Close encounters of the third kind? Neanderthals and modern humans in Belgium, a bone story

Abrams, G.C.M.G.

Chapter 6

Discussion and Conclusion

The cover of the PhD thesis depicts an ideal image of the encounter between Neanderthals and modern humans (AMHs) that illustrates perfectly the topic discussed in the thesis: did Neanderthals and AMHs ever met in North-western Europe, or more specifically, did they co-existed on the Belgian territory?

1. A new MUPT model for Belgium

The model that has been used so far, based on the classical radiocarbon dating and the interpretation of the chronostratigraphic context of several sites (Chapter 4; Pirson et al., 2012) indicated an overlap of several centuries between the Aurignacian, associated to the Early AMHs, and the Mousterian produced by Neanderthals. It assumes also a wider chronological distribution of the last Neanderthals that were, for those from Spy Cave, associated to the LRJ (Fig. 1; Rougier et al., 2016b; Semal et al., 2013a; Semal et al., 2009; Wißing et al., 2016). Considering particularly the very wide range of chronological data, this model raised many questions about the reliability of the radiocarbon dating (possible contaminations) as well as its inadequacy regarding the recent archaeological data where interstratification of Aurignacian and Mousterian is not documented.

However, the new data on Mousterian and Aurignacian industries change the narrative for the Middle to Upper Palaeolithic Transition (MUPT) in Belgium. The HYP dates (Fig. 1 & 2), which are more reliable, point to a chronological hiatus of almost one to five millennia between the end of the Mousterian (45,900–42,900 cal BP) and the earliest Aurignacian (42,100–40,300 cal BP). These results do not support the scenario of coexistence of different hominin populations on the

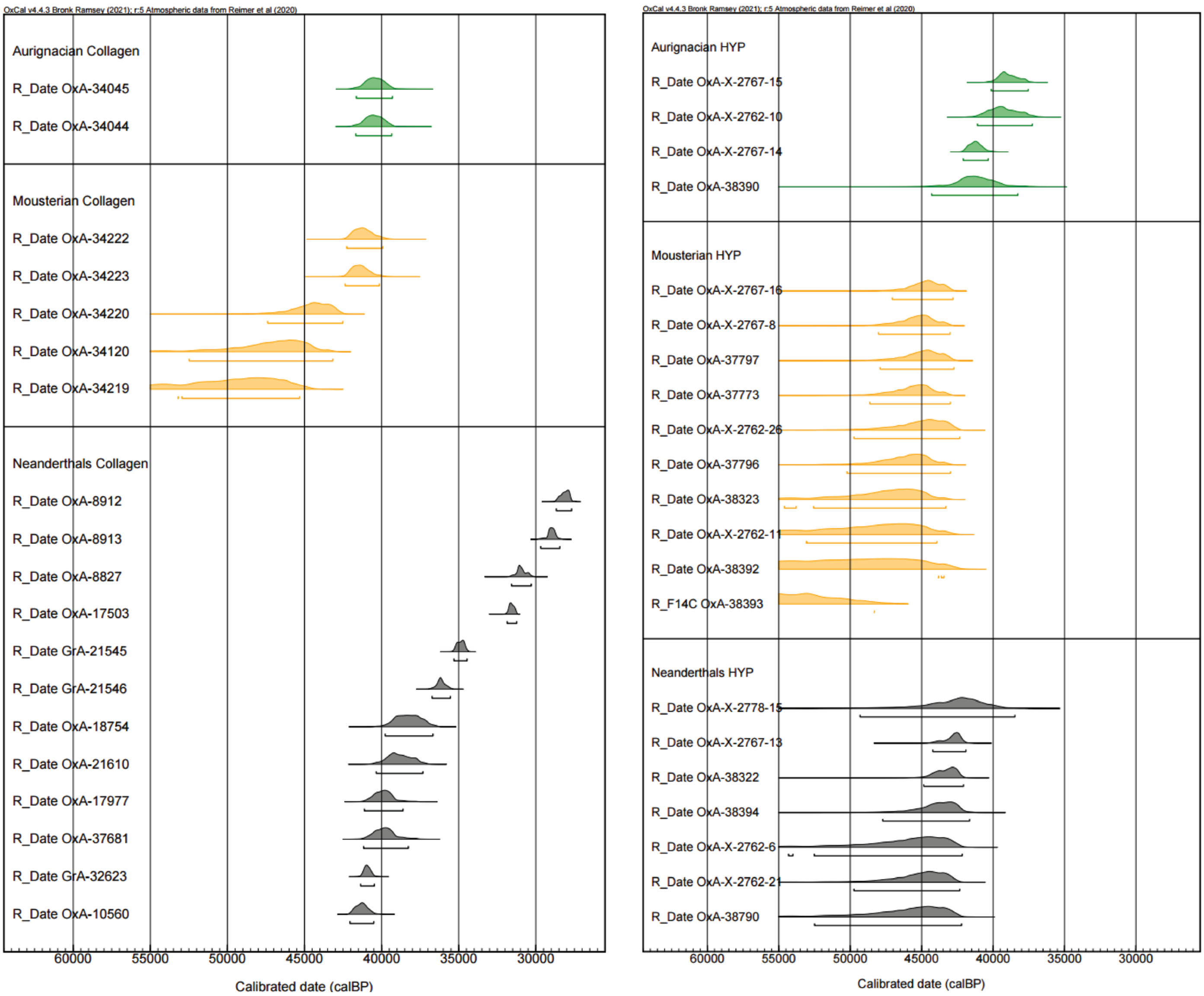

FIGURE 1: Comparisons between direct radiocarbon dating on collagen (left) and direct radiocarbon dating on hydroxyproline (HYP) (right).

Belgian territory during the MUPT (see Chapter 5).

The revised model of the Middle to Upper Palaeolithic transition in Belgium indicates that:

- The Late Neanderthals, associated with the Late Middle Palaeolithic industries, disappeared without having contact with Early AMH's;
- The so-called transitional industries LRJ seems to have been produced by the last Neanderthals and should, therefore be assigned to the Late Middle Palaeolithic.

The assumption that there is a chronological hiatus is based on different lines of evidence:

- The absence of indications for hybridization between the Neanderthals and the AMHs in North-western Europe (Hajdinjak et al., 2021).

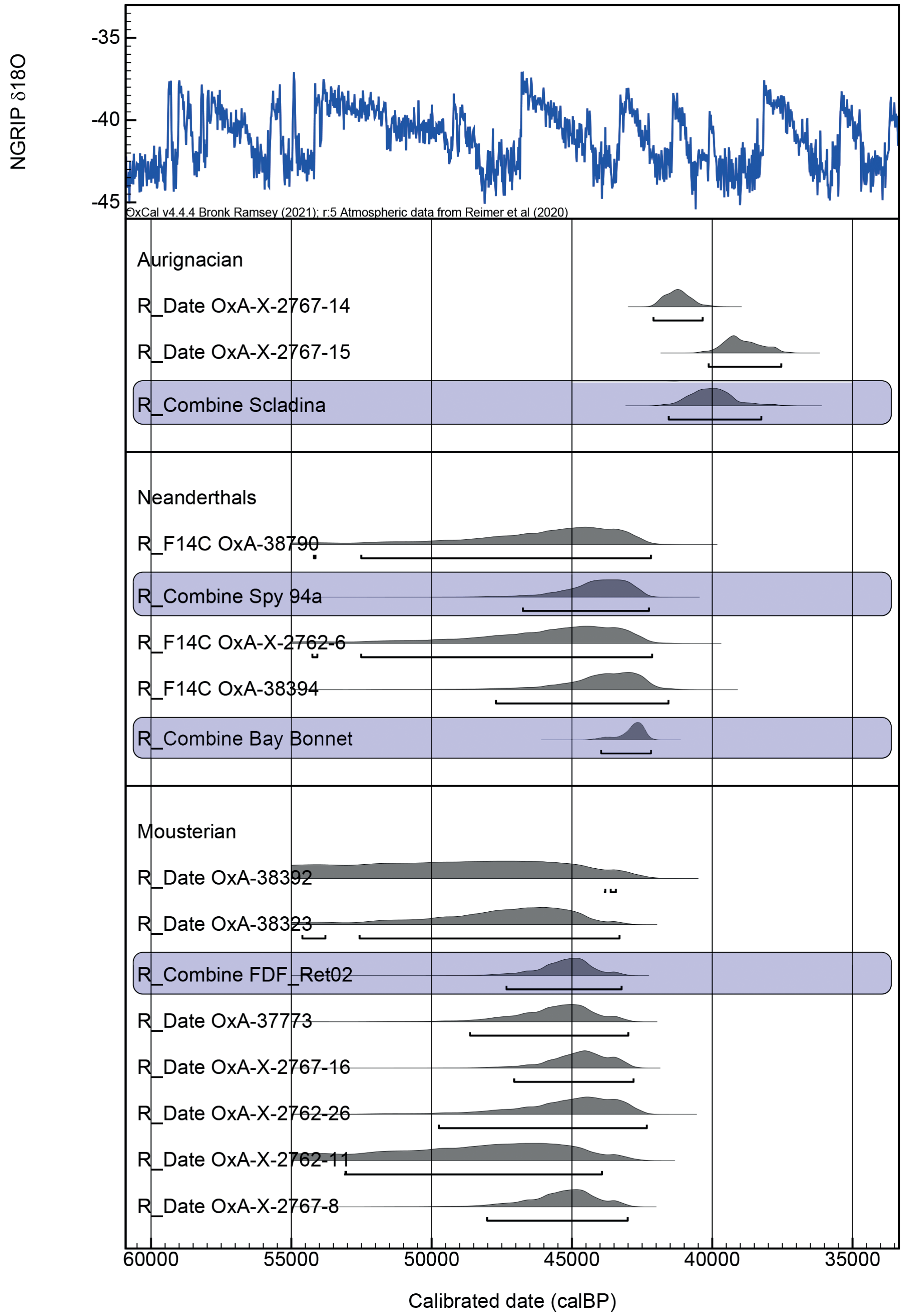

FIGURE 2: Calibrated age ranges of the bone implements (see Chapter 4) and Neanderthal remains (see Chapter 5). The data are modeled in a single-phase model and compared tentatively against the North Greenland Ice Core Project dataset from Greenland (Rasmussen et al., 2006). Numbers indicate interstadials in Greenland.

- The absence of interstratification of Aurignacian and Mousterian material in the recently excavated sites such as Walou and Scladina (Chapter 2);
- The new results of the extensive radiocarbon dating programme, which combined classical pre-treatment and the CSRA approach that allowed us to perform several cross-dating of the same archaeological material (Chapters 4 and 5).

The radiocarbon dating programme produced a total of 31 radiocarbon dates of 22 objects from 12 different sites across Belgium (Fig. 3): bone points (N=2), bone tools (N=13) and Neanderthal bone remains (N=7) (Chapters 4 and 5). Eight radiocarbon dates (one Neanderthal remain and seven bone retouchers) were obtained on collagen using the ultrafiltration method, a routine radiocarbon pre-treatment, and 23 (eight Neanderthal remains, two bone points and thirteen bone retouchers) were obtained using a more robust and chemically reliable method targeting a single amino acid (hydroxyproline) from the bone collagen for AMS dating (Devièse et al., 2018a). Most of the specimens are recontextualised and newly sampled for paleogenetic or proteomic analysis, in addition to collagen extraction for the radiocarbon dating.

The dating programme is unique in the quantity and diversity of the investigated remains, even if constrained by the relatively small amount of available remains. In total, 12 objects (five Neanderthal remains, six bone retouchers and one bone point) have been cross-dated, opposing the results of the HYP dating method to more classical radiocarbon pre-treatments (such as ultrafiltration), to improve the reliability of the results. It appeared that extracting and dating the hydroxyproline (HYP) provide a level of reliability that is unmatched by other pre-treatment methods (Devièse et al., 2018a). In addition, the application of the so-called "Compound Specific Radiocarbon Analysis" (CSRA) is often getting older the results compared to those obtained when rou-

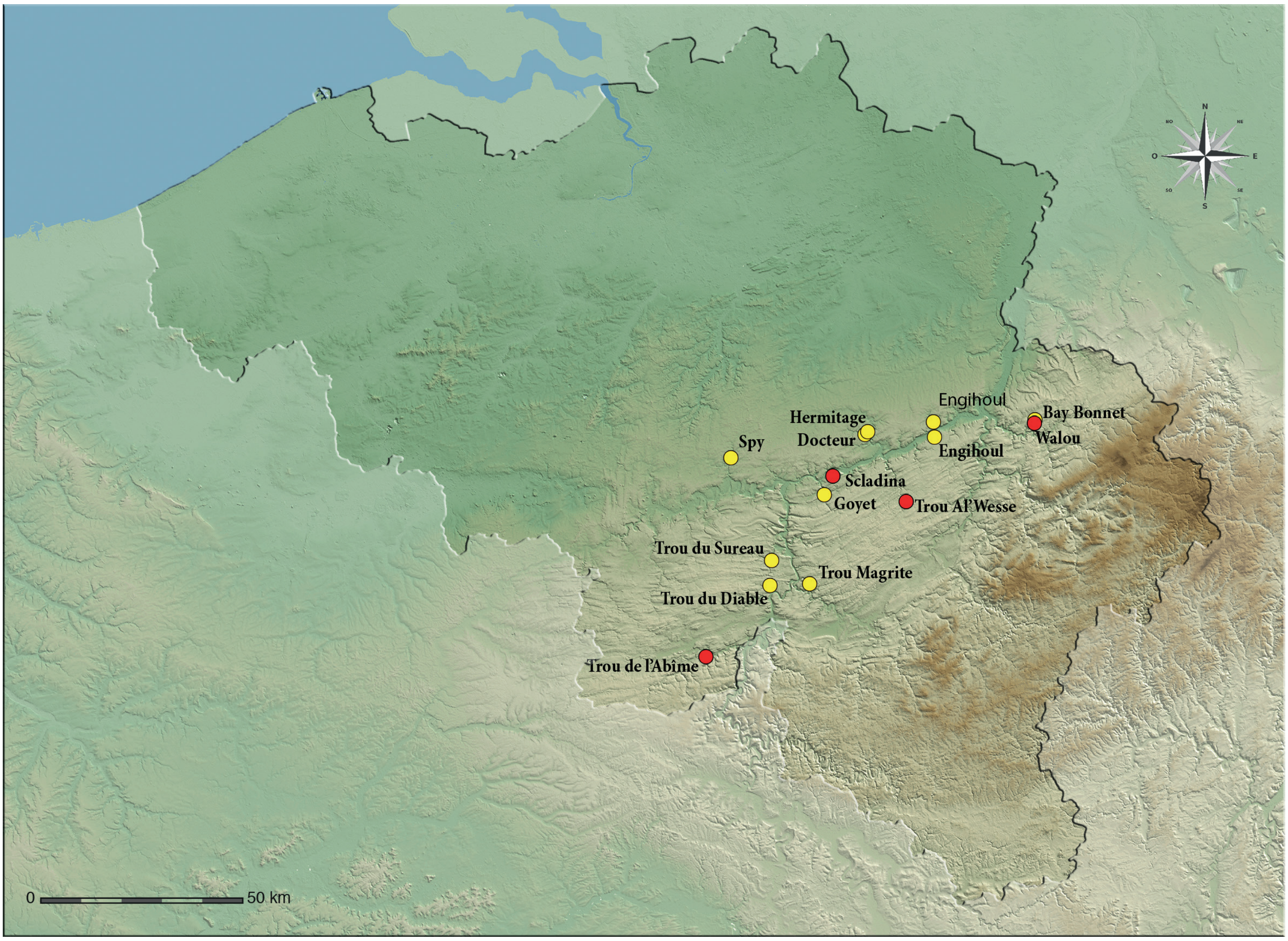

FIGURE 3: Distribution map of the sites that have yielded the analysed bone tools and human remains. Historic collections are figured in yellow and modern in red (modified after Abrams, 2018).

tine purification methods are applied. This indicates that many of the previous radiocarbon dates obtained after less robust pre-treatments (e.g. the age of the bone point of Spy (Flas et al., 2013), are often inaccurately young (Devièse et al., 2017; Devièse et al., 2018b; Dinnis et al., 2019; Hublin, 2017) due to possible contamination of the collagen. HYP dates are usually aged due to a better removal of contaminants that caused a younger age. This conclusion, that is based on our experience with Belgian fossil material, is supported by data from other sites such as Vindija (Devièse et al., 2017).

The consistency of the results obtained by this dating method (Chapters 4 and 5) and the protocol of extraction of the hydroxyproline (Devièse et al., 2017) leads us to consider it as the most effective radiocarbon dating method to date. However, the CSRA approach involves the use of a greater amount of material and provides a wider standard deviation.

Despite the slight increase in age, the Neanderthals from Belgium remain among the youngest Neanderthals in Central and Western Europe (Chapter 4; Devièse et al., 2017). Neanderthals still inhabited the Belgian territory when early AMHs already lived in Eastern and Central Europe (Hajdinjak et al., 2021; Hublin et al., 2020; Prüfer et al., 2021).

2. The MUPT in Central and Eastern Europe

In Central and Eastern Europe, a continuous occupation of the territory and the encounter between different hominins are notably highlighted by genetic data that indicate hybridisation between Neanderthals and the first AMH populations. This is attested in remains from several sites: Peştera cu Oase (Romania) (Fu et al., 2015), Ust'Ishim (Siberia) (Fu et al., 2014), Bacho Kiro (Bulgaria) (Hajdinjak et al., 2021) and Zlatý kůň (Czechia) (Prüfer et al., 2021). The human remains from these sites clearly show modern features, their aDNA data indicate genetic interaction with Neanderthals.

The human remains from Bacho Kiro are associated with a hybrid techno-complex, which combines Mousterian and modern features, called the Initial Upper Palaeolithic (IUP; Hublin et al., 2020; Chapter 1). So far, it is the only site with clear evidence for the link between the hybrid techno-complex and hybrid hominin remains. The other sites where hybrid hominin remains have been found, did not yield archaeological data that could contribute to the discussion about the possible link between hybrid hominins and the IUP techno-complex.

Regarding the chronological aspect in Central and Eastern Europe, the absolute dates of the Neanderthal and modern human remains show an overlap in the existence of the two species that confirm the continuous occupation of the region. However, most of the dating related to the MUPT in this region is still based on routine radiocarbon dating method, which are less accurate. Except for those obviously contaminated by modern collagen, such as Zlatý kůň (Prüfer et al., 2021), most of the HYP dates that have been made provides older results than those obtained by routine purification methods (Devièse et al., 2017; Dinnis et al., 2019). It would therefore be interesting to challenge this chronology by using the HYP method. Although it will not challenge the coexistence of the different hominins, asserted by the genetic hybridisation, the use of HYP will allow us to better define the temporality of events and thus to better calibrate them on a continental scale, in relation to the results we have obtained.

Whereas there is convincing evidence of the coexistence of Neanderthals and AMHs in Eastern and Central Europe, leading to their interbreeding (Hajdinjak et al., 2021; Hublin et al., 2020; Prüfer et al., 2021), there is no such proof for North-western Europe. The current archaeological, genetic, and chronological data all indicate a scenario in which AMHs arrived in a territory (North-western Europe) already deserted by the last Neanderthals.

North-western Europe is a remote region, at the edge of Neanderthal's geographical distribution. The geographical distance between the areas of incursion of AMHs and North-western Europe. Geographic remoteness and low population density could have played a major role in the absence of direct contact between Neanderthals and AMH in North-western Europe.

3. The LRJ techno-complex

But what about the presence of the so-called transitional techno-complex (LRJ)? Is the occurrence of the LRJ techno-complex an indication for the presence of AMHs or "hybrids"?

The LRJ techno-complex is present in an area stretching from the UK to Poland. LRJ testimonies are also found in Belgium, in the caves of Spy and Goyet (Flas, 2011b). This techno-complex is often placed between the Late Mousterian and the Early Aurignacian mainly based on the technological features of this industry that are qualified as transitional. However, there is little convincing evidence that validates this hypothesis. Most of the sites that yielded LRJ material, are deprived of consistent stratigraphic records. Even the recent dating programme led on the Nietoperzowa Cave is questionable regarding notably the use of classical radiocarbon dating method and the material selected. This material was recovered from old excavations, deprived of consistent stratigraphic context and with no evidence of anthropogenic modifications (Krajcarz et al., 2018). The most reliable collagen dates for this techno-complex are, currently, around 42,000 to 44,000 cal BP based on finds from Glaston (UK; Cooper et al., 2012). These dates indicate that the LRJ would be contemporaneous with the Late Mousterian but the dates do not answer the "who was the maker" question. There is no evidence of the presence of AMHs before 42,000–40,000 cal BP in North-western Europe. Moreover, we cannot exclude the possibility that the Glaston collagen dates are minimum ages due to unremoved contamination as demonstrated on Neanderthals and bone implements from Belgium (Chapters 4 and 5). This would reinforce the association of the LRJ with the Late Middle Palaeolithic industries, which lasted until 42,000 cal BP in our regions.

Despite a multidisciplinary research programme carried out in the field and the detailed investigation of "old" Belgian collections, we have not been able to recover new LRJ artefacts that would enhance the few testimonies found in the caves of Spy and Goyet.

In Belgium, the survival of Neanderthals, somewhat beyond the end of the Mousterian makes their association with the LRJ tempting (Figs. 1 & 2). However, the HYP dating of a Neanderthal individual from Spy Cave (46,800–42,200 cal BP), which was hypothetically associated to the LRJ (Semal et al., 2009), provided the same range of age than the Neanderthal individual from Bay-Bonnet Cave (44,100–42,100 cal BP) where there is no evidence of LRJ in the archaeological records. The assignment of Spy Neanderthals to the Late Mousterian seems to be most plausible in this case or, if Neanderthals are the makers of the LRJ, then this industry should be correlated to the Late Middle Palaeolithic instead of the Early Upper Palaeolithic in this region.

It is therefore essential to enrich the debate on the LRJ. It is always the same data that are rehashed without any new and tangible elements to enhance the discussion regarding the "who was the maker of these industries" question and the origin of this techno-complex. So far, it seems that the association with the Late Neanderthals is the best hypothesis. This assumption is solely based on chronological data from one single site (Glaston) that are correlated with the Late Neanderthals from Belgium. But, we must be aware that in this region we have no AMH remains unambiguously associated with the LRJ, or even with the Early Aurignacian (Benazzi et al., 2015) as the dating of the modern human found in Kent's Cavern is still highly controversial (Proctor et al., 2017; White and Pettitt, 2012).

A recent review of Moravian archaeological records attributed to the LRJ proposes to link it to the Initial Upper Palaeolithic (IUP), based on technological features, and thus possibly to AMHs, without any human remains being associated (Demidenko and Škrdla, 2020). The chronological data mentioned (without any details) suggest an age around 46,000–42,000 cal BP, equivalent to the ages already proposed for IUP and the Early AMHs in Central and Eastern Europe (Hajdinjak et al.,

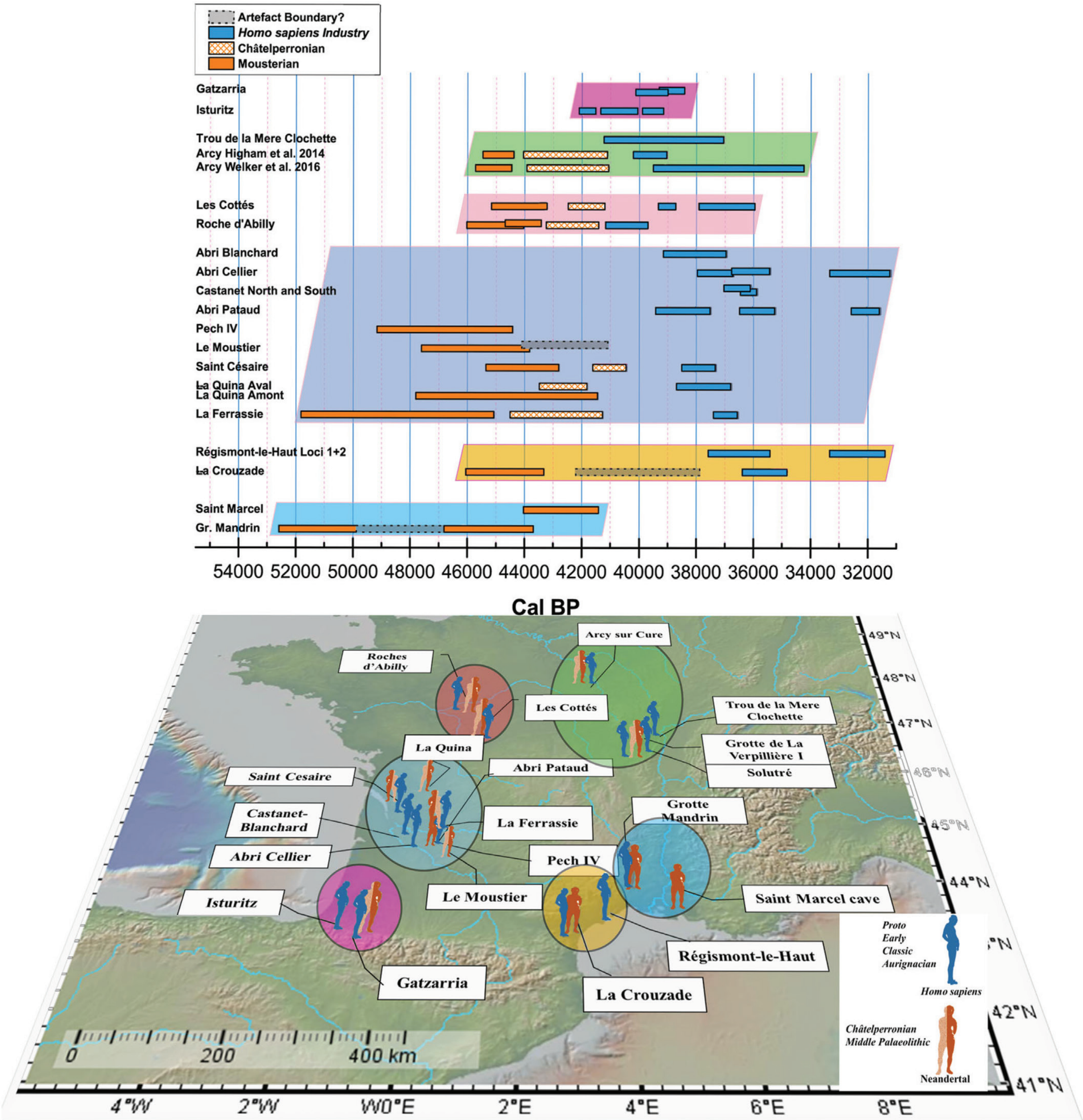

FIGURE 4: Regional chronological comparison. Chronological comparison of La Ferrassie with other French late Middle to early Upper Palaeolithic sites. The horizontal bars are the ranges produced from the 'date' command in OxCal (See SI from Talamo et al., 2020 for more details), except for the direct dates of humans in pink, which are the calibrated ranges. Upper Palaeolithic (*Homo sapiens*) layers are in blue, Middle Palaeolithic (Neandertals) are in orange, and the Châtelperronian (Neanderthals) in orange cross-hatching. The grey bars correspond to an 'artificial' boundary, probably imposed by the Bayesian model due to very poor sample selection or the absence of dates (empty phases). Since the diachronic succession between Protoaurignacian and Early Aurignacian is not always preserved in the sites selected, and the aim of the discussion is to reconstruct the dispersal of *Homo sapiens* across France, no differentiation in colours between different types of Aurignacian are displayed. All the bars represent 68.2% probability cal BP. The different coloured circles on the map are the different French areas discussed in the text. The colour of the circles in the map correspond to the colour of the squares in the graphic on top. (Color figure can be viewed at wileyonlinelibrary.com; reproduced from Talamo et al., 2020)

2021; Hublin et al., 2020; Prüfer et al., 2021), which are also still consistent with those from Late Neanderthals in Belgium (Chapters 4 and 5).

The Eastern European origin of this techno-complex is still questionable as well as its association with AMHs. The idea of a modern and eastern origin of these lithic productions seems to us to deal more with ideology (mainly based on "modern" technological features) than with tangible facts.

4. The Late Middle Palaeolithic – Early Upper Palaeolithic hiatus

Because of the absence of evidence of genetic introgression between North-western Neanderthals and AMHs (Hajdinjak et al., 2018) and the absence of interstratification between the Mousterian and the Aurignacian industries in the region we assume a chronological hiatus between the occurrence of the Neanderthals and the Early AMHs. The absence of interstratification between the Mousterian and the Aurignacian industries is not restricted to the Belgian sites; a recent synthesis summarizing the French Palaeolithic record, emphasises the absence of interstratification between the Mousterian and the Aurignacian (Talamo et al., 2020). They only observe interstratifications of Mousterian and Châtelperronian industries (Talamo et al., 2020). The earliest French Aurignacian sites are in the northern part of France and the dates coincide with those of the Belgium Aurignacian record (Fig. 4).

Based solely on the chronological data, it seems to show a diffusion of the Aurignacian from the North of Europe towards the South. This hypothesis also finds an interesting echo in the recent chronological data of the Aurignacian from Willendorf (Nigst et al., 2014), which are older than those from western Europe. It would therefore be interesting to compare the chronological data with the cultural data provided by the archaeological material.

Our data show that Neanderthals left the Belgian territory long before the early AMH arrived. What is the reason for the early disappearance of the Neanderthals?

5. Could the disappearance be linked to climatic and environmental changes?

So far, the correlation between the timing of the depopulation of western Europe and the paleoclimate record is challenging to assert as both are based on different records: the Greenland ice-core records, defining the paleoclimate evolution, is based on precise calendar data (expressed in b2k; Rasmussen et al., 2014) while the radiocarbon dating are statistical ages based on ever-improving purification techniques and calibration curves (expressed in cal BP). Depending on the dating technique and calibration curve used, the archaeological events can be correlated with different paleoclimatic phases, sometimes jumping from one stadial episode to another, sometimes even from a stadial episode to an interstadial or vice versa. Moreover, even if a strict correlation of these calendars was possible, the time lag between the Greenland ice-core records and their European continental equivalents makes all comparisons questionable. However, bearing in mind the above-mentioned precautions, the climate record shows numerous fluctuations between the GI-12 (46,680 b2k) and GI-9 (39,900 b2k) (Rasmussen et al., 2014), which had almost certainly impact on the distribution and density of species. Model simulations of the hominin dispersion and the replacement of Neanderthals by AMHs tend to show that those climatic changes played a minor role in the demise of Neanderthals (Timmermann, 2020).

The decline of Neanderthals seems to have been initiated during the Weichselian Pleniglacial (MIS 4). A lower mtDNA diversity was observed across the European territory after this glacial phase than before (Hajdinjak et al., 2018; Hublin and Roebroeks, 2009; Peyrégne et al., 2019; Timmermann, 2020). Genetic diversity and demographic data are pointing to a decrease of the Neanderthal population, which was distributed in local and isolated smaller groups (Hajdinjak et al., 2018; Melchionna et al., 2018; Rogers et al., 2017). While the Neanderthals were already in decline, the rapid expansion of modern humans begun (Hajdinjak et al., 2021; Haws et al., 2020; Hublin et al., 2020). AMHs seemed to have been favoured by many factors such as a faster migration speed, higher levels of mobility, fecundity, and technical innovations than Neanderthals (Timmermann, 2020). Although there would have been no direct contact between North-western European Neanderthals and modern humans, the pressure the latter exerted on the more eastern regions must have had a direct impact on the more remote regions, albeit unintentionally.

AMHs outcompeted an already vulnerable Neanderthal population. This situation could have also impacted more deeply the Neanderthal behaviour, constraining them to more extreme opportunistic acts such as cannibalism, attested in few sites like Goyet (Rougier et al., 2016b). It is almost impossible to determine with certainty how these human carcasses were collected. If it turns out that the Neanderthals from Goyet were the result of a deliberate slaughter, this could have contributed to lowering density of an already sparse population that could have led to to their disappearance.

6. Concluding remarks and future challenges

The use of innovative techniques, particularly in terms of dating, opens new perspectives for research and for refining the chronology of a pivotal period in human history. The results we obtained contribute to the documentation of the Neanderthal - AMH transition, although the research was carried out on a rather limited number of specimens in a geographically limited area.

The multidisciplinary conception of our research, which combines classical zooarchaeological studies with modern investigative techniques such as mineralogical, proteomic, and digital imaging studies, has enabled us to further refine our knowledge of the management of animal resources collected by prehistoric populations. Our research has also contributed to the significant enrichment of the corpus of bone industries in Belgium and to their recontextualization. This research was made possible by close collaborations with different disciplines such as Palaeoanthropology, Geology, Chemistry, etc. Inclusive research is determinate for the purity/integrity of a sample to be analysed and its interpretation.

We were also able to document one of the limits of the CSRA approach, which appears when the modern and ancient collagens are bounded. This has been observed for some specimens excavated during the 19th Century, where preservation treatments were applied using collagen-based glue (Spy 572a, see Chapter 5). To avoid this problem, supplementary analyses (ZooMS/Proteomic, paleogenetic, and even pyrolysis) were conducted prior to the dating, to assure the antiquity of the material and to confirm the absence of contamination by modern collagen.

From a methodological point of view, the CSRA approach needs to be improved so that the confidence interval can be revised downwards. More than that, the quantity of material necessary to carry out these analyses is still too substantial, especially when rare material is involved, such as for example hominin remains or bone points.

However, the hydroxyproline (HYP) dating method is regarded as the most reliable and effective radiocarbon dating method of the collagen. Ideally, this dating method should be applied on material with an age close to the limit of the radiocarbon range, where the slightest contamination deeply affects the results of the dating analysis.

Although only a small number of laboratories apply this method, the HYP dates tend to be more frequently produced, as a new technical dating standard on which researchers are increasingly relying (Devièse et al., 2021; Devièse et al., 2018a; Devièse et al., 2017; Dinnis et al., 2019; Hublin, 2017; Prüfer et al., 2021). Our results, especially regarding the chronology, have impacted the understanding of lithic industries that are difficult to date and have had repercussions on the understanding of human occupations during the MUPT as well. The settlement dynamics of North-western Europe is now better documented.

A refined chronology of the Late Middle Palaeolithic and Upper Palaeolithic based on HYP dates should be established in a larger geographic scale. This should concern more Late Neanderthals and Early AMHS as well as more archaeological finds that are culturally diagnostic or strictly correlated to human occupations.

However, the application of the HYP dating method is still infrequent and many new dates need to be produced prior to the establishment of a new reference system based solely on CSRA. This new reference system will therefore take a lot of time to be established. A new chronological model is not an end but a stumbling block to a more global reflection that integrates all the archaeological, environmental, and anthropological data to better seize the subtlety of the dynamic transformation of the European territory and the replacement of Neanderthal populations by anatomically modern humans as well as the true nature of their contacts and the origin of the modernity of the hybrid industries (so-called transitional industries).

Very intriguing is the underrepresentation of ancient modern human remains in the Aurignacian fossil record. As has been done with ancient collections from the Middle Palaeolithic (which allowed the rediscovery of many individuals), reassessments of collections attributed to the Aurignacian should also be undertaken with the aim to recover AMH bone or dental fragments. Detailed biomolecular investigation of these remains could make a major contribution to the hybridisation debate.

Zooarchaeological studies are proving to be a major component in the interpretation of hominin behaviour, both from a technological and a chronological point of view, while the detailed study of the bone retouchers has offered the possibility of a precise cultural attribution as well as the identification of the exploited species used for the tool production. These data, although promising, have yet to be analysed further in ongoing research (Abrams et al., in preparation).

Our model shows that in these remote regions, the last Neanderthals did not come into contact with anatomically modern humans. This scenario remains fragile and may be confirmed or questioned by new research. In this way, the dynamics of prehistoric research that have stimulated this work will continue, as they will stimulate many generations of researchers in the future.