

The present study deals with the socio-economic behaviour of Late Upper Palaeolithic hunter-gatherers before the austere winter season, as well as a re-evaluation of the relationship between two of the relevant entities of this period, the Hamburgian and the Final Magdalenian. The study approaches these topics by a technological analysis of selected Hamburgian and Magdalenian reindeer antler assemblages from North-Western Europe.

As some of the Hamburgian reindeer antler assemblages (Meiendorf, Stellmoor, Poggenwisch, Slotseng) are among the richest of the Late Upper Palaeolithic, the study on hand adds data from the technological analysis of these assemblages, as well as the description of two potentially Hamburgian single finds from the south of the Danish island of Sjælland (Køge Bugt) to the discussion. Furthermore, many Magdalenian sites with organic preservation are located in the Paris Basin. Radiocarbon dating indicated an archaeological contemporaneity with the Hamburgian. Therefore, the Hamburgian antler technology is compared with the antler technology of this region and in particular with that of the multi-layered site of Verberie (Buisson-Campin).

Reindeer antler are preserved on all sites of the archaeological corpus in this study; moreover, all of the sites have zooarchaeological evidence that indicates an occupation during the autumn period. This season is of particular importance for societies that are highly – but not necessarily exclusively – dependent on reindeer. The animals have their highest fat content their skins are in their prime condition and all reindeer sport fully-grown and mineralised antlers. Furthermore, the animals aggregate for the rut and the migration to the winter grazing areas and are easy to hunt in large numbers. However, planning ahead and the successful execution of tasks in autumn is essential to be prepared for the long winter season, when the successful hunting of reindeer and horses is not ensured. Therefore, the autumn is the season of the most opportunities but also the season of the highest risk of failure. The present technological analysis of selected Late Upper Palaeolithic antler assemblages gives insights into the socio-economic constraints of a Late Upper Palaeolithic strategy to reduce such risk of failure during the autumn period.

Although the data from the different sites is rather fragmented and heterogeneous, certain characteristics can be described. All of these sites are located in valley bottoms or lowlands with access to a nearby water body. Furthermore, of the classic Hamburgian sites in the Ahrensburg tunnel valley at least three are thought to lie close to former reindeer migration routes, while they seem to not have been far from Slotseng and Verberie, too. The zooarchaeological data suggests that the sites were inhabited during the fall migration and that initial butchering of reindeer took place on all sites. However, traces of further butchering are only present at the Ahrensburg tunnel valley sites, while Slotseng and Verberie lack this evidence. Analysis of the lithic assemblages of Verberie suggests the presence of learners and more experienced flint knappers on site, while such information on group composition is not yet given for the other sites.

The main part of the present study concerns the technical description and technological analysis of the antler inventories. This technological approach as applied in this study splits into five distinct parts, including the methods to determine reindeer antler and distinguish it from other materials, as well as the determination of anthropogenic stigmata in comparison to natural stigmata. The central part of the method chapter presents the tools that are applied in the reconstruction of the operational schemes from single technical stigmata of antler working and the attribution of artefacts into technological classes (raw material blocks, waste pieces, blanks, roughouts and finished objects). This includes the theoretical hierarchic ordering of different primary and secondary stigmata into (sub)families of techniques as well as an hierarchic ordering of techniques to procedures and procedures to methods. The different parts of the operational schemes are reconstructed using the non-physical refitting by default method. Additional to these theoretical considerations, the families of techniques fracturing, impressing, cutting, and abrading, as well as the corresponding reference collections, are introduced. The final part that is complementary to the qualitative description is marked by the quantification and measurements of traces and artefacts.

In this study, 474 antler specimens were recorded and analysed. Of the recorded artefacts, 216 are unmodified fragments (45.47%) and 96 pieces are unmodified primary raw material blocks (20.25%). Of the

remaining 162 artefacts, 70 (43.21%) are waste pieces. Two basic procedures to obtain blanks were applied in the Late Upper Palaeolithic. The first is the groove and splinter procedure that represents a debitage by extracting. The second are the diverse transversal segmentation procedures that include uni- or bilateral hacking/pecking/sawing or grooving. These function together with the few examples of semi-circumferential and circumferential hacking/pecking as a debitage by segmenting.

The groove and splinter procedure is applied to extract a single blank from the anterior part of the antler. This procedure is applied in at least three different variants of operational schemes. In the first, the groove and splinter procedure is applied on primary raw material blocks, usually between the bez tine and the palmation. The two other variants include the former preparation of secondary raw material blocks by different segmentation procedures. The second operational scheme variant that includes the groove and splinter procedure comprises the detachment of the brow and bez tine, as well as of the palmation, by unilaterally worked predetermined breaking points on the inner curvature of the antler. A blank is extracted between bez or brow tine and palmation. Variant 3 sees the detachment of the beam above the bez tine by a bilaterally worked predetermined breaking point, as well as the detachment of the palmation by a unilaterally worked modification on the inner curvature of the antler, resulting in a so-called bow-shaped matrix. The blank is extracted from a full length of this secondary raw material block.

The discussion of the present study concerns four aspects of the results and interpretations, including possible tools used in antler working, techno-typology and socio-economic implications of antler working for understanding the behaviour of Late Upper Palaeolithic hunter-gatherers. The first part of this chapter deals with the tools used for antler working, including the potential secondary use of blade cores for hacking and pecking. Despite this discussion, the tools with which the hunter-gatherers primarily installed predetermined breaking points have not been identified so far. Furthermore, it seems plausible that the Hamburgian hunter-gatherers used antler wedges for splitting off the blanks from the antler matrices during the application of the groove and splinter procedure. Although these artefacts have not been recorded for the Hamburgian, the traces on the matrices and the presence of distal ends of small osseous wedges that got stuck in furrows indicate this.

This leads to the next part of the discussion, where the techno-typology of the Hamburgian in its Magdalenian context is addressed. Comparable choices of raw material for different tool classes (as described above) can be observed in both entities. Of the blank production by the groove and splinter procedure, only the third variant (on bow-shaped matrices) – which was recorded in small numbers at Meiendorf and Stellmoor and often at Slotseng – has been observed at Verberie. However, the other variants are also well known in the Magdalenian that shows an even more diverse spectrum of operational schemes that include the groove and splinter procedure. However, at the very end of the GS-2a, variant three is by far the most typical variant for the Magdalenian. The finished objects, however, do not directly support this clear connectedness of the two Late Upper Palaeolithic entities.

However, some evidence exists that connects the supposedly unfamiliar double-bevelled and barbed point from Meiendorf with the Final Magdalenian. Also, for the Hamburgian foreshafts, at least a single Magdalenian counterpart from Thuringia is reported. Furthermore, it is discussed whether the Hamburgian foreshafts are just a development from Magdalenian composite projectiles. The absence of typical Magdalenian eyed needles as well as bâton percés in the Hamburgian assemblages on the other hand is explained by taphonomic issues, as these artefacts might not have been discarded in the waterside discard zones where organic items were preserved. A few Hamburgian artefacts at least point in the direction that needles and bâton percés were actually known. Finally, the handles of the *Riemenschneider* type with their lithic inserts seem to be the only real Hamburgian innovation. To pay tribute to the shared knowledge of the two entities but also the few particularities and chronological aspects of the Hamburgian, it is proposed to speak of the *Hamburgian facies of the Final Magdalenian*.

For the two main variants (1 & 3) of the groove and splinter procedure, two spatio-temporal schemes are presented. While full raw material blocks of a nearby kill site were imported to the place of extraction for variant 1, the waste pieces of variant 3 were dispersed over different sites. At the first site, only the basal antler and the palmation was detached and, on another site, the bow-shaped matrix had been discarded. The main objective of both schemes is, thus, the *lightening of the load* – the continuous reduction of antler in size and weight during its transport.

At the classic Hamburgian sites, furthermore, an abundance of smaller antlers were found that show grooved furrows and other modifications – which are typical for the groove and splinter procedure – without

the final extraction of blanks. While they have for a long time been considered as test furrows to check for antler quality, the differences between these raw material blocks in the quality of the modifications and the wasted matrices of the groove and splinter procedure speak for them as being the work of learners. These only have a basic understanding of the operational scheme and only basic motor skills. These observations lead to a re-evaluation of the terms 'apprenticeship' and 'teaching' – the general concepts to explain the process of learning in Palaeolithic archaeology. Furthermore, a replacement of these learning concepts when describing hunter-gather societies is recommended. Therefore a concept deriving from developmental psychology and including ethnographic and anthropologic data is introduced. It includes a holistic view of learning in non-industrial societies and even explains possible differences in cognitive abilities between their children and those in industrial societies. It can be stated that at the beginning of the habitation whole groups were present, while after a while a certain part of the group (the experienced antler workers) split off from it.

Altogether, this is interpreted as different sites with the same seasonal behavioural strategy. At the beginning of the migration, the whole group waited at a strategic position for the reindeer herd. In the best case, a large number of animals was killed. While these animals and their antlers were processed, a group of hunters left the camp to further hunt animals in the vicinity. During these hunting trips, the killed animals and collected shed antlers were reduced in size and weight (lightening the load). The richest meat parts (extremities without metapodials) and the most important antler parts (mesial beams) were transported from one site to another before the hunters returned with additional provisions for the cold season, resulting from the multiple hunts, to the first camp where they met the rest of the group. Afterwards, the whole group left for their winter camp together with the stored meat and abundant antler blanks, which had been extracted from the primary and secondary raw material blocks. This strategy, including the splitting of the group, made it possible to hunt further animals while the others were already being processed. Furthermore, it allowed a flexible reaction to a non-successful early autumn hunt or a very successful late autumn hunt. The latter is indicated by the presence of the whole group at Verberie. The postulated strategy reduces the risk of starvation in the winter considerably, as ethnographic studies show that hunting success in winter is not guaranteed at all and the majority of the food supply necessary for survival in the winter derives from animals killed in autumn.

With these findings, the present study integrates well into the existing research and it enables us to glance at the complex anticipatory strategy of hunter-gatherers of the Hamburgian culture during the main hunting season. In doing so, it gives valuable insights into important aspects of human behaviour, including economic and social choices. Finally, the present study adds an element to the important research on the Late Upper Palaeolithic and paves the way for diverse future research regarding the sites under consideration, the cultural entities and the methods applied, as well as research on ancient human behaviour in general.