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► **To cite this version:**

Nicolas Teyssandier. Us and Them: How to Reconcile Archaeological and Biological Data at the Middle-to-Upper Palaeolithic Transition in Europe?. *Journal of Paleolithic Archaeology*, 2024, 7, pp.1. 10.1007/s41982-023-00166-8. hal-04369579

HAL Id: hal-04369579

<https://hal.science/hal-04369579v1>

Submitted on 2 Jan 2024

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Us and them: how to reconcile archaeological and biological data at the Middle-to-Upper Palaeolithic transition in Europe?

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Abstract

Between ca. 50,000 and 35,000 years ago, one of the most profound upheavals in the history of humanity occurred with the replacement of the so-called "archaic" groups (Neanderthals, Denisovans, *Homo luzonensis*) by anatomically modern humans. Distinct macro-regional technocomplexes have long been distinguished in the European archaeological record, mainly based on their lithic typo-technological attributes and intermediate archaeo-stratigraphic position between final Mousterian and early Aurignacian assemblages. Here, I first review the data on the Châtelperronian, Uluzzian and Lincombian-Ranisian-Jzermanowician groups, and finish with the industries grouped under the term Initial Upper Palaeolithic. I then attempt to discuss the archaeological data in the light of the most recent palaeogenomic data obtained from *Homo sapiens* fossils and integrate this information into considerations of the relationships between the so-called transitional industries and the first phases of the Aurignacian, the latter of which are always posterior to the former on the European continental scale.

Key-words

Middle-to-Upper Paleolithic transition, Neanderthals, *Homo sapiens*, Châtelperronian, Uluzzian, Lincombian-Ranisian-Jzermanowician, Initial Upper Palaeolithic

Between ca. 50,000 and 35,000 years ago one of the most profound upheavals in the history of humanity occurred with the replacement of the so-called "archaic" groups (Neanderthals, Denisovans, *Homo luzonensis*) by anatomically modern humans. Initiated in Africa (Hublin et al., 2017; Scerri et al., 2019), this process involving various lineages occurred everywhere in western Eurasia, but we know from major advances in paleogenetics that interbreeding processes between several of these human taxa took place (Green et al., 2010; Prüfer et al., 2014; Fu et al., 2015, 2016) and that they necessarily had a diverse impact on the sociocultural context of the new arrivals on this continent. The situations indeed differed according to the regions, even if, in all cases, human societies entered the Upper Palaeolithic by developing technical and symbolic innovations that were rapidly imposed—though neither simultaneously nor at the same pace in different places. Whether it is the multiplication and diversification of graphic and symbolic expressions, or micro- and composite hunting equipment made of stone or animal materials, these new types of artefacts reflect more global modifications in both subsistence strategies and the structuring of human societies.

In this perspective, the so-called Middle to Upper Palaeolithic transition plays a pivotal role in the debate. For a long time, "The Transition" has been directly associated with the extinction of the last Neanderthals, the emergence of the first modern humans and the interactions that may have taken place between these two human taxa. From a cultural viewpoint, the period documents the emergence of distinctive traits, some of them are said to be of Upper Paleolithic type such as an increasing focus on standardised laminar technology (Bachellerie et al., 2007; Bachellerie 2011; Roussel 2011), forms of microlithization associated with the intensification of bladelet production (Roussel 2014; Roussel et al., 2016) and the development of light lithic tips and the explosion of symbolic behavior evidenced in terms of quantity and diversity (Granger and Lévêque 1997; Caron et al., 2011; Vanhaeren et al., 2019; Martisius et al., 2022). Simultaneously, new raw materials were exploited more intensively than ever before, in particular animal bones and teeth, which gave rise to new forms of tools (Julien et al., 2019; Arrighi et al., 2020; Martisius et al., 2022).

Distinct macro-regional technocomplexes have long been distinguished in the European archaeological record, mainly based on their lithic typo-technological attributes and their intermediate archaeo-stratigraphic position between final Mousterian and Aurignacian assemblages. From west to east, this is the case, for example, for the Châtelperronian, Uluzzian, Bohunician, Szeletian, and Lincombian-Ranisian-Jerzmanowician (LRJ) groups in northwestern Europe and, more recently, the Bachokirian in the Balkans. Labelled as "transitional" industries, it is important to remember that this term has no anthropological value and does not imply that these industries are part of a genuine process of transition from one state to another. Rather, it seems that each of these technocomplexes may represent distinct technological, chronological and paleoanthropological realities. We will first discuss the Châtelperronian case, followed by the Uluzzian and LRJ, and finish with the industries grouped under the term Initial Upper Palaeolithic (IUP).

The Châtelperronian

The Châtelperronian is geographically restricted to western Europe and is known only in France and northern Spain. Thanks to the improved decontamination of samples by ultrafiltration, the key sequence of the Grotte du Renne at Arcy-sur-Cure now situates the development of the Châtelperronian between 45,000 and 41,000 cal BP (Hublin et al., 2012), a chronological interval consistent with other known and dated sites (e.g., Talamo et al., 2012; Ruebens et al., 2015). Wherever it is present in a multi-stratified context, the Châtelperronian always follows a final Mousterian (often of the "denticulate" type with discoid debitage) occupation and precedes one of the early phases of the Aurignacian, which are now known to be structured around the Protoaurignacian/Early Aurignacian evolutionary trend (e.g. Discamps et al., 2011; Banks et al., 2013).

In terms of lithic equipment, the Châtelperronian is not, as was long thought, composed of mixed Middle and Upper Palaeolithic features (e.g., Bordes, 1958; Leroi-Gourhan, 1965; Sonnevile-Bordes, 1972; Harrold, 1989; Guilbaud, 1993; Demars, 1994). This view comes from when cave and rock shelter deposits in southwestern France were still considered without critical hindsight. Since then, it has been demonstrated several times that the Middle Palaeolithic component of the Châtelperronian assemblages resulted from mixing with the underlying Mousterian ones (e.g., Bachellerie et al., 2007; Bachellerie, 2011; Bordes & Teyssandier, 2011; Gravina et al., 2018). The results of modern excavations of open-air sites, where no mixing with the Mousterian could have occurred (e.g. La Côte, Pelegrin, 1995; Canaule II, Bachellerie, et al., 2007; Vieux Coutets, Grigoletto, et al., 2008; Les Tambourets, Scandiuzzi, 2008), have demonstrated that the Châtelperronian is an industry produced from a *chaîne opératoire* aimed at obtaining blade blanks in a clear Upper Palaeolithic manner. The productions are, moreover, oriented towards the production of broad and short blades with a rectilinear profile, intended for the manufacture of knives or backed points (Châtelperronian points) (Pelegrin, 1995; Connet, 2002; Bachellerie, 2011; Roussel, 2011). These blades were detached by direct marginal percussion with a soft stone hammer and

there is no clear independent flake *débitage* as known in the late Middle Palaeolithic. Recently, at Quinçay, Roussel (2014) added to this definition an independent bladelet debitage, which has diminutive modalities similar to those of blade production, and which provided Dufour bladelet (subtype Dufour) blanks similar to those of the Protoaurignacian. While the existence of an Upper Palaeolithic-type bladelet *débitage* is confirmed at other Châtelperronian sites (Rios-Garaizar et al., 2022), we must remain cautious concerning the occurrence of typical Protoaurignacian Dufour bladelets in the Châtelperronian. Although Roussel states that there is no Protoaurignacian above the Châtelperronian at Quinçay, there is nothing to prevent us from thinking that the assemblage results from a palimpsest mixing chronologically differentiated occupations. We must, therefore, remain cautious insofar as this presence of Dufour blanks in the Châtelperronian of Quinçay remains the only known occurrence, with the exception of one single very small Dufour fragment at Aranbaltza II (Rios-Garaizar et al., 2022).

Bone tools are rare in most Châtelperronian deposits and are only known based on an abundant and diverse corpus in the Grotte du Renne at Arcy-sur-Cure. Just over 200 objects have been inventoried there (e.g., Julien et al., 2019). The fairly standardised production of ivory spear points with shafts of varied sizes undoubtedly attests to the diverse functions of hunting weapons. A fairly large number of bone awls, some of which are made of carnivore fibulae diaphyses, were intensively used to perforate skins. There are also less technically invested objects, such as *lissoirs* (smoothers) on large mammal ribs.

Ornaments are also known, but again, this is nearly specific to the Grotte du Renne since elsewhere, only a few specimens have been identified at Quinçay (Granger & Lévêque, 1997). Fifty-two pieces comprise the ornament assemblage from Grotte du Renne (Vanhaeren et al., 2019) and include mainly animal teeth, comprising fox, wolf and bear canines, bovine, reindeer, and horse incisors, a hyena incisor, and a rhinoceros molar. There are also two ivory rings, sawed bird diaphyses, eagle or great horned owl claws, and a few mineral objects (stalactite, pyrite).

We should also note, here again, that the Grotte du Renne provides remarkable evidence for the presence of colouring materials testifying to an intensive exploitation (Bodu et al., 2017; Salomon, 2019).

The interpretation of the innovative characteristics of the Châtelperronian, in particular the status of the bone industry and ornaments at Grotte du Renne, has given rise to numerous debates and contradictory hypotheses over the past thirty years, some of which have even become paradigms. Four main interpretations have been proposed: a) these objects are indeed *in situ* in the Châtelperronian and are Neandertal innovations (d'Errico et al., 1998; d'Errico, 2003; Zilhão, 2013), or; b) these objects are *in situ* in the Châtelperronian and made by Neanderthals but result from an acculturation process via contact with contemporary modern human populations (e.g. Mellars, 1999, 2005; Mellars et al., 2007; Hublin, 2000, 2015), or; c) result from vertical displacement and thus from contamination from the overlying Protoaurignacian Layer VII (Taborin 1998, 2002; White 2001, 2002), or; d) these objects are indeed Châtelperronian but this technocomplex was not made by Neanderthals, but by modern humans. In the latter case, the Neanderthal remains would have been displaced and mixed post-depositionally from the underlying Mousterian levels (Bar-Yosef, 2006; Bar-Yosef & Bordes, 2010).

I agree with the refutation of the acculturation hypothesis by a significant number of scholars (e.g., d'Errico et al., 1998; Zilhão & d'Errico, 1999; d'Errico, 2003; Zilhão, 2013; Julien et al., 2019; Vanhaeren et al., 2019) as the Châtelperronian still, over its entire range, stratigraphically underlies the first Aurignacian incursions into these regions. Moreover, the types of bone tools and ornaments as well as their production modes are quite specific and in no way resemble the material and symbolic productions of the Aurignacians (d'Errico et al., 2003; Julien et al., 2019; Vanhaeren et al., 2019).

Concerning the possible displacement of objects from the overlying layer (Layer VII, attributed to the Protoaurignacian), there is no evidence to support this hypothesis and it is formally contradicted by all the primary data (e.g., in particular, Caron et al., 2011). In effect, the Châtelperronian bone and ornamental productions are both numerically significantly larger and, more importantly, very different in type and process when compared to those of the Protoaurignacian (Julien et al., 2019). Furthermore, the archaeo-stratigraphic distribution of these objects does not agree with this hypothesis since $\frac{3}{4}$ of the objects in question do not originate from Layer VIII, directly underlying the Protoaurignacian layer, but from the deepest Châtelperronian level, namely Layer X (e.g., Caron et al., 2011; Zilhão, 2013).

We can, therefore, already accept that the Châtelperronian does constitute a singular technocomplex characterised by blade production and an Upper Palaeolithic lithic toolkit associated with diverse bone tools and ornaments that are clearly distinct from those of the Aurignacian. Due to the C14 chronology and its

stratigraphic position, it thus constitutes a specific cultural development and there is no need to assume acculturation through contact with another cultural complex to explain its specific nature. The question of the author of the Châtelperronian has been the subject of much discussion since the first publication relative to the "archaic" characteristics of the dental corpus of the Grotte du Renne (Leroi-Gourhan, 1958) until the discovery of the Roche-à-Pierrot in Saint-Césaire, which seemed to confirm the association between Neanderthal and the Châtelperronian (Lévêque and Vandermeersch, 1979). Today, and even among the proponents of opposing interpretations concerning the status of the Châtelperronian (acculturation with *Homo sapiens* versus autonomous development), most agree that Neanderthals authored this cultural entity (e.g., Hublin et al., 2012; Zilhão, 2013; Hublin, 2015, Welker et al., 2015).

However, we should remember that this association is only known from two sites: the Grotte du Renne and La Roche-à-Pierrot.

For the latter, we have recently been able to demonstrate (Gravina et al., 2018) that the EJOP Sup Layer within which the Neanderthal remains were discovered corresponds to a significant mixture between a majority of Mousterian remains and a few Châtelperronian objects. Moreover, this mixture has not retained any stratigraphic coherence that would suggest that the Mousterian component is more at the base of EJOP Sup, with the Châtelperronian component at the top. The most likely explanation is to consider EJOP Sup as the post-depositional redistribution of a brief Châtelperronian stopover within one or more much larger Mousterian occupations that were also affected by similar post-depositional processes.

In terms of the human remains discovered, for a certain part in anatomical connection and which were the object of block sampling for subsequent laboratory excavations, it is now clear that the post-depositional processes that affected the deposits were largely responsible for the truncation or destruction of part of the partial skeleton (this is certain if one compares the bone conservation of the upper and lower left alveolar arches relative to the right ones, to the arrangement of some of the right teeth at the time of the excavation; Maureille, pers. com), a possibility reinforced by the fact that numerous naturally modified lithic pieces were found in the vicinity of the skeleton. In conclusion, we proposed three possibilities for the status of the human remains (Gravina et al., 2018): a) they were deposited after the reworking of EJOP Sup and are therefore of Aurignacian age, b) they are associated with a brief Châtelperronian occupation, and c) they represent the remains of a reworked Mousterian anthropogenic deposit.

The hypothesis of an Aurignacian deposit seems very unlikely, both because no remains of this technocomplex have been found in the vicinity of the human remains or within the plaster block (the only lithics directly associated with the human remains are undoubtedly Mousterian) but also because the taxonomic attribution of these remains to Neanderthal is clearly established and this would run counter to everything we know about the Aurignacian (Gravina et al., 2018). It should further be noted that our ongoing re-evaluation of the Aurignacian sequence at this site demonstrates that, contrary to what was originally published by Lévêque (Lévêque et al., 1993), we find no evidence of the Protoaurignacian in these deposits, which correspond mostly to an Early/Middle/Recent Aurignacian palimpsest. The possibility of an Aurignacian/Neanderthal association thus seems nil to us.

To distinguish between the other two scenarios based on the available evidence remains highly speculative (Gravina et al., 2018). The top of the sedimentary block containing the Neanderthal remains, however, appears to be near the base of EJOP Sup or at the top of the sterile horizon, which would be consistent with the extremely limited amount of lithic material recovered from the plaster block. This potentially suggests that the introduction of the human remains predates the reworking event that would have partially disturbed some of the human remains, eroded the top of EJOP Sup, and mixed the overlying archaeological material (Gravina et al., 2018). However, it is also possible to consider, based on various spatial and taphonomic data, that this deposit of human remains, most likely of anthropogenic origin, is intrusive in this part of the archaeo-stratigraphy and that it is, therefore, chronologically, a bit younger than the age of the main lithic component that it delivers. Unfortunately, to move forward on this question, it would be necessary for the analysis of this deposit to be completed or for the data to be accessible to other researchers, which is still not the case more than 40 years after the discovery. It is thus impossible to securely associate the human remains with either of these two cultural components. Saint-Césaire can, therefore, no longer be used to discuss the author of the Châtelperronian, except by considering only the direct C14 date obtained on the skeleton, which provides an age between 42,200 and 40,000 cal BP (36,200,750, OxA-18099, Hublin, et al., 2012). We should note, however, that while this value falls within an expected chronological interval for a Châtelperronian context, the collagen content is very low and, given the difficulties in obtaining robust ages for this period (e.g., Devière et al., 2017, 2021), it is quite likely that it constitutes only a minimum age. At La Ferrassie, a hominin bone associated with Neanderthal based

on its mitochondrial DNA yielded a comparable direct ^{14}C age (Balzeau et al., 2020) but its association with a Châtelperronian context remains uncertain.

Therefore, to document the Châtelperronian author, we must turn to the Grotte du Renne. A precise inventory of all the human remains was recently published (Maureille & Hublin, 2019). As was already known, the human remains consist, for the most part, of isolated teeth discovered at the base of the Châtelperronian sequence in Layer X. Their taxonomic status is clear and all are attributed, based on morphological patterns, to Neanderthal (Bailey & Hublin, 2006; Maureille & Hublin, 2019). There is also a juvenile temporal bone attributed to Neanderthal (Hublin et al., 1996). These attributions were further confirmed by biomolecular data following the analysis of 196 presumed unidentifiable bone fragments by ZooMS and the mitochondrial DNA sequence of two of these, identified as human, from individuals clearly related to the Neanderthal lineage (Welker et al., 2016). In addition, we have a direct C14 measurement of 42,400-40,800 cal BP. Only the right ilium of a perinatal (AR-63) presents a morphology that makes its taxonomic diagnosis difficult (Maureille & Hublin, 2019), probably not fitting into the known variability of Neanderthals. A recent study confirms this diagnosis, emphasizing that "(...) results indicate a morphological distinction between the ilia of Neanderthals and anatomically modern neonates. Although AR-63 is slightly outside recent variability, it clearly differs from the Neanderthals. We propose that this is due to its belonging to an early modern human lineage whose morphology differs slightly from present-day humans" (Gicqueau et al., 2023).

Until now, all authors agree on an exclusive attribution of the Grotte du Renne Châtelperronian sequence to Neanderthals (e.g., Caron et al., 2011; Hublin et al., 2012; Welker et al., 2016; Zilhão, 2013). Only Bar-Yosef and Bordes (2010) have raised serious doubts about these conclusions by proposing an alternative scenario. In particular, they insist that both the observation of the sections and the published plans and photographs demonstrate the existence of digging and levelling of the underlying Mousterian levels by the Châtelperronians. This possibility is confirmed by the most recent analysis of the archaeo-stratigraphy of the first Châtelperronian occupations in which Roblin-Jouve (2019: 60) emphasises that "*les Hommes eux-mêmes ont tassé les dépôts par leur passage et ils ont aménagé leur habitat*". These phenomena could have taken place during the installation of the first Châtelperronians (Layer X) with the construction of a hearth and the displacement of limestone blocks that could have been used as seats, as well as the digging of "post holes" in the previous deposits. These spatial planning phenomena by the Châtelperronian inhabitants could suggest that the isolated and scattered human remains were located in the upper part and/or on the surface of the Mousterian occupation floor and would have been moved by the Châtelperronians and deposited mainly near the cave entrance (Bar-Yosef & Bordes, 2010). This would explain why most (but not all) of the Neanderthal human remains are found in the lower part of the Châtelperronian deposits and thus near the stratigraphic contact with the last Mousterian occupation.

In sum, the author of the Châtelperronian technocomplex has still not been definitively identified. While many arguments have been formulated, with various analyses pleading for a Neanderthal association, a single sequence (Grotte du Renne) supports the entire edifice of this hypothesis. A few points can be mentioned here:

a) the overall coherence in the archaeo-stratigraphic distribution of some remarkable artefact categories seems to us to be operative and there is no doubt that the Châtelperronian of the Grotte du Renne is indeed characterised by the production of bone tools and diverse ornaments (e.g., Caron et al., 2011). Everything thus points in the direction of a Châtelperronian attribution of these objects, which clearly differ from those found in the Protoaurignacian assemblage;

b) however, other signals may potentially account for a certain singularity of the Châtelperronian of the Grotte du Renne, in terms of the lithic equipment for example. Contrary to elsewhere, flake *débitage* is abundant here, as are Mousterian remnants in the form of flake tools and even more abundant scrapers (461 pieces, Connet, 2019a), which constitute a strong Mousterian substrate. N. Connet (2019a: 453), without taking a definite position, nevertheless specifies that unmistakable mixtures with the underlying Mousterian affected the Châtelperronian layers: "*dans le cas d'Arcy, il n'est pas hors de propos d'imaginer une pollution possible d'éléments moustériens dans le Châtelperronien, soit par les aménagements de l'espace réalisés par les Hommes eux-mêmes, soit par la complexité de la sédimentation des cavités jumelles du Renne et du Bison*". In the retouched tool blanks, Connet also notes (2019a: 455) the presence of 15 pseudo-Levallois-type *débordant* (core-edge) flakes and short flakes originating from multidirectional or centripetal reduction sequences. The presence of pseudo-Levallois points is consistent with the situation at Saint-Césaire (Gravina et al., 2018), where these blanks undoubtedly originated from a discoid-type *chaîne opératoire* and result from mixing with the underlying Denticulate Mousterian layers. Knowing that the same type of Denticulate Mousterian is present in

Layer XI of the Grotte du Renne, it is probable that these blanks result from mixing with the underlying Mousterian;

c) it is also known that very clear contamination has affected the entire sequence of the Grotte du Renne, as shown by the presence in fairly large numbers (30 pieces, 8% of the total number of retouched tools) of typical Protoaurignacian Dufour bladelets in the overlying Layer VI, attributed to the Gravettian (Mével, 2000);

d) finally, in an attempt to understand the taphonomic processes at work in the Grotte du Renne, N. Connet (2019b: 516-517) states that "(...) *parmi les phénomènes typiques des milieux périglaciaires (solifluxion, cryoturbation) ayant pu impacter la séquence de la Grotte du Renne, des coulées de solifluxion à front pierreux auraient pu dessiner les arcs de cercle relevés à la base de la couche X. De tels phénomènes auraient pu remobiliser et balayer des couches antérieures notamment dans le cas de couches meubles composées de plaquettes comme celles qui constituent le sommet de la séquence moustérienne du Bison. Dans cette hypothèse, la base de la couche X du Renne correspondrait à la mise en place d'un dépôt de pente en contexte périglaciaire remobilisant des vestiges (moustériens et Châtelperroniens?) sur et dans lesquels les Châtelperroniens se seraient installés*". Such phenomena with stone-fronted solifluction flows are also discussed based on Leroi-Gourhan's maps by Bertan et al. (2010: 25): "Plausible stone-banked solifluction lobes can be found also in the Castelperronian level of the Grotte du Renne, Arcy-sur-Cure (Leroi-Gourhan, 1982), where preferred slope-parallel bone orientation and bow-like arrangement of stones are readily visible. Well-preserved fireplaces may be interpreted here as remnants of formerly excavated structures, the bottom of which were below the Layer deformed by daily freeze-thaw cycles."

In sum, the Châtelperronian sequence at Grotte du Renne preserves an overall coherence that makes it possible to define a technocomplex that is definitely Upper Palaeolithic. This being said, the question of the clear association of these cultural elements (e.g. the Châtelperronian diagnostic attributes) with the Neanderthal human remains scattered within the layers is not sufficiently demonstrated. Indeed, contamination with the underlying Mousterian, particularly in Layer X, which contains the greatest number of human remains, is certain. They are also very probably associated with post-depositional sedimentary phenomena reflecting the processes typical of periglacial environments that distorted the arrangement of deposits and acted concomitantly with spatial arrangements by the Châtelperronians that clearly disturbed the sediments left by the Mousterian. There is thus no guarantee that all the Neanderthal human remains in Layer X are indeed associated with the Châtelperronian and not the result of mixing with the underlying Mousterian. Based on these elements and the conclusions of the La Roche-à-Pierrot analysis (Gravina et al., 2018), we consider that the author of the Châtelperronian remains an open question and clearly requires: a) a shared (open), interdisciplinary analysis of data from very old to old excavations, and; b) renewed archaeological and paleoanthropological documentation from recent field research with the production—before any interpretative conclusions are reached concerning the history of the occupation—of the primary data set concerning the sedimentary lithofacies and the processes underlying them, i.e. the lithic, faunal, and paleoanthropological material that enables an evaluation of the integrity of the defined chronocultural entities.

The Uluzzian

The Uluzzian is represented across a large part of Italy, from the south of the peninsula at Castelcivita, Grotta La Cala, Grotta del Cavallo, Uluzzo, Gratta Bernardini, to the northeast at Fumane and Riparo del Broion, and through the centre of the country at Grotta La Fabbrica and Colle Rotondo (e.g., Villa et al., 2018). Outside of Italy, it is only known from Klissoura in the Peloponnese, Greece (Koumouzelis et al., 2011). Stratigraphically, where observations can be made, the Uluzzian is always later than the Mousterian levels on which it rests and always underlying the Protoaurignacian by which it is followed. According to Douka et al. (2014), it appeared in Italy around 45,000 cal BP and, given its stratigraphic position below the Protoaurignacian at Fumane, La Fabbrica, Castelcivita, and Grotta La Cala, it ended before its replacement by the Protoaurignacian ca 41,500 cal BP at Mocchi and Fumane (Douka et al., *ibid.*). Some have recently argued, based on two teeth with "modern" features, that the Cavallo Uluzzian is associated with *Homo sapiens* (Benazzi et al., 2011), but this proposal has been rejected by others (Zilhão et al., 2015) insisting on the reworked nature of the deposits which, in the Uluzzian, include Dufour bladelets typical of the Protoaurignacian. The same is true of the five Dufour bladelets at Castelcivita, discovered at the top of the Uluzzian, which are quite characteristic of the stratigraphically overlying Protoaurignacian and do not correspond in any way to the technological features of the associated Uluzzian industry which is mostly intended to produce flakes. In this sense, the presence of Dufour bladelets in an Uluzzian context would result from mixtures (Zilhão et al., 2015; Villa et al., 2018). As it stands, and in the absence of reliable DNA or paleoanthropological data, the Uluzzian author has not yet been reliably determined (Villa et al., 2018).

Based on new analyses, Villa et al. (2018: 49) conclude that "(...) the general technological and typological features of the assemblages of Castelcivita, Grotta del Cavallo, La Fabbrica, and Colle Rotondo define the Uluzzian as a valid cultural unit with an approximate duration of five millennia". In these sites, the Uluzzian can be distinguished from the underlying Mousterian by innovations including a fairly high frequency of splintered pieces, the presence of elongated pieces with convex backs ("lunates"), non-regular blades and bladelets detached by direct percussion or by bipolar percussion on an anvil, bone tools and perforated shell. The same is true concerning lithic production systems at Castelcivita (Rossini et al., 2022). At Roccia San Sebastiao as well at other sites, Uluzzian technology shows the use of local raw materials used for "simple and slightly predetermined production" (Collina et al., 2020: 165). Production methods may be simple, but lunates demonstrate sophisticated know-how to make composite tools with the use of adhesives in order to create mechanically delivered armatures (Sano et al., 2019).

Problems persist, however, at Fumane since Layers A4 and A3—already clearly mixed with Aurignacian pieces in fairly large quantities—are related to the Uluzzian (Peresani et al., 2015), while they also contain relatively large proportions of objects associated with a Levallois production that is absent at all the other Uluzzian sites considered (Villa et al., 2018). While Villa et al. (ibid.: 34) cautiously note that "(...) the presence of Levallois cores and products, which are completely absent in sites from southern and central Italy (La Fabbrica, Colle Rotondo, Castelcivita, Cavallo) implies that the Uluzzian of Fumane developed with a different trajectory compared to those sites, as also suggested by the very low frequencies of scaled pieces," I lean more towards an interpretation of a palimpsest of levels that reshuffled the remains of several diachronous occupations of which a large part consists of a recent Mousterian with Levallois debitage.

Without being able to reliably determine the author of the Uluzzian, it is nevertheless possible to note that, once again, the Uluzzian marks a discontinuity in the archaeological record at the Middle/Upper Palaeolithic boundary with the emergence of clear innovations (formal bone tools, perforated shell, lunates), some of which (formal bone tools, ochred shells, irregular flakes clearly different from the Upper Palaeolithic and Protoaurignacian productions, in particular) were already present during the Middle Palaeolithic (e.g. Zilhão et al., 2010; Faivre 2012; Soressi et al., 2013; Metz 2015; Hoffmann et al., 2018).

The LRJ

In northwestern Europe, the LRJ "super" complex is represented from Wales to Poland. Here, authors generally agree to situate the emergence of this complex, dated to ca. 43,000 cal BP, in the late local Middle Palaeolithic (e.g., Flas 2011 a-b for a synthesis). In the LRJ, the diagnostic tool, the Jerzmanowice point, consists of a foliated point made by partial bifacial retouching on large, robust blades resulting from volumetric bidirectional flaking. Here again, as is likely in the Châtelperronian, the concept of lithic points that were, according to their morphology and impact fractures, probably hafted axially for use as projectiles (Wisniewski et al., 2022), reflects a common idea in several "transitional" industries. In the LRJ, the rest of the lithic tool kit is composed of classic Upper Palaeolithic tools (end-scrapers, burins, pointed and retouched blades) with fewer Middle Palaeolithic types (scrapers, notches, and denticulates). Based on the presence of bifacial, sometimes foliated and pointed pieces, and volumetric laminar expressions in the late Middle Palaeolithic Europe, most researchers agree on a local origin of the LRJ (Flas 2011 a-b). Flas summarises his view on the subject of LRJ origins as follows: "The development of the LRJ technocomplex may therefore have originated from these Late Middle Palaeolithic substrates in northwestern Europe, with a local transformation appearing far more plausible than diffusion from an unseen external origin" (Flas 2011 b: 270). The origin of the LRJ remains unknown at this time, and the latest C14 dates obtained from Neanderthals at Spy, Belgium, indicate that they are older than previously assumed. Using more sophisticated methods for processing bone samples, direct dates indicate that these latest Neanderthals found in Belgian caves date to between 44,200 and 40,600 cal BP (Deviese et al., 2021). As it stands, it is, therefore, not possible to determine the author of the LRJ¹.

¹ Since the article was written, an oral communication at the 2023 ESHE symposium has provided important new data on the author of the LRJ. At Ranis, the LRJ occupation from 2 thin layers is now dated between 47 490 and 43 260 cal BP (Hublin et al., 2023). Proteomic screening of bones from both old and recent excavation as well as morphological screening identify 13 hominin bones associated with LRJ layers. The authors extracted "mtDNA from 11 of the hominin remains, all of which were identified as *Homo sapiens*" (Hublin et al., 2023). It therefore seems now clear that this transitional industry is related to anatomically modern humans. These new data are in line with the proposals made a few months earlier by Demidenko and Škrdl (2023: 1), who concluded after a careful examination of new Moravian sites that "LRJ assemblages were produced by *Homo sapiens*, and that its roots are in the Bohunician industry". From a technological view point they add that "the

Questioning the alleged IUP industries in Europe

One of the most distinct technical trends observed in the Initial Upper Paleolithic relates to the production of blades and, especially, convergent blanks that resemble Levallois points, detached by direct hard percussion from non-Levallois cores. This is the case, for example, in the Bachokirian of Bulgaria (Tsanova & Bordes, 2003; Teyssandier, 2006, 2007a-b; Tsanova, 2008; Hublin et al., 2020) and the Bohunician of central Europe (Škrdla 2003, 2017). On this basis, it has been proposed that some of these manifestations resulted from a migration of early *Homo sapiens* into Europe from the Levant and the industries included in the Emirean technocomplex, also referred to as the IUP (Škrdla, 2003; Svoboda & Bar-Yosef, 2003; Hoffecker, 2009; Hublin, 2012, 2015; Hublin et al., 2020).

The Levantine perspective

The term IUP was introduced in the 1980s by A. Marks based on the single lithic assemblage from Layer 4 of Boker Tachtit (Israel) in the Negev Desert, Israel (Marks & Volkman, 1983). According to Marks, this level, the most recent at this site, marked the culmination of a process of local technological evolution with a gradual change from Levallois point bidirectional productions to a unipolar laminar “Upper Palaeolithic” exploitation. Based on new chronological results, this evolutive technological process would have taken place between ca. 50 000 and 44 000 BP (Boaretto et al., 2021). This definition of the IUP was later extended by Kuhn (Kuhn et al., 1999) to the site of Üçağızlı in Turkey and other assemblages in Lebanon (Antelias, Ksar 'Akil) or Syria (Umm el Tlel). According to Kuhn (2019), the term IUP is preferable to the former regional name of Emirean because its *fossile directeur*, a Levallois point with thinning at its base (Emireh point), is unknown from cave sequences. In the Levant, where the IUP was originally defined, the archaeological assemblages included under this term share common characteristics that can be summarised as follows (Kuhn, 2019):

- a) a method for producing blades and convergent elongated blanks by direct hard stone percussion with faceted butts and cores that, when abandoned, morphologically resemble Levallois cores. However, these cores are distinct from the Levallois concept *stricto sensu* in that they include a crested ridge in the shaping process and an Upper Palaeolithic volumetric exploitation;
- b) the retouched tool kit includes typical Middle and Upper Palaeolithic forms (end-scrapers, burins);
- c) IUP assemblages may include, in a variable manner, bone tools and ornaments, the latter mainly in the Levant in the form of perforated shells (Kuhn et al., 1999; Stiner et al., 2013),
- d) from an archaeo-stratigraphic perspective, the IUP always follows late Middle Palaeolithic assemblages, always constitutes the first Upper Palaeolithic industry and, in the Levant, precedes the Early Ahmarian.

The Moravian Bohunician

Dated to approximately 48,000 BP at the Brno-Bohunice type site locality (Richter et al., 2008), the Bohunician is mostly known from surface occurrences and includes few stratified sites, such as at the type locality of Brno-Bohunice and the Stránská skála hill sites on the eastern margin of the Brno basin (Škrdla 2017; Svoboda & Bar-Yosef, 2003). It is characterised by a set of typological and technological Middle and Upper Palaeolithic components. The toolkit includes a range of Middle Palaeolithic forms such as lateral scrapers, notches, and denticulates, while Upper Palaeolithic ones are mostly end-scrapers and burins. But the most characteristic feature, fully representative of the main objective of the knappers, is related to the unretouched blanks. It consists of elongated “Levallois” points obtained from a specific core type, well described by Škrdla (2003). These are shaped to have a narrow surface prepared with a crest and, more often than not, have two opposed platforms which are used to produce blades to create a debitage surface with a more or less triangular shape. Once this process is completed, “Levallois” points are extracted from one main platform with carefully prepared faceted butts. Then, a new bidirectional removal of blades is achieved to enable the production of new morphologically predetermined points. In the Bohunician, blades are thus not the primary objective of lithic production; they are rather a by-product of the procedure to produce cores with the proper morphology to produce points. These are not symmetrical in shape and the tip of the point is skewed from the morphological axis of the blank.

Based on detailed technological comparisons and extensive refits (at Boker Tachtit) between Stanska skála and Boker Tachtit, especially in Levels 1 and 2 (Škrdla 2003), and as there is no local antecedent to the Bohunician in Moravia, most authors consider it to be intrusive and thus phylogenetically related to Levantine IUP

LRJ originated as a result of a gradual technological transition, centering on the development of Levallois points into Jerzmanowice-type blade-points” (Demidenko & Škrdla 2023: 1).

assemblages. Only Zilhão (2006, 2011) strongly criticises this connection by seeing Polish laminar industries as possible antecedents of the Bohunician and of a local evolutionary process specific to central Europe: "In nearby southern Poland, the sites of Piekary IIa and Ksiecja Jozefa document the in situ development of volumetric Upper Palaeolithic methods of blade debitage out of Levallois flake based technologies during the time interval of the Moravian hiatus (ca. 53-43 kyr calBP). Parsimony dictates that there is no need to look into the Middle East for the source of the Bohunician if a better local alternative is available" (Zilhão 2006: 187-189). However, as Soriano has pointed out, and I agree, the Polish industries "are in all respects comparable to the laminar Mousterian industries of northwestern Europe such as Rencourt-lès-Bapaume and (above all, we emphasise) do not present any production of triangular points and blanks as was supposed to be shown by the antecedent to the Bohunician and Boker Tachtit levels 1-2" (Soriano 2015: 161).

Given the specificities recognised by Škrdla between the Bohunician and the Boker Tachtit industries, which, for the latter, are the foundation of the definition of the Levantine and then Eurasian IUP, it is not inappropriate to see in the Bohunician the expression of a possible technical diffusion from the Levant to the Moravian plains, passing through Anatolia, and this even if, at present, no intermediate geographical milestone has been recognised. This is not illogical in chronological terms either, since the Bohunician would fall roughly within the same chronological interval as Boker Tachtit with a weighted average of 11 samples giving a TL age of 48,200 +/- 1900 BP (Richter et al. 2009).

The Balkan Bachokirian

The Bachokirian has long been interpreted as a formative 'facies' of the Aurignacian in Europe (e.g., Kozłowski & Otte, 2000). More recent analyses of the eponymous industry coming from Level 11 of Bacho Kiro (see Rigaud & Lucas 2006; Tsanova & Bordes, 2003; Teyssandier 2004, 2006, 2007; Tsanova 2006;) reveal characteristics that are clearly distinct from the common Aurignacian norms: a Levallois-type debitage exploiting wide, slightly convex surfaces by direct hard-hammer percussion; the intentional production of elongated blanks, modified into points; the absence of bladelet production, etc. The technological definition of the Bachokirian is thus comparable to that of Levallois-derived lithic industries situated at the boundary between the Middle and Upper Palaeolithic. I have argued elsewhere that the few cores present in the Layer 11 assemblage are not related to blade production and that, based on the technological reading of the blade blanks themselves, we can infer that they came from large and flat core surfaces clearly distinct from an Upper Palaeolithic prismatic core reduction sequence (Teyssandier 2006, 2007).

In 2015, an international team resumed work at Bacho Kiro in two distinct sectors: the "main" sector where Ginter and Kozłowski conducted their excavations in the 1970s, and the "Niche 1" sector. At the base of the sequence, Layer K yielded a poor Middle Palaeolithic assemblage, and is overlain by Layers J and I, first attributed to the Bachokirian and now to the IUP (Hublin et al., 2020). While Level J remains relatively poor, its upper part is richer and contains artefacts directly comparable to those of Level I, the latter being an easily recognised and archaeologically rich deposit, 14C dated from 45,800 to 43,600 cal BP (Fewlass et al., 2020). A *Homo sapiens* second lower molar was found in the upper part of Layer J and the screening of 1,271 non-identifiable bone fragments by ZooMS led to the identification of six more hominin bone fragments, four of which come from Layer I with 14 C dates ranging from 46,790 to 42,801 Cal BP. All of the extracted DNA genomes from the Bacho Kiro human remains in Layers I and J fall within the present and ancient variation of *Homo sapiens* (Hajdinjak et al., 2021).

Based on this new discovery, archaeological assemblages from Layers J and I are said to be directly comparable to the one of Layer 11 of the Ginter and Kozłowski excavation and are now attributed to the IUP with direct comparisons with sites such as Boker Tachtit and Üçağızlı Cave, Layers I and F. Most of the lithics from the new excavation come from Layer N1-I in the niche sector with 1,468 pieces. It is dominated by the production of wide and relatively thick blade blanks in a way combining Levallois and Upper Palaeolithic technology. As I noted in the study of Layer 11, the blades were obtained from cores with a wide and relatively flat surface, and they are most often the result of unipolar, sometimes bidirectional, debitage (Teyssandier, 2006, 2007a, b). The butts are plain or faceted and the prominent bulbs clearly attest to direct percussion with a hard stone hammer. The tools comprise mostly retouched or pointed blades, the latter frequently resembling true Mousterian points on thick elongated blanks.

It is clear that the assemblages of Layers I and J are related to the Bachokirian of Layer 11 of the Ginter and Kozłowski excavations. The interesting new data are to now have very coherent 14C chronology and clearly modern human remains. However, I do not agree with the generic attribution of this assemblage to the IUP as it has been defined in the Levant. In fact, in the IUP as defined in the Levant, there is a modification of the

volumetric structures of blade debitage, with the development and exploitation of a volume by the installation of crests and volumetric debitage of the "Upper Palaeolithic" type. This modification in the volumetric structure of the cores is accompanied by the production of points and blades, as is the case in the transitional industries of Europe, but we also note the presence in fairly large quantities of classic Upper Palaeolithic tools, such as end-scrapers and burins on blades. The latter are, however, rare, if not absent, in the Balkan Bachokirian, where, in addition, the debitage is based on a Levallois concept and not on a volumetric orientation of the Upper Palaeolithic-type (Tsanova & Bordes 2003; Teyssandier 2006, 2007a-b; Tsanova 2008). In addition, in the Bachokirian, the debitage is not directly oriented towards the production of convergent blanks (points) since the points are essentially developed by a direct convergent retouch (Teyssandier 2007a) and not obtained in this form *via* the debitage of predetermined blanks.

In my view, there is a strong differentiation between the Bachokirian from both the Central European Bohunician (Škrdla 2003) and the Levantine IUP. In this respect, I do not agree with the conclusions of Hublin et al. (2020) following the new excavations conducted at Bacho Kiro. While the latter reveals a major element, with the presence of *Homo sapiens* between 46,700 and 42,800 Cal BP in the Balkans, these human remains are associated with an industry identical to those we attributed to the Bachokirian based on previous excavations (Kozłowski ed. 1982).

The new discoveries do not change the situation in terms of the interpretation of lithic assemblages and an attribution to the IUP seems to me inadequate and premature based on the published industry. I, therefore, disagree with the authors' conclusions that "(...) the Bacho Kiro cave IUP is similar to the IUP from Layers I-F at Üçağızlı cave (Turkey) in terms of lithic technology, typology and the presence of shaped bone tools and pendants, as well as with respect to ages" (Hublin et al. 2020: 3). Furthermore, it is important to note that while ornaments are well documented in the new excavations via one fragment of an ivory bead and 12 perforated or grooved pendants, 11 of which are made on bear teeth, these clearly differ from the Levantine IUP traditions where all the known ornaments are perforated shells (Stiner et al., 2013). On the other hand, the Bacho Kiro ornaments show striking similarities with those of the Grotte du Renne Châtelperronian (Martisius et al., 2022).

Is the Neronian a game-changer?

The Neronian is a technocomplex first defined in southeastern France from a typotechnological viewpoint by Slimak in his PhD (2004). It was then defined as a late Mousterian with Upper Paleolithic traits. Among its particularities are the absence of an independent flake debitage and the exclusive orientation of its lithic industry towards the production of points, blades and bladelets (Slimak 2007). At this stage of research, the Neronian was seen as a local evolution from a Charentian Mousterian well defined in the Rhône valley since the work of Combier (Combier 1967; Slimak 2007, 2008). Ten years later, Slimak (2017) began to modify his interpretation, and stated that the Neronian corresponds to a lithic technological anomaly in the Mandrin archaeosequence and that it is in sharp discontinuity with local Mousterian industries. He further clarified his position by drawing a clear parallel between the production of Neronian points and those found in the oldest layers of the IUP at Ksar Aqil in Lebanon: "the technical systems of the Neronian in the Western Mediterranean are similar to those documented at the beginning of what is known as the Initial Upper Paleolithic in the Eastern Mediterranean" (Slimak 2019, 334). In this sense, around the 50th millennium before present, a technocomplex unified by common technical practices would have been present on both shores of the Mediterranean Sea. Another important point is that at the key site of Grotte Mandrin the Neronian is interstratified between two Mousterian complexes. In this sense, the Neronian represents an anomaly, corresponding to the intrusion of an exotic population clearly distinct from the Mousterian ones (Slimak 2019). The author adds that the break between the Mousterian of Mandrin layer F and the Neronian of Mandrin layer E was particularly abrupt, since microchronological analysis of the soot deposits would suggest that no more than a few seasons passed between the two occupations (Vandeveldt et al., 2017; Slimak 2019). A few years later, the Neronian was attributed to *Homo sapiens* on the basis of the discovery in layer E of Mandrin of a single incomplete deciduous tooth (dURm2; (# MAN 12 E 1300)) attributed to anatomically modern humans (Slimak et al., 2022). According to Slimak et al. (ibid), the Mandrin discovery reveals, based on the finding of that single tooth, one the earliest incursion of *Homo sapiens* into this part of western Europe at between 56 800 and 51 700 cal BP. This early anatomically modern human incursion would have taken place in a Neanderthal world represented by the preceding Mousterian layer F and the succeeding Mousterian layers D and C.

Although it pre-dates the MP/UP transition as it is currently understood, it is important to mention the Neronian, as it is now attributed by Slimak to an IUP. First of all, it does not seem so obvious to me that the Neronian is directly comparable to the IUP at Ksar Aqil. At the latter site, it should not be forgotten that the points (Levallois unretouched and Emireh points) are associated with a full Upper Palaeolithic lithic tool-kit, with numerous end-

scrapers, burins. This is not the case at Mandrin, where lithic points are associated with sidescrapers, notches and denticulates made on flakes, an information that is extracted from Slimak's PhD (2004) but not found in the most recent articles. Secondly, Slimak asserts that the Neronian type-fossil (the Soyons point) is found only in the Rhône valley and in particular at Mandrin. This is not the case, and specimens are known from Mediterranean Spain at Cova Negra for example (Villaverde 1984). Does this mean that IUP extends all the way to the Spanish coast? Third, it is true that the Mandrin layer E points are particularly regular and include microlithic specimens, and this is a specific and interesting feature of the Neronian assemblage. I also note that concerning the few "nanopoints" illustrated (see Fig. 2, Slimak et al., 2022, n° 1-11), most of them look like distal tips of fragmented points. This raises the question of how large they would really be if they were complete. The larger points are reminiscent of other well-known specimens from the European Middle Paleolithic, sometimes present in abundance in certain assemblages, as is the case, for example, in northern France from MIS 7 to MIS 3 (Goval 2016). Consequently, using the lithic industry to attribute the Neronian to a distinct population group (i.e. *Homo sapiens*) other than Neanderthals does not seem to me to be the way forward. That leaves the presence of the deciduous tooth fragment of Mandrin layer E as the single evidence supporting modern humans in southeast France 10 000 years earlier than previously thought. In stratified caves or rock-shelters, it is now commonly known that archaeological deposits are more often than not mixed by diverse anthropogenic (excavation methods, preliminary interpretation of the archaeostratigraphy (see for example the recent case study of the accepted - during 40 years - association of the Saint-Césaire Neanderthal skeleton to a supposedly Châtelperronian layer (Gravina et al., 2018), analytical practices, etc.) and/or natural processes (site formation processes, animal burrowing...). The discovery of a single, isolated, very small tooth crown fragment therefore naturally attracts attention and calls for a thorough inspection of the archaeological context's integrity. But is the deciduous tooth fragment unambiguously associated with the Neronian lithic component, given the fact that the overlying stratigraphy also includes typical *Homo sapiens* occupation patterns of the Protoaurignacian and the Bronze Age (Slimak et al., 2006). Surprisingly, no analysis of the systematic inter-level refitting is presented to justify the good coherence and perfect stratigraphic integrity of the different archaeological assemblages distinguished, which seems to have been asserted post-excavation only and via the 2D projections of items pieced-plotted by layer. This is clearly not enough, especially as the literature on Mandrin does not, to my knowledge, include detailed stratigraphic and geoarchaeological analyses. Finally, while the Mousterian/Neronian/Mousterian interstratification is very interesting, I am troubled by the interpretation made of the speed of passage between these complexes, especially when we read that no more than a year would have elapsed between the Neanderthals of layer F and the supposed modern humans of layer E. This information, of a precision never before achieved in the world of Paleolithic archaeology, is based on the study of soot deposits on the cavity walls and the rock fragments that detach from them and are subsequently found in archaeological deposits (Vandeveldel et al., 2017). While this method is relevant and needs to be considered very seriously for what it offers in terms of promising prospects, it should be remembered that it cannot go beyond what the reliability of stratigraphy allows. In other words, to believe in what the author is announcing, we would also have to believe in the fact that, at Mandrin Cave, each archaeological level corresponds to a "single" episode of occupation. However, there is no evidence for this at Mandrin, and it is therefore equally conceivable that each micro-layer of soot corresponds to a palimpsest of multiple human occupation events, and that the barcode sequences obtained actually record much longer intervals during which the cave was occupied, separated by equally long intervals during which it was not. Moreover, nowhere do we see evidence that these alternations of dark and light bands definitely represent an annual alternation of dry and wet seasons, and therefore one, and only one, year of calcite deposition. I do not see why this alternation should not represent much longer climatic cycles between drier and wetter conditions, which may well represent decades or even centuries. In my view, there is no guarantee that Mousterian layer F is separated from Neronian layer E by a single year and no more.

In sum, it seems to me that the robust data required for acceptance of the notion that anatomically modern humans were present in France between 56 000 and 52 000 cal BP remains missing.

The European transitional assemblages now grouped by several authors under the generic term IUP and affiliated in this way with this technocomplex and a possible human dispersal of *Homo sapiens* from southwest Asia (e.g., Hublin 2015; Hublin et al., 2020) seem to arise from distinct archaeological realities. In particular, the differences noted between the Bohunician and Bachokirian reveal a real distinction of debitage concepts that does not enable us to relate them to the same technocomplex. If the question of a connection between the IUP of the Levant and the Bohunician remains plausible, it is different from the Bachokirian, which seems to result from a distinct process. In my opinion, the Bachokirian is equivalent to a transitional industry with a strong Levallois-type technological substrate intended to produce elongated and laminar blanks, some of which are retouched into Mousterian points. There are no Upper Palaeolithic-type volumetric concepts here, but, on the contrary, concepts inherited from the Middle Palaeolithic.

Discussion

The archaeological situation of the Middle-to-Upper Palaeolithic transition between ca. 50,000 and 40,000 BP is complex, and the relationships between the different complexes distinguished are not clear. The Châtelperronian is undoubtedly the most emblematic case since nothing in its archaeological composition should place it in this movement. It does not include any elements inherited from the Middle Palaeolithic and clearly constitutes the first stage of the Upper Palaeolithic in France and northern Spain. Even if it differs quite clearly from the Protoaurignacian in terms of its lithic systems, it is in its general orientation much closer to the Protoaurignacian than to any of the late Middle Palaeolithic assemblages. It is, therefore, a case apart and needs to be placed in the context of discussions on the emergence and development of the first phases of the Upper Palaeolithic.

This is not the case for all the other techno-cultural assemblages that systematically integrate elements inherited from the Middle Palaeolithic with new elements or innovations that explain their integration into the movement of the transitional industries.

Paleoanthropological documentation of the timing of the “transition” is far too sparse, with occurrences of human remains discovered in quality archaeological contexts still remaining very few (Hublin, 2010, 2015). Concerning Eurasia, we further know that biologically modern fossils consistently exhibit varying proportions of genetic introgression from an archaic human type, in this case, Neanderthals. Denisovan genetic introgressions are also assumed based on the study of the genetic diversity of present-day human groups and the molecular phylogeny that can be reconstructed based on the few reconstructed genomes of the Denisovians. It is currently estimated that there were several episodes of introgression between Neanderthals and modern humans between 65,000 and 47,000 BP and between Denisovans and modern humans between 54,000 and 44,000 BP (Kuhlwilm et al., 2016; Larena et al., 2021). Based on the complete genome obtained from the morphologically modern femoral shaft of Ust'-Ishim in western Siberia, it has been proposed that Neanderthal gene flow dates to 230-400 generations before the life of this individual, or between 50-60,000 years before the present (Fu et al., 2014). Very different data were obtained on the relatively closely-aged fossils of Zlatý Kůň (Prüfer et al., 2021) and Peștera cu Oase 1 (e.g., the mandible; Fu et al., 2015).

At Zlatý Kůň in the Czech Republic, direct C14 dates are problematic due to heavy contamination of the specimen by animal glue, and the oldest age obtained after hydroxyproline treatment is 34,000 cal. BP (Prüfer et al., 2021). This is considered a minimum age, however, as the assumed age of the lineage represented by this fossil, based on the length of the Neanderthal DNA segments in its nuclear genome, must be more than 45,000 years before present (Prüfer et al., 2021). The last interbreeding with a Neanderthal in the family tree of this modern human would be 70 to 80 generations before her. With Peștera cu Oase 1, we may be even closer to one of the episodes of interbreeding between the two human lineages since this fossil has a higher proportion of Neanderthal genes than any other specimen, between 6 and 9%, and the Neanderthal/*Homo sapiens* mixing would have taken place six generations before the birth of Peștera cu Oase 1 (Fu et al., 2015), indicating from its age that groups of both populations occupied central Europe around 40,000 cal BP, which is a minimum age for this fossil given that its dating has not been subjected to hydroxyproline treatment.

Several paleoanthropologists have long been pointed out, before the results of paleogenomics, that some anatomically modern humans of the Upper Palaeolithic show mixed modern and archaic traits, suggesting interbreeding with Neanderthals (e.g., McCown and Ketih, 1939; Coon 1962; Wolpoff et al., 2004). This was also proposed more recently with different arguments by Trinkaus and colleagues based on the study of the Lagar Velho child (Portugal) dated between 29,500 and 28,000 cal. BP (Duarte et al., 1999), and then from that of the remains of Peștera Muierii dated between 36,500 and 33,000 cal. BP (Soficaru et al., 2006), and finally that of the mandible of Peștera cu Oase 1 in Romania with a minimum age of ca. 40,000 cal. BP (Trinkaus et al., 2003). It is now known, and logical to expect, that the closer one gets to introgression with Neanderthals, the higher the proportion of Neanderthal genes in the *Homo sapiens* genome, from an average of 5.7-4.3% to 2.2-1.1% today (Fu et al., 2016).

In terms of settlement dynamics for the Eurasian Early Upper Palaeolithic, it appears that the notion of a single wave of settlement from Africa via southwest Asia is no longer relevant and that the situation is far more complex than was previously accepted (e.g., Mellars, 2004, 2005). Indeed, studies by Fu et al. (2016) and Posth et al. (2023) show that the analysed individuals of Early Upper Palaeolithic age are all identified within 'clusters' where they are alone and isolated, in contrast to clusters grouping several human fossils of Late Aurignacian or Gravettian age. Thus, whether it is Ust'-Ishim, Oase 1, Kostienki 14 and Goyet, dated between 45,000 and 35,000 cal BP, and thus all included within a chronological interval before or sub-contemporaneous with the

early Aurignacian phases or with certain transitional industries, each belongs to a distinct lineage and thus does not show affinities that would allow them to be grouped together. Furthermore, even within these four fossils, significant differences appear in that of the Kostenki and Goyet individuals, dated to ca. 37,000 and 35,000 cal BP respectively. These fossils are related in that they share more alleles with present-day Europeans than with east Asian populations (Fu et al., 2016; Hajdinjak et al., 2021), whereas for individuals earlier than 40,000 cal BP (Ust'-Ishim dated ca. 45,000 cal BP Fu et al., 2014, Oase 1, Bacho Kiro), they show no genetic affinity with later European populations (Fu et al., *ibid.*), suggesting that they correspond to migrations that did not enjoy prolonged success and became extinct without leaving any descendants.

This is a major result for the chronological context of the Transition: the first *Homo sapiens* associated with Middle-to-Upper Palaeolithic transitional contexts left no posterior traces and did not genetically contribute to the current gene pool, whereas from 37,000 cal BP and probably even earlier if the Oase fossils were re-dated by hydroxyproline, all the individuals analysed have an ancestry with the present Europeans. We can therefore postulate that modern pre-Aurignacian humans, authors of the transitional industries, interbred with Neanderthals and did not leave any descendants, a situation that would explain the fact that from the Protoaurignacian onwards, these technical traditions were abandoned. On the contrary, from the Protoaurignacian /Early Aurignacian succession, modern populations would leave their genetic imprint in later populations, and this would account for a certain continuity that is observed archaeologically within the Aurignacian phylum.

Another individual analysed very recently, from the Bacho Kiro cave in Bulgaria and dated between 45,000 and 42,500 cal BP, interbred with a Neanderthal less than six generations prior (thus a 'situation' close to that of Oase 1). Paleogenomic results indicate that this individual was related not to western Eurasian populations but to populations found today in east Asia and the Americas (Hajdinjak et al., 2021). In other words, it is becoming increasingly clear that between roughly 47/45,000 and 42/40,000 cal BP, the few anatomically modern individuals analysed by palaeogenomics indicate the existence of several populations on the European continent that did not pass on genetic inheritance to the subsequent European Upper Palaeolithic populations. It could therefore be assumed that there was a major change in the settlement pattern of Europe with the introduction of the Aurignacian populations, a hypothesis that some interpret in relation to the Campanian Ignimbrite (CI) volcanic mega-irruption dated around 39,000 cal BP and which would have had major consequences on the climate of the northern hemisphere and thus reduced the potential territories of the populations living in western Eurasia at the time (Black et al., 2015; Giaccio et al., 2017).

Conclusion

The various regional complexes grouped under the term Middle-to-Upper Palaeolithic transition illustrate distinct archaeological realities. While most of them include both characteristics inherited from the Middle Palaeolithic and innovations of the Upper Palaeolithic-type, the Châtelperronian stands out as a full Upper Palaeolithic entity, in total rupture with the Middle Palaeolithic complexes that preceded it locally. Thus, before the emergence of the Protoaurignacian, there is no global movement unifying Europe but, rather, regionally contrasting and different situations.

For too long, this debate has focused solely on the question of the author of these cultural events. In most cases, however, the state of the archaeological record simply does not allow us to answer this question. In the interest of caution, we should acknowledge that the author of the Bohunician, Uluzzian and Châtelperronian is not known with certainty. Only the Bachokirian and the LRJ are now clearly associated with *Homo sapiens*. Moreover, advances in paleogenomics show very clearly that these complexes developed in a continent that experienced extremely important flows and mixtures of populations, between *Homo sapiens* newcomers and Neanderthal natives. Therefore, and given that we know that some of these fossils dated precisely to this period are situated almost at the moment of interbreeding between individuals of these two populations, the question of who did what should no longer be at the centre of the debate.

What is important today, from a cultural point of view, is to understand the dynamics of change operating at the evolutionary level. It seems clear, in fact, that the transitional industries are all in a position of more or less clear discontinuity with the last Mousterian. However, while evolution proceeded in some cases, such as the Bachokirian, via a gradual change in lithic production and the addition of new elements (ornaments, bone industry), a clear and total break occurred in others, such as the Châtelperronian.

In the Châtelperronian, all the elements of the material and symbolic culture display a clear break from what existed at the end of the Middle Palaeolithic. In this context, it is difficult to understand why we should speak of

acculturation since there is nothing in the technical systems that attests to a relationship with what preceded it. On the contrary, the Châtelperronian is a full Upper Palaeolithic entity with no Mousterian remnants. The Châtelperronian is therefore characterised by a clear break in the modes of transmission and learning, suggesting a population change. On the other hand, it is equally clear that in western Europe, the Châtelperronian inaugurates a new evolutionary cycle, which then continued and became more pronounced in the early stages of the Aurignacian. If we consider from an evolutionary perspective all the successive technocomplexes between the last Mousterian, the Châtelperronian, and the Protoaurignacian, a consensus can easily be established to situate the break between the Mousterian and Châtelperronian. The situation is very different between the Châtelperronian and the Protoaurignacian, on the other hand, which display remarkable similarities in terms of the orientation of lithic production: mainly towards obtaining blades and bladelets according to strict Upper Palaeolithic volumetric conceptions with the use of marginal percussion and a common functional destination of the main desired blanks, intended to be transformed into projectile elements. While the Protoaurignacian marked the systematisation of bladelet productions, the Châtelperronian was also part of this trend, since bladelets were made at several Châtelperronian sites in a clear Upper Palaeolithic manner.

Acknowledgments

My gratitude goes to Magen O'Farrell who patiently proofread this text and greatly helped to improve my English. I would also like to thank Bruno Maureille and João Zilhão for the many discussions on the themes developed in this article. I would also like to thank the four anonymous reviewers for all their comments and criticisms, which helped to improve the final form of this text. Finally, my sincere thanks to Shannon McPherron, the editor of the journal, for his careful proofreading and follow-up of the manuscript.

Declarations

Ethical Approval
Not applicable

Competing interests
The author has no competing interests.

Authors' contributions
Not applicable

Funding
No specific funding was acquired for the writing of this article;

Availability of data and materials
Not applicable

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