1 – Introduction

During the marine isotope stage (MIS) 3, *i.e.* between 60 and 25 ka BP, there is a change in the western Eurasian archaeological record characterized by the disappearance of Neanderthals and Middle Palaeolithic technocomplexes and the appearance of anatomically modern humans (AMH) and Upper Palaeolithic technocomplexes. This phenomenon is referred to as the Middle to Upper Palaeolithic transition and despite decades of research, the timing and conditions of the replacement of Neanderthals by AMH continue to be debated (see discussion in, *e.g.*, Brantingham *et al.* 2004; Conard 2006; Klein 1999; Mellars & Stringer 1989; Mellars *et al.* 2007; Zilhão & d'Errico 2003).

The archaeological record of the Early Upper Palaeolithic (EUP) in Europe is characterized by a number of so-called transitional technocomplexes (including Châtelperronian, Uluzzian, Szeletian, and Lincombian-Ranisian-Jerzmanowician), the Bohunician/Initial Upper Palaeolithic, and the Aurignacian. In part these technocomplexes seem to overlap in time within and/or between regions. As an example, there seems to be a coexistence of Bohunician, Szeletian, and Early Aurignacian in the Middle Danube region (*e.g.*, Svoboda *et al.* 1996). The discussion of the Middle to Upper Palaeolithic transition centres on (1) the age and definition of the first Aurignacian in Europe, (2) the age and definition of the various transitional technocomplexes, and (3) the relationship of these transitional technocomplexes with the Aurignacian. The transitional technocomplexes are characterized by a mixture of Middle and Upper Palaeolithic features, including tool types and technological features. Important in order to be classified as a transitional technocomplex is the fact that they show features connecting them to the local late Middle Palaeolithic (see definition criteria of "transitional" technocomplex after Kuhn 2003). The occurrence of Middle Palaeolithic features in these assemblages not observed in the local Middle Palaeolithic technocomplexes do not allow their classification as transitional technocomplexes.

Several models have been proposed to explain the existing temporal-spatial patterns in the human fossil and material culture records, *i.e.* in the Middle to Upper Palaeolithic transition (Table 1):

(1) *Local evolution model*

The local evolution model argues that the Upper Palaeolithic evolved locally once or several times in different geographic locations without influence from outside, *i.e.* Neanderthals had their own Middle to Upper Palaeolithic transition prior to the arrival of AMH and there was no acculturation due to diffusion or stimulus diffusion processes (Bordes 2002; d'Errico 2003; d'Errico *et al.* 1998; Oliva 1991; Teyssandier 2008; Zilhão 2006; Zilhão & d'Errico 1999; 2000; 2003a; 2003b; Zilhão *et al.* 2007).

(2) *Diffusion model*

The diffusion model goes back to Klein's proposal for the development of the Châtelperronian (Klein 1973). Up to now various versions of the model with some differences have been proposed (Bar-Yosef 2000; 2002; Davies 2001; 2007; Demars & Hublin 1989; Harrold 1989; Hublin 2007; Hublin *et al.* 1995; 1996; Klein 1973; 1995; 2008; Kozlowski & Otte 2000; Mellars 1989; 2005; 2006; Otte & Kozlowski 2001; Svoboda & Bar-Yosef 2003; Svoboda *et al.* 1996; Tostevin 2000a; 2003; 2007). All argue that the cause of changes in the late Middle Palaeolithic (LMP) and the development of the transitional technocomplexes (Châtelperronian, Szeletian, etc.) are a result of incoming AMH that influenced local Neanderthal populations.

Table 1: Models of the Middle of Upper Palaeolithic transition.

Local evolution model	Local evolution, *i.e.* independent innovation, of Neanderthals resulted in changes in material culture patterning.
Diffusion model	Diffusion of behaviour from incoming AMH resulted in changes in material culture patterning among the late Neanderthals.
Stimulus diffusion model	Stimulus diffusion, *i.e.* diffusion of ideas, from incoming AMH resulted in changes in material culture patterning among the late Neanderthals.

(3) *Stimulus diffusion model*

The stimulus diffusion model argues that stimulus diffusion, *i.e.* diffusion of ideas, from incoming AMH resulted in changes in material culture patterning among the late Neanderthals. The model can be regarded as a variant of the diffusion model but with stimulus diffusion no direct contact between the acculturated Neanderthals and the AMH occurred in the region where the transitional technocomplex is observed. The concept of stimulus diffusion was defined by Kroeber (1940) and introduced into the Middle to Upper Palaeolithic transition discussion by Tostevin (2000a; 2000b; 2003; 2007). In fact, many proponents of the diffusion model (*e.g.*, Davies 2001; Hublin 2007; Klein 1973; Mellars 2005) argue with the expectations of the stimulus diffusion model.

When taking western Europe as an example, the local evolution model argues that innovations among late Neanderthals led to the development of the Châtelperronian, while the diffusion and stimulus diffusion models argue that the modern humans entered Europe and that direct (diffusion) or indirect (stimulus diffusion) contact between Neanderthals and AMH led to a diffusion of behaviour/ideas and an acculturation process, which resulted in the Châtelperronian.

To address the Middle to Upper Palaeolithic transition, this research focuses on the Middle Danube region, consisting of parts of Austria, Czech Republic, Slovakia, and Hungary. This area plays an important role in the discussion due to its geographical location on the middle course of the Danube, one of the proposed routes of modern human dispersal into Europe (*e.g.*, Conard & Bolus 2003; Davies 2001; 2007; Richter *et al.* 2000). Further, the Middle Danube region is interesting as a case study area because of the existence of several EUP technocomplexes (Szeletian, Bohunician, and Aurignacian) between roughly 50 and 30 ka BP (*e.g.*, Svoboda *et al.* 1996; Svoboda 2004; Nigst 2006). The region is known for (1) Early Aurignacian sites, (2) fossil remains of AMH from Mladeč, (3) variability of EUP technocomplexes (Szeletian, Early Aurignacian, and Bohunician), and (4) an apparent coexistence of the Early Aurignacian, Bohunician, and Szeletian.

The Middle Danube region therefore offers a good test case for the following hypotheses: the two-phase dispersal model that argues for first an initial and then a developed phase of AMH dispersal into Europe (Davies 2001; 2007), the Danube Corridor hypothesis that argues for an early (40 ka ^{14}C BP) dispersal of AMH along the course of the Danube river into Europe (*e.g.*, Bolus & Conard 2001; Conard & Bolus 2003; Richter *et al.* 2000), the late-appearance (*i.e.* after 36.5 ka ^{14}C BP) model for the Aurignacian (*e.g.*, Zilhão & d'Errico 1999; 2003), and the model that the Bohunician/Initial Upper Palaeolithic represents the material culture of the first AMH in Europe (*e.g.*, Bar-Yosef 2006; 2007; Svoboda & Bar-Yosef 2003; Tostevin 2000; 2003; 2007).

The sites selected for analysis are the key sites for the EUP in the Middle Danube region and include Willendorf II, Vedrovice V, Stránská skála IIIc, and Stratzing 94 (Figure 1). The studied assemblages are selected due to certain criteria such as stratification, information on site formation processes, availability of dates and chronostratigraphic information, etc. Some of the assemblages were never studied before, so adding new materials/datasets to the discussion.

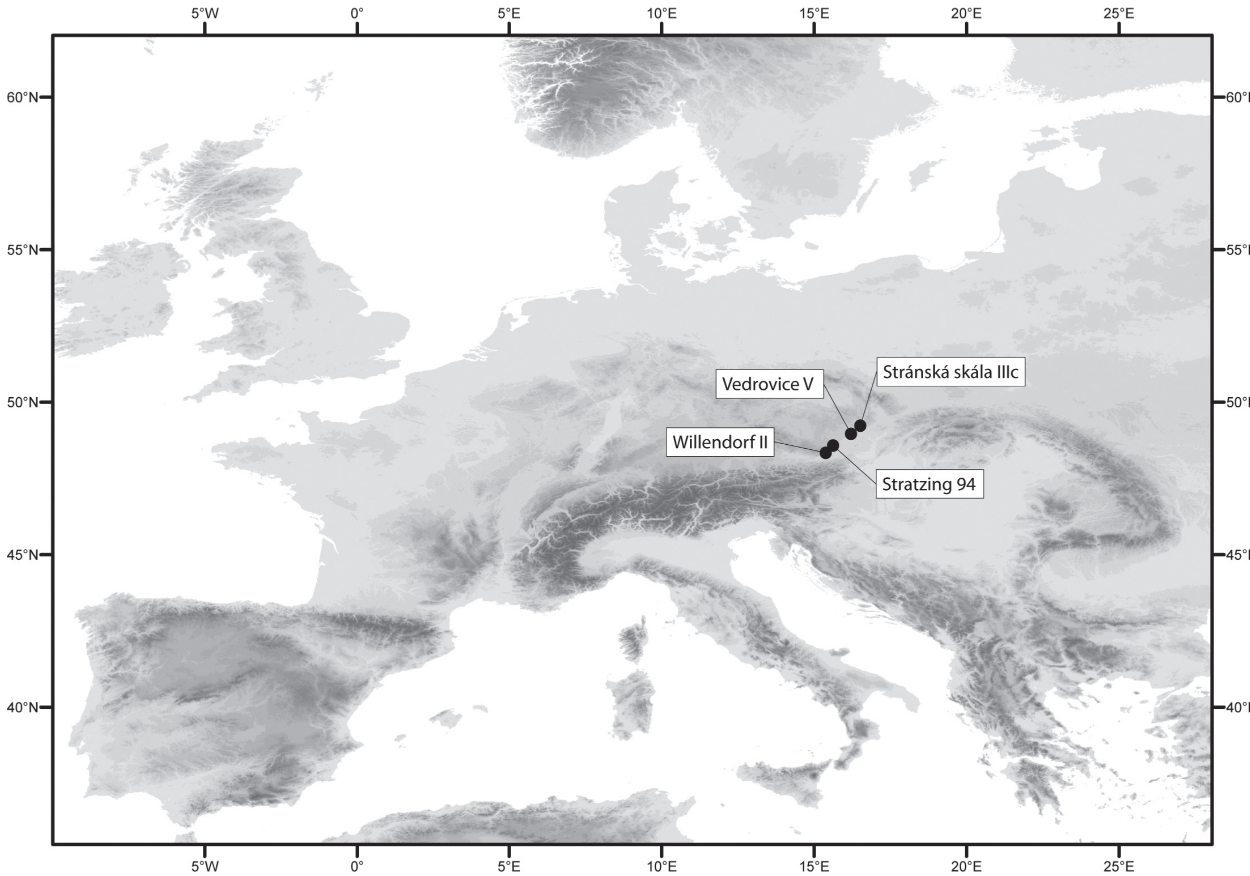

Figure 1: Map of Europe showing the location of the sites of Willendorf II, Vedrovice V, Stránská skála IIIc, and Stratzing 94. Digital elevation model: GTOPO30 data.

In a more general sense, the goal of this study is not to study the "evolution" of stone tools or techno-complexes, but to understand human evolution and especially behavioural/cultural adaptations and their variability through time. Material culture in itself does not "evolve", but humans do and they change their adaptation through time. Technological behaviour and how it changes through time is the focus of this work. The style of this behaviour differs between groups, environmental settings, time, etc., and is passed on between generations. These different styles of technological behaviour introduce variation in the archaeological record, which can be studied.

This research uses the EUP record of the Middle Danube region to test the models of local evolution, diffusion, and stimulus diffusion. Three research questions were formulated:

(1) What are the characteristics of the technocomplexes spanning the Middle to Upper Palaeolithic transition in the Middle Danube region in terms of lithic technological behaviour?

(2) Which of the three proposed models (*i.e.* local evolution, diffusion, and stimulus diffusion) is supported by the archaeological evidence?

(3) Does the regional patterning of the EUP technocomplexes support an early or a late appearance of the Aurignacian?

To answer these three questions this research is focusing on the study of lithic artefacts. The reason is that lithics are abundant and – in contrast to organic finds – always preserved. This is especially true for the Middle Danube region where some of the EUP assemblages have been found in palaeosol horizons, and therefore the preservation of organic material is not good.

The approach followed here is an operational sequence approach to studying knapping behaviours along the reduction sequence and to compare cumulative knapping behaviours by using a measure of difference. All that is based on a detailed attribute analysis of the lithic assemblages.

From the attempts to answer the research questions and test the above models a few goals emerge that allow a more detailed formulation of what this research wants to achieve.

Goal 1: Working out a methodology for assessing local evolution versus diffusion/stimulus diffusion of technological behaviours.

For addressing the question of a possible local evolution of the EUP without any influences from outside a methodology suitable to answer these questions is needed. Especially, for the models of local innovation, diffusion, and stimulus diffusion testable model expectations have to be formulated. The methodology is based on the operational sequence approach to the study of lithic technology. This approach is sometimes also called reduction sequence approach, *chaîne opératoire* approach, or behavioural chain approach (Bar-Yosef & Van Peer 2009; Lemonnier 1992; Schiffer 1976; Shott 2003; Tostevin 2000; 2011). The basic analytical units are etic in nature, although in some versions of the *chaîne opératoire* approach attempts to use emic categories are applied (see discussion in Tostevin 2011). Recently, Tostevin (2000a; 2003a; 2003b; 2007; 2011) provided a theoretical perspective and methodology for comparing behavioural steps in the production of lithic material culture of different assemblages. Tostevin's approach is applied here, as it is a viable way of assessing the question of whether changes in lithic material culture are the result of local evolution or diffusion.

The basic method used here is an attribute analysis of the lithic assemblages that is based on cumulative and recorded observations of the overall assemblage. More on the theoretical background, the models, and the methods is explained in Chapter 3.

Goal 2: Description of the patterns in lithic reduction sequences based on the attribute analysis and comparison of the lithic technology between the studied assemblages.

Using the methodology worked out and an attribute analysis, complemented by data from refitting, the patterns in lithic technology of the studied assemblages are described. The technological analysis follows an idealized reduction sequence as a basic framework to compare patterning in the reduction sequences.

Goal 3: Placing the observed behavioural patterns in a temporal/chronostratigraphic framework

Understanding a historical process like the Middle to Upper Palaeolithic transition and the replacement of Neanderthals by AMH is only possible in a chronostratigraphic framework. In order to discuss the patterns and to give them meaning in the local evolution versus diffusion debate as well as in the general understanding of the Middle to Upper Palaeolithic transition it is needed to date the assemblages and place them in a chronostratigraphic framework with correlations to global climatic episodes. The chronostratigraphic sequence of the Middle Danube region is presented in Chapter 7 and in Chapter 8.4 the observed lithic behavioural patterns are put together with the chronostratigraphic information.

Goal 4: Testing models of local evolution and diffusion/stimulus diffusion.

The models and model expectations are formulated in Chapter 3. Models of local evolution versus diffusion and stimulus diffusion are tested with the data and results from Chapters 5 and 6. The results of this model testing are presented in Chapter 8.

Goal 5: Comparing the patterning and results of model testing with other regions and putting them in a wider European picture.

The observed patterning in human behaviour over the Middle to Upper Palaeolithic transition in the Middle Danube region and its implications are discussed on a continental scale. Specifically the role of the Bohunician in AMH dispersal into Europe and the implications of the early age of the Aurignacian in central Europe for the local evolution of the transitional technocomplexes elsewhere in Europe are discussed (Chapter 8.8).

The dissertation is structured according to these goals. A lot of emphasis is put on explaining the testable models and model expectations, and the approach and methods used.