layer 14, and of sample 6 to layer 22. Until at least 2003, this area was considered to belong in layer 11, and it remains so in the geological description found in Jacob et al.'s Supplementary Table 18.

samples from the same chamber. Whereas results in full agreement with those on charcoal were obtained for the four bones of taxa in the size range that, based on Kamenka, one might expect to have been the main target of the human hunters (*Capra* sp. and *Ovis/Capra*), infinite ages, >50,300 BP, were obtained for two bones of *Bos/Bison* that, based on Turner et al., one might expect to reflect the activity of Middle Palaeolithic hyaenas.

5.5.2. The artefacts' direct dates

Two of [Douka et al.'s \(2019\)](#) artefact dates are for bone points from “level 11” of the Main Chamber. Both are at odds with expectations derived from the dates on the charcoal and the bones of the caprines from the same level and chamber: one, for an item made on a horse bone and retrieved in 2016, is too old by some five millennia; the other, for an item made on a bison bone and retrieved in 1997, is too old by some ten millennia ([Fig. 27](#)). As [Kuzmin and Keates \(2020\)](#) have remarked, it remains to be demonstrated that these are not just naturally pointed, hyaena-digested shaft fragments, which are known to sometimes mimic the morphologies produced by human modification ([Villa and d'Errico, 2001](#)). But, if artefacts indeed, these two objects are akin to the minimally modified bone tools of the European Middle Palaeolithic. They could derive from the underlying strata, or they could simply reflect that the raw material was procured by the cave's Upper Palaeolithic occupants from among the abundant bones scattered across the coeval cave floor, which must have included material of Middle Palaeolithic age displaced by hyaena burrowing.

The directly dated tooth pendants are four: one is a perforated tooth of moose (*Alces alces*) from the Main Chamber, was collected while profile cleaning, is of uncertain stratigraphic provenience, and was dated to $28,390 \pm 330$ BP (OxA-34729); another perforated moose tooth is from the East Chamber, comes from “level 11” of 2014, and was dated to $41,300 \pm 2400$ BP (OxA-30963); the other two pendants are perforated red deer teeth from “level 11” of the East Chamber, were collected in 2007 and 2006, and have been dated to $27,820 \pm 340$ BP (OxA-30006) and to $35,400 \pm 900$ BP (OxA-30005), respectively. These four results are on non-ultrafiltrated collagen but there is no reason to

suspect that they are minimum ages only because [Douka et al. \(2019\)](#) obtained statistically identical results when dating, with and without ultrafiltration, sub-samples of the same bone sample. [Zilhão's \(2007\)](#) suggestion that most of Denisova's “level 11” ornaments relate to human use of the cave in post-IUP, most likely Gravettian times, would therefore seem to be vindicated; indeed, such is also the range indicated by the charcoal dates that, in the South Chamber, have been suggested to provide an age bracket for the perforated red deer tooth recently published by [Essel et al. \(2023\)](#) ([Fig. 27](#)).

With regard to the two older results for the tooth pendants, OxA-30005 is within the range to be expected based on the charcoal dates for the parts of “level 11” of the Main Chamber that are claimed to be undisturbed; considering its 95.4 % probability interval, so is OxA-30963. Note, however, that, according to [Jacobs et al. \(2019b\)](#), the number of moose remains in Denisova's identified mammal bone assemblages is, all layers combined and excluding small animals, (a) zero among the Main Chamber's 1412 remains, and (b) four among the East Chamber's 8003 remains (all four coming from different subunits of “level 11,” no body part given, presumably including at least the perforated tooth from subunit 11.2 that was directly dated). With regard to the South Chamber, moose is only represented, and by a single find, in level 16 of the species list published by [Vasiliev et al. \(2021\)](#) for the recent, 2019–2020 excavations (totalling >100,000 bones, of which >6000 identified), while the other taxon whose perforated teeth were directly dated, red deer, is absent from level 11.

Given these numbers, the possibility must be entertained that OxA-30005 and OxA-30963 reflect Gravettian-age usage of scavenged material, either obtained on-site from hyaena-scattered remains of an earlier age or available in the cave's environment ([d'Errico et al., 2024](#)). Bearing in mind the dramatic oscillations that the climates of the northern hemisphere experienced during MIS 3, one would expect erosion and melting of the permafrost to have provided multiple opportunities for Siberian hunters to obtain rare (and thereby prized) items from well-preserved, freshly exposed carcasses of long-dead animals — much as with mammoths and mammoth ivory in the present-day. This caveat — when dating osseous material, one is dating the time of death

of the animal the bone or the tooth belonged to, not the time of manufacture of the artefact that such raw material was transformed into — is the more important in the case of Denisova because (a) the “level 11” assemblage of symbolic artefacts includes items that, typologically, are strongly suggestive of a more recent, even Holocene, age, namely, the polished green stone bracelet published by Derevianko et al. (2008), and (b) the age estimates derived from the human and deer DNA extracted from the surface of the pendant published by Essel et al. (2023) and from the sediment adhering to it do not exclude a relatively recent Holocene chronology either.

Thus, as is the case with the other Siberian sites, Denisova has yielded no reliable evidence for the Upper Palaeolithic to have emerged in central and eastern Asia prior to ~41.5 ka cal BP. Douka et al.’s (2019) speculation that the site’s pendants and bone tools may have been made by Denisovans is based, presumably, on the genetic determination to that lineage of two “level 11” remains — the Denisova 4 molar and the Denisova 3 hand phalange. However, (a) neither has been directly dated, (b) the level is ambiguously defined, heterogeneous, and it also yielded the Denisova 5 foot phalange and the Denisova 15 long bone fragment, both genetically determined as Neandertal, and (c) Denisova 15 has been directly dated to >50,200 BP (OxA-36012) (Fig. 27). In all likelihood, therefore, the association that Douka et al. rely on is incidental, and the makers of Denisova’s earliest symbolic items are neither Neandertals nor Denisovans but the regional equivalent of western Eurasia’s post-admixture, genetically and morphologically modern or near-modern people. In eastern Asia, such people are represented by the Tianyuan 1 partial skeleton from China, directly dated to $34,430 \pm 510$ BP (BA-03222), i.e., to 37.9–40.7 ka cal BP (Fu et al., 2013; Shang et al., 2007).

6. What’s to be done?

Modern/Sapiens and Archaic/Neandertal are concepts whose definition is based on the skeleton and on features fixed by natural selection and drift, ones that change over geological time, while the genomic history of the Transition is based on inferences relating to lineage and to changes in the genomes that take place over generational time. The interchangeable use of Neandertal and Modern as categories that are valid in both realms, Human Palaeontology and Genetics, assumes that the differences observed in the latter can be mapped onto differences observed in aspects of the skeleton or the behaviour. Yet, they cannot (Ackermann et al., 2019; Colagè and d’Errico, 2020). This is the fundamental paradigmatic obstacle hindering significant advances in the modelling of what happened in northern Africa and western Eurasia between 35,000 and 45,000 years ago.

The genomes of all European fossils reliably dated to this time interval are consistent with (a) their belonging in the Neandertal lineage, as indicated by skeletal morphology or, (b) if diagnosed as genetically Modern, their having had Neandertal ancestors less than ten generations back in their family history, in some cases no more than four to six (i.e., with their Neandertal ancestors having lived no more than a couple of centuries earlier). If those genetically “modern” people and their genetically “neandertal” ancestors were both alive within a 200-year bracket encompassed by the two-millennial duration of a given technocomplex, and if their descendants are of a mosaic nature, both anatomically and genetically, then discussing the Transition and the associated process of Neandertal assimilation in the dichotomic framework of the 1980s and 1990s is, by definition, a non-starter.

Elements of the traditional framework, namely the chronostratigraphic structure of the Transition interval, retain validity, but others have lost the relevance that they once had. For instance, *in illo tempore*, demonstrating that the Châtelperronian predated anatomically modern humans in western Europe, whether the latter were identified based on diagnostic skeletal remains or based on artefactual index fossils, could and did play a major role in the falsification of models of recent human evolution such as ROA and Acculturation — ones that, as Villa and

Roebroeks (2014) aptly put it, suffered from the “modern human superiority complex.” These days, however, we know that the evidence for Neandertal symbolic thinking goes back to tens of thousands of years before the Transition. In this updated context, debating whether the Châtelperronian’s personal ornaments stand for independent invention or for the influence of coeval, putatively modern human-associated technocomplexes no longer carries implications for the Big Issue question, i.e., whether the Neandertals were a distinct species and cognitively not as modern as their African contemporaries. Yet, the notion that “behavioural modernity” and Neandertal-ness are somehow incompatible continues to inspire, explicitly or implicitly, persistent attempts at assigning to “modern humans” the authorship of the Transition’s technocomplexes, or at least the precedence of “modern humans” in coming up with the innovations that those technocomplexes stand for — and this not just with regard to the Châtelperronian but now also with regard to the Bachokirian and the Ranisian.

Yet, what the genetic evidence from Bacho Kiro and Ranis actually does is add to the obsolescence of the 19th-century mindset whereby (a) the Linnaean names given to human fossils stand for discrete entities and true biological species, (b) a difference in morphology necessarily implies a difference in cognition and behaviour, and (c) one-to-one correlations should be expected to exist between sets of skeletal features (or of genes) and a given material culture or given cultural traits. If the people of the Bachokirian and the Ranisian are eventually shown to have been anatomically modern humans of very recent non-European origin, the fact that their personal ornaments are of a Neandertal/European tradition would be an excellent illustration of the fact that, when it comes to understanding cultural variation and population dynamics over the last 100,000 years, Neandertal and Modern are categories that have outlived their use-by date. Instead, what we are seeing ever more clearly is a dynamic and fluid landscape of interaction whereby genes and cultural traits spread across the Old World regardless of the artificial boundaries created by the two bad habits of (a) using Linnaean taxonomy to frame variation among ancient human populations, and (b) taking categories of modern cartography to frame the realities of Ice Age Human Geography.

Unlike the original one, the resurrected Acculturation Hypothesis can now be assessed thanks to the progress made by Genetics over the last two decades, which makes it possible to ask about Upper Pleistocene humans the questions that truly are fundamental here: Does it make any sense to posit that an individual’s cultural identity is determined by their genetic make-up and physical appearance, the more so when, such as with Denisovans, Bachokirians, and Ranisians, said physical appearance is entirely unknown? And can we really assume that the cultural self-identification of Bachokirian and Ranisian communities would have been based on how much of the genomes of each of their individual members would have been inherited from ancestral lineages?

Consider the fact that the Denisova 11 individual has been shown to be the female child of a Neandertal mother and a Denisovan father (Slon et al., 2018): Was that person a “Neandertal,” or a “Denisovan?” And even if the question had any sense in terms of lineage history, does whatever we might want to call the child have any implications for our understanding of the period’s cultural, social, and family life? Likewise, what do staunch dichotomists propose that we call the father, or the mother, of that grandson or great-grandson of a Neandertal who died in the Banat mountains of Romania some 40,000 years ago?

Furthermore, in what sense are the Neandertals not directly ancestral to the people of the Transition if, whenever we are able to peer into the latter’s genomes, we realise that every single one of them had had fully Neandertal grandparents or great-grandparents? And, at a population level, what kind of an “extinction” is one whereby people of the “replaced” population/species are to be found in the immediate ancestry of every single individual of the “replacing” population/species? And, even closer to issues that lie within the realm of archaeological enquiry, can we really assume that when two populations mix, the material culture will automatically undergo change, and that said change will

necessarily consist of adopting the culture of the side whose genes eventually predominate? In fact, is there any basis to assume that the material culture of the genetically distinct populations whose admixture is documented at Oase, Bacho Kiro, and Ranis was itself also distinct in any archaeologically visible way?

More to the point, would reducing such fragmentary material as the Bacho Kiro and Ranis remains to the Neandertal/Modern dichotomy even be attempted if the classification were not considered to impact our perception of the dichotomy's poles in terms of their putatively species-specific behavioural capabilities and achievements? We posit that it would not. We posit that, absent that framework, the fossil remains of the Transition, if incomplete and fragmentary, would simply be treated as a chronologically intermediate sample useful in the assessment of (a) how aspects of skeletal and dental morphology changed between the early and the late Upper Pleistocene, and (b) what such change means in terms of the long term co-evolution of body, mind, and culture.

Clearly, the Transition was a time of complex processes involving migration, local extinction, replacement, avoidance, interbreeding, and assimilation. In western Eurasia, the start and end points of the process are clear (Holliday, 2023): prior to about 45,000 years ago, its inhabitants are of the Neandertal phenotype, and their lithic technology is of the Middle Palaeolithic kind; after 35,000 years ago, its inhabitants are of the Cro-Magnon phenotype (albeit unevenly displaying, at least in south-west Europe, Neandertal-inherited features, such as the low cranial indexes of the Lagar Velho child and of two of the Cro-Magnon adults; Trinkaus et al., 2022; Zilhão and Trinkaus, 2002) and their lithic technology is of the Upper Palaeolithic kind. In between, many things happened, starting with the appearance in western Siberia, no later than ~45 ka ago, of people with a non-Neandertal post-cranial skeleton, as represented by the Ust'-Ishim femur (Fu et al., 2014). Namely:

- Given the implications of femoral shape for the body's proportions and bauplan, it is likely that the Ust'-Ishim people had recent ancestors in lower latitudes, e.g. the Arabian Peninsula or north-eastern Africa — where, however, skull-wise, the coeval people were not quite modern, as exemplified by the Nazlet Khater 2 individual.
- So far, no unambiguous evidence has been found as to the behavioural and material culture manifestations associated with the demic processes involved in the emergence of the Ust'-Ishim pattern — in Siberia and central Asia, the earliest Upper Palaeolithic is several millennia later and of broadly the same age as the Protoaurignacian/Ahmari and the Early Aurignacian of Europe and the Near East.
- The genomes derived from undiagnostic, fragmentary human remains of eastern and central Europe dated to the 40–45 ka ago interval suggest increased gene flow, including migration, from populations that, genetically, were distinct from the Neandertals living in humanity's northernmost frontier (the periglacial belt adjacent to the ice caps) — but such genomes do not exclude that, morphologically, those populations could have been Neandertal-like too.
- If immigrant communities with a very recent origin in Africa are indeed involved in these processes, the consistent presence in the genomes of their descendants of a significant, recent contribution from the northern Neandertals shows that such immigrants admixed extensively with the locals, everywhere and as a rule.
- The Oase fossils show that the people we find in eastern Europe during the 40–45 ka ago interval were, skull-wise, of an archaic/modern, mosaic anatomy, but, because we still know nothing about their post-cranial skeleton and body proportions, we can't tell whether the reason lies in that (a) such was the “type” of their Nazlet Khater-like putative ancestors, (b) is what, anatomically, ought to be expected from their mixing with local Neandertals, or (c) both.
- This moment in time marks the threshold for the pattern of intermittent intercontinental gene flow of preceding times to have given rise, over a relatively short period of intense interaction, to the emergence of a fully unified, pancontinental gene reservoir, and to

the attendant merger (i.e., Assimilation) of the regionally distinct populations of the past into the “anatomically modern human” physical pattern since extant worldwide (for a concurrent view from the side of Genetics, see Iasi et al., 2024; for a largely concurrent view from the side of Archaeology, see Greenbaum et al., 2019).

- The ultimate cause of such increased levels of interaction must lie in the significant demographic growth implied by the novel ritual behaviours (burial, personal ornamentation, cave painting) seen in the archaeological record of the Last Interglacial and the early Last Glacial, which bespeak of the complexification of social relations to be expected in a scenario of rising population numbers, and this in Africa as much as in Eurasia (where additional evidence to that effect is provided by the significant increase in the number of Middle Palaeolithic sites of MIS 3 rather than MIS 4 or MIS 5 age) (Zilhão, 2015, 2020).
- Starting at about the same time, ~45 ka ago, the Levallois method is altogether abandoned, and lithic production systems that are based on the reduction of prismatic cores and target the production of slender blanks (blades and bladelets) become ubiquitous, with such a widespread process probably reflecting the rise to dominance of weaponry systems based on lighter projectiles with a longer range.
- Such lithic production systems have deep roots in the early Upper and late Middle Pleistocene of Europe, the Near East, and Africa, and neither their earlier developments nor their ~45 ka ago blooming bear specific relation to any one of the various taxonomic entities of Human Palaeontology.
- In the Levant, the emergence of new lithic production systems, exemplified by the IUP (in the sense of a “Boker Tachtit level 4 industry”), lacks clarity with regard to the identity of their creators.
- In central and eastern Europe, similar systems characterise the Bohunician and Ranisian cultures; no human remains are associated with the former, while the Ranisian of the eponymous site is associated with undiagnostic remains that, genetically, differ from those of the previous Neandertal inhabitants of Eurasia's steppe-tundra belt (who, as shown to have been the case with the Bachokirians of Bulgaria, may nonetheless have also been among the Ranisians' ancestors).
- In western Europe, the range of the Ranisian extends into southern England, encompassing Belgium, where diagnostics of the technocomplex co-occur at the site of Spy with diagnostic Neandertal remains directly dated to many centuries after the technocomplex's start date.
- In south-western Europe, the Châtelperronian is associated with Neandertal skeletal remains within the same archaeological site or stratigraphic unit, indicating, directly or indirectly, that this cultural tradition represents an indigenous Neandertal development.
- The innovations in the realm of lithic technology are parsimoniously explained by convergence, but cultural diffusion is indicated, ~41.5 ka, by the addition of beadworks crafted from small marine gastropod shells to Neandertal Europe's record of body decoration items, which is documented since at least 115,000 years ago both directly (by pendants made of large bivalve shells, raptor talons, fossils, bones, and teeth) and indirectly (by the zooarchaeological evidence for the procurement of feathers).
- The data remain consistent with the persistence, all along, of a Neandertal, Middle Palaeolithic isolat in southern and western Iberia, but, eventually, no later than 37 ka ago, the interaction dynamics of preceding millennia gave rise to a pattern of cultural and genetic homogeneity across vast swathes of Eurasia, from Portugal to Siberia, as reflected in the geographical extent of the Gravettian and the Cro-Magnon people, a.k.a., the “Hunters of the Golden Age” (Roebroeks et al., 2000).

Processes of population turnover involving the regional extinction of entire genetic lineages were involved in the neolithisation of parts of Europe and in the spread of the Bell Beaker culture to the British Isles

(Allentoft et al., 2024a; Olalde et al., 2018). For instance, Allentoft et al. found that the genetic contribution of people of the regional Mesolithic to subsequent early farmer populations was <10 % in Denmark, and zero in Sweden, i.e., inferior to the contribution of regional Neandertals to the ancestry of the Romanian early Upper Palaeolithic people represented by the Oase 1 individual. This evidence makes it clear that the Neandertals' participation in the genetic make-up of the post-admixture peoples of Europe was fully within the range of what to expect based on patterns of interaction between recent human populations with distinct ancestries but that, by definition, belonged to the same biological species. Also consider that, (a) morphologically, most of the individuals from the Transition dubbed "*Homo sapiens*" in the ROA sense of the concept in fact differ from recent humans in several aspects of their skeletons, and (b) genetically, their contribution to the ancestry of living people was as limited as the Neandertals' (Zeberg et al., 2024). Yet, these observations have led no one to conclude that those individuals belonged in a now-extinct species. We see no reason to view coeval Neandertals differently.

That ancient genomics has been able to shed much light on Holocene population dynamics is largely due to an abundance of samples. The processes of biological and cultural interaction that took place in recent prehistory are thereby much better understood, and ought to provide the adequate source of inspiration for modelling the Transition — the more so given the paucity and limited geographical scope of the data available to study the latter. As we hopefully have shown, it is in any case clear that the spatial and temporal patterning of the events and processes involved is irreducible to the Rapid-Replacement-of-One-Species-by-Another worldview. The latter's scenarios of competitive exclusion whereby a "for-whatever-reason-inferior" species was not just driven to but in fact doomed to extinction are mostly imaginary: individuals are reduced to one or the other of two essential types, and populations are mapped onto technocomplexes modelled as abstract, bio-behaviourally homogeneous entities. This rationale then leads to explorations of the period's complex dynamics that would resonate with Plato but not with Darwin and provide good examples of the seductive and enduring power of simplifying complexity into binary oppositions. That the practice remains widespread is otherwise a clear manifestation of the so-called anchoring problem (Kahneman, 2011) — a by-product of the entrenched framework that King's (1864) definition of the Neandertals as *Homo neanderthalensis* set for our understanding of ancestral human populations.

To be fair, we must note that a remarkable contrast exists between current attitudes to recent human evolution prevailing among archaeologists and biological anthropologists, on one hand, and geneticists, on the other. The latter were the driving force behind the rise to dominance of ROA but, these days, one hardly finds a Genetics paper that does not frame the issues in terms of populations and lineages. Yet, like so many archaeologists and biological anthropologists, most geneticists remain subject, despite the weight of their own evidence, to the "tyranny of the discontinuous mind" (Dawkins, 2017; Zilhão, 2019). Most continue to accept and operate within the dichotomic framework of the "Neandertal versus Modern" and the "Timing of the Split in the Tree" approaches; few are those (e.g., Tournebise and Chikhi, 2023) who manage to breach the shackles imposed by the categories of Human Palaeontology to embrace uneven geographical development and population structure as the foundations of their enquiry.

In the manner that the Transition is treated under ROA we can also see how History often gives way to Teleology, as is readily apparent in the tendency to approach the period not as something worthy of study in its own right but rather as a chain of events featuring present-day humans as its Aristotelian final cause. This finalist approach in turn leads to circularity: the limited contribution that Neandertals made to recent human genomes and the disappearance of their phenotype is taken as evidence of their having been a separate, extinct species; and this conclusion is then used retrospectively as the assumption upon which to ground the interpretation of what happened at the time of their

disappearance. Yet, it should go without saying that, when studying a given present, causality can only be found in the past of that present, not in its future. The point with the Transition is not how much and what did today's people inherit from the Neandertals, the point lies in (a) how much and in what manner did the phenotypically Neandertal populations of western Eurasia participate, 40–45 ka ago, in the making-up of the biology and culture of succeeding populations, and (b) what variation there was across time and space in the manner that that process unfolded in the different regions concerned.

7. Conclusion

The widespread adoption of the taphonomic perspective when dealing with the associations and the dating of the fossils has brought immense clarification on key issues relating to the early stages of human evolution, as exemplified by the study of the Trinil sites — a model on how to deal with old excavations — or the way deposition and redeposition are adequately dealt with in the context of the origin of stone tools in Africa (e.g., Archer et al., 2020; Hilgen et al., 2023; Pop et al., 2023). The same cannot be said about the Transition, a field where little progress has been made in the incorporation of the lessons that "The Neandertal Problem" debate ought to have taught us: definitions continue to be abused; misunderstanding of dating records remains widespread; diversion of the Bayesian approach to support exercises in the affirmation of the consequent is commonplace; treatment of stratigraphic units as the sealed museum drawers that they are not seems to be unstoppable; the genetic evidence for the Neandertal ancestry of Upper Palaeolithic humans is paid lip-service but otherwise largely ignored; and most interpretations of the archaeological record remain fixed in pre-1960s reified visions of material culture as the by-product of monolithic bio-behavioural entities. We posit that the explanation for this state of affairs lies in the obsolete dichotomic framework that continues to inspire much Transition research. The time to move on is overdue.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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