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Bakalářská práce

Characteristics of the end of the Mesolithic in central Europe based on findings of artefactual and environmental archaeology

Charakteristika vyznívání mezolitu ve střední Evropě na základě poznatků artefaktuální a environmentální archeologie

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Anotace

Předkládaná práce se zabývá procesem neolitizace ve střední Evropě se zaměřením na území České republiky, který je nastíněn na základě literární rešerše. Pozornost je dále věnována mezolitickému pozadí procesu neolitizace, a to s ohledem na vliv mezolitického člověka na přírodní prostředí. Sledovány jsou zejména ekonomické a sociální aspekty využívání rostlin v evropském mezolitu.

Annotation

The present work deals with the process of Neolithisation of central Europe with a focus on the territory of the Czech Republic, which is outlined on the basis of a literature review. A further emphasis is placed on the Mesolithic background for the Neolithisation process with respect to the impact of Mesolithic humans on the natural environment, particularly in terms of plant use in the European Mesolithic and its economic and social aspects.

Contents

1. Introduction

"That river goeth through the land of Pigmies, where that the folk be of little stature, that be but three span long, and they be right fair and gentle, after their quantities, both the men and the women. And they marry them when they be half year of age and get children. And they live not but six year or seven at the most; and he that liveth eight year, men hold him there right passing old. These men be the best workers of gold, silver, cotton, silk and of all such things, of any other that be in the world. And they have oftentimes war with the birds of the country that they take and eat. This little folk neither labour in lands ne in vines; but they have great men amongst them of our stature that till the land and labour amongst the vines for them. And of those men of our stature have they as great scorn and wonder as we would have among us of giants, if they were amongst us."

Sir John Mandeville

The present work is an attempt at evaluating the process of Neolithisation of central Europe, which remains one of the most contentious issues in European prehistoric archaeology. Special attention is given to the Mesolithic background for the Neolithisation process, especially in terms of plant use in the Mesolithic and its economic and social aspects.

The aim of this work is to evaluate the existing state of research into the Neolithisation process, which is outlined on the basis of a literature review. A further aim is to consider the impact of man on the landscape in central European pre-Neolithic period from perspective of environmental archaeology.

The work is divided into four main chapters. The first part brings the general introduction to the problem, which sets out the overall framework of the work.

Chapter 2 *'An outline of the history of research into the Neolithisation process in central Europe'* provides a look at selected views of the Neolithisation process that have appeared in the literature. This chapter is not meant to be a complete literature review of the subject. Rather, some particular aspects (genetics, stable isotope analysis, lithic studies, and demography) of investigations of the agricultural transition were selected to gain a clearer picture of the nature of this phenomenon. This chapter also presents a case study of recent bioarchaeological research at Vedrovice in southern

Moravia and brings to a close the second part of the work by considering some concluding remarks on the subject.

Chapter 3 *'The Mesolithic background for the Neolithisation process with an emphasis on the human-environment relationship'* represents the Mesolithic by considering changing perceptions of the hunter-gatherers in Czech archaeology. Particular emphasis is placed on the role of plant use and perceptions of the landscape in the European Mesolithic in comparison to the situation in the Czech Republic from an environmental-archaeological point of view. To do so, a particular case study concerning recently discovered Mesolithic settlement network around the extinct Lake Švarcenberk in southern Bohemia is presented. Text also discusses economic and social aspects of human impact on the landscape, respectively on the vegetation within it. The chapter concludes by examining the impact of humans on the landscape in the Mesolithic with a focus on possible continuity between the Mesolithic and the Neolithic, in terms of human-environment relationship. Research data and generalisations from the fields of archaeology, archaeobotany, ethnography, and ecology are here drawn on in an attempt to provide a new insight into the archaeology of hunter-gatherers.

The work concludes with a more general review of the subject. This closing section of the work reflects the significance of a holistic comprehensive research and a growing need for interdisciplinary activities between specialists in both natural sciences and humanities.

1.1. Chronological and spatial framework of the work

This study covers the region of central Europe with an emphasis on the territory of **the Czech Republic.** For key sites mentioned in the work, projected on a map of central Europe, see map in Fig. 1. Chronologically, this work concerns the period during which **the Mesolithic**, particularly the later Mesolithic, and the early Neolithic, which was dominated in earlier phase by **the Linear Pottery Culture** (LBK, derived from the German term *Linearbandkeramik*). Chronological questions may be addressed by various types of records such as biostratigraphic evidence, archaeological typology, and radiocarbon dating (*Kuna et al. 2007,* 101-105). According to archaeological chronology, *the Early Mesolithic*, predominantly characterised by presence of microlithic triangles, segments and Tardenoisian points as a diagnostic tool types, lasted between 10,000 – 7000 BP. *The Late Mesolithic*, a period of dominance of geometric trapezes and blades longer than before, concerns the period between 7000 – 6500 BP (*Svoboda 2008,* 227). The existence of the LBK can be linked to the period i.e. from the beginning of the 6th millennium BC to the beginning of the 5th millennium BC (5600-4900 BC) (*Pavlů 2004; Mateiciucová 2008*). Of particular interest is the Early LBK, the period between 5500 – 5200 BC (*Pavlů 2004*), which covers the establishment of farming communities within the area of interest.

Environmentally, this period covers the time span from the Preboreal to the Atlantic stage of Holocene (Fig. 2) (*Dreslerová et al. 2007*). **The Preboreal** was marked by dramatic climatic change with annual temperatures about 3 degrees lower than today and an observable growing density the birch-pine stands and a simultaneous retreat of steppe vegetation. **The Boreal** can be characterised by a further temperature increase. The birch-pine forests were invaded by *Quercus, Ulmus,* and *Corylus*, whereas heliophilous and montane plants disappeared. **The Atlantic** was marked by continuity of warm and human condition, characterised by thermophilous oak forest and mesophilous mixed lime-oak forest spreading in the lowlands and new trees such as *Tilia*, *Acer*, *Fraxinus*, *Ulmus*, and *Taxus* spreading over the whole area (Fig. 2) (*Roberts 1989*; *Ložek 2007*; *Svoboda 2008*).

2. An outline of the history of research into the Neolithisation process in central Europe

2.1. Basic models of the Neolithisation process in central Europe

At the end of the 19th century, it was generally accepted that a hiatus occurred between the Palaeolithic and the Neolithic. Therefore, the appearance of the Neolithic in Europe was associated with the arrival of new people, colonists from the south-east (*Mateiciucová 2008b*, 31). Since that time, the Mesolithic period and the emergence of farming in the Near East and its spread to Europe has received broad attention among researchers, particularly in the English-speaking world (*Zvelebil ed. 1986; Gronenborn 2007*, 73-75). Thus, a whole number of hypotheses of the process of Neolithisation have been suggested, which can be divided into three main groups, based on the relative contribution of local hunter-gatherers and newcomers, early farming communities, to the European Neolithic.

The first group of models consists of **migration hypotheses** which explain that the Neolithic arrived in central Europe along with first farmers from the Near East and south-eastern Europe. The second group, in contrast, explains the arrival of the Neolithic through **the acculturation theories** suggesting that the local hunter-gatherers played the decisive role and accepted the Neolithic way of life themselves only through the spread of information and plant-animal package. Finally, the most recent group of models, **the integrationist view**, suggests that both indigenous Mesolithic population and neighbouring Neolithic societies played an important role in the Neolithisation of central Europe (Fig. 3).

2.1.1. The migration theories

According to Marek Zvelebil, the notion of farmers as our ancestors is one of the pervading claims to national and European identity. He argues that there was traditionally a tendency for the European prehistorians to put extraordinary emphasis on the Neolithic. Zvelebil considers three particular reasons for this tendency. The first is the prejudice against savage, primitive and barbarian foragers, particularly in contrast to civilised, ordered and cultured farming communities. The second arose from the rise of urbanism which resulted in the idealization of the pastoral and rural way of life. The last one is the need of some nation-states, including the former Czechoslovakia, to construct a national identity. Besides archaeology, this theme, which Zvelebil calls '*farmers our ancestors*', can be found also in literature or the popular culture (*Zvelebil 1995a*, 145-147).

In archaeology, these views were supported by Vere Gordon Childe, who offers the *ex oriente lux* interpretation of the agricultural dispersal. In his book *The Dawn of European Civilisation*, published in London in 1925, he argues that the transition from foraging to farming in Europe was the result of immigration of populations from the Near East, who brought with them advanced and superior technology and culture, and replaced the indigenous Mesolithic hunter-gatherers. He believes that this process was a major turning point in human history and referred to it as a 'Neolithic revolution'. On the other hand, he emphasizes that the term 'Neolithic revolution' means a gradual, rather than radical, but transformational process (*Childe 1925; 1936*).

A whole series of authors have substantiated these diffusionist and migration models (e.g. *Clark 1966; Tringham 1971; Runnels – van Andel 1995; Bogucki 2003*). Furthermore, these hypotheses were supported by genetic studies. Well known are pioneering works of Albert Ammerman, an archaeologist, and L. L. Cavalli-Sforza, a population geneticist (*1984)*, however, their model was intensively criticised (see below). A special contribution to this hypothesis has been offered by Colin Renfrew, who has added a linguistic aspect to the discussion and linked the Neolithic colonisation of Europe to the advent of the first agrarian populations speaking Indo-European languages (*Renfrew 1987, 145-152*).

An outline of the history of research into the Neolithisation process in central Europe

Traditionally, the spread of farming across central Europe has been accepted as an example of agricultural colonization by farmers of LBK (*Vencl 1986; Bogucki 2001; Neustupný 2004*). In the Czech Republic, one of the most notable studies of the Neolithisation of central Europe has been carried out by S. Vencl (*1982*). On the basis of anthropological, demographic, botanical, ecological and last but not least archaeological evidence, he has supported the notion that the Neolithisation of central Europe involved several waves of colonisation, in which the colonists settled in almost unoccupied land. Vencl assumes that the indigenous Mesolithic population played a negligible role in the transition, except some peripheral regions, where the quality of environment was insufficient for the advancing agriculture societies. Vencl has also considered some parallels from ethnography and antique sources and pointed out that the first farmers were mentally more advanced than the indigenous hunter-gatherers and such a difference could lead to some hostile violent conflicts (*Vencl 1982,* 665-678*; Vencl 1986*). In terms of the further development of research into the nature of the transition to agriculture, a special offshoot of the models has been applied by Petr Květina (*2007*). On the basis of anthropological and ethnographic evidence, Květina makes an attempt to reconstruct the encounter between early farmers and local hunter-gatherers and suggests possible violent clashes between the domestic and incoming populations. Květina, however, considers only the first contact between the communities.

Despite the fact that the migration theories appeared to be compatible with the rate of spread of the Neolithic measured from radiocarbon dates (*Ammerman – Cavalli-Sforza 1984*), there are several implications for this immigrationist explanation. The first is that this process had to be driven by the rapid population growth experienced by the emergence of Neolithic farming populations (e.g. *Renfrew 1987*). However, such a population growth as an explanation for agriculture transition has been criticised for the lack of evidence by many scholars (e.g. *Zvelebil 2002*). Secondly, this approach fails to consider the role of the original hunter-gatherer population. Unfortunately, very sparse evidence of late Mesolithic settlement in central Europe may support these hypotheses (*Mateiciucová 2008b,* 34-36*; Zvelebil 1986a,* 9).

2.1.2. The acculturation theories

The acculturation theories represent the opposite perspective to the migration hypotheses. The adoption of farming in Europe and the origins of the Neolithic are viewed exclusively as the uptake of so-called '*Neolithic package*', including a sedentary way of life, first permanent villages, domesticated crops and animals, and new skills such as polished stone production and pottery, by local forager populations. These hypotheses do not credit that migration from the Near East played any important role. Then, the transition of hunters and gatherers to agriculture is mostly explained by reduction of available resources with an emphasis on the fact that hunter-gatherers adopted farming under pressure. A further emphasis is placed on the sedentary way of life, which is perceived as the crucial aspect leading to the farming (*Binford 1968; Zvelebil 1981; 1986a; Rowley-Conwy 1983; Mateiciuciová 2008b*). In this group may be placed authors such as Dennel (*1983*), Barker (*1985*), Tillmann (*1993*), Pavúk (*1994*), Kind (*1998*), or later work of Tringham (*2000*).

These authors believe that domesticated animals and plants were acquired via trade with the Neolithic population of the Near East, and subsequently with agriculturalists living in the Balkans and Mediterranean area. This idea is supported by accumulating archaeobotanical evidence pointing out to agricultural activity in central and northern Europe well before the onset of the Neolithic *(Erny-Rodmann et al. 1997; Gehlen – Schön 2003; Innes et al. 2003; Poska – Saarse 2006; Behre 2007; Tinner et al. 2007*). On the basis of these results, authors suggest that agriculture developed locally throughout the late Mesolithic and Neolithic.

Mention should be done also of A. Whittle (*1996*), who provides a view of acculturation process from a social perspective and suggests local adoption of non-local resources and technologies, facilitated through contacts and interactions outside of central Europe. According to him, however, the original forager population was motivated by existing social ethics, instead of accepting the notion that population growth leading to the colonisation of new territories.

2.1.3. The integrationist theories

Besides the previous two groups of hypotheses, a number of scholars have regarded both types of processes, involving migration and acculturation, as playing an important role in the transition to farming in central Europe. This intermediate model, described by Zvelebil *(2002*) as '*integrationism*', sees the agricultural transition in terms of selective colonization by fairly small groups through mechanisms such as 'leapfrog colonisation', frontier mobility, and contact (*Zvelebil 1986a; 1986b; Gronenborn 1994; Mateiciucová 2004; 2008b*). The availability model, suggested by Zvelebil and Rowley-Conwy (*1984; 1986; Zvelebil 1986a; Zvelebil 1986b*), placed a lot of emphasis, in contrast to the earlier ones, on the members of Mesolithic societies. Therefore, this theory is based on the assumption that there is not a substantial difference between Mesolithic foragers and the early farming population. Then, the entire zone of foraging-farming interactions is assumed as the frontier, rather than merely the line of forager-farmer contact. The availability model is divided into three phases depending on the relationship between incoming farmers and indigenous Mesolithic populations within a region and by the intensity of farming practises (Fig. 4):

1) *the availability phase*

The availability phase exists in the early stages of the agricultural frontier, when farmers and foragers are developing contacts but they are still two culturally and economically independent units. During this phase, the agricultural way of life is known to the Mesolithic population through some exchange of materials and information. The availability phase ends with the adoption of some elements of farming by foragers or with the settlement of farmers in the territory used by hunter-gatherers.

2) *the substitution phase*

The substitution phase is divided into two forms: external, in which farmers settled in forager territory and competed with the remaining hunter-gatherers for land and resources, and internal, in which foragers add some elements of farming into their range of subsistence strategies. In both cases, the key concept is the competition between two mutually incompatible ways of life.

3) *the consolidation phase*

This consolidation phase, final stage in the transition to farming, is the first phase with a predominantly Neolithic economy, marked by the extensive and intensive growth of food production: having occupied the best soils, extending to new, secondary areas, and having exhausted, the possibilities of the extensive form of land-use, more intensive farming practices are employed. The use of wild resources is merely complementary, and its role increases only as an emergency strategy. This phase ends when the socio-economic conditions in the area become indistinguishable from those in areas settled earlier and the effects of the transition disappear (*Zvelebil 1986a*, 10-13).

This third group of hypotheses is supported by analysis of the isotope of strontium and sulphur contained in the bones and teeth of early farmers, showing that not all people buried within the same place spent their childhood or adulthood there. Thus, they are likely immigrants from the area which isotopic values correspond to those found in the previously hunting-gathering regions (*Bentley et al. 2002; Richards et al. 2008*). Arguments supporting the integrationist model of the transition to agriculture have been also provided by genetic researchers discussing the ancestry of Europeans (*Richards 2003*), and analysis of chipped stone artefacts, showing that early farmers of central Europe partly continued in traditions of the local forager populations (*Tillmann 1993; Mateiciucová 2004; 2008b*).

The availability model introduced space, time, and regional variability into the transition and this model has been widely referred to. However, there are also some problems related to this complex view of the Neolithisation process. Firstly, the transition is basically seen as a one-way process, populations are defined within it according to the stage they have reached towards a pre-defined end, farming. Thus, particular difficulties derive from the application of the general model in some areas. Another problem involves the fact that the model assumes both the general process and the end result as constant, despite the huge diversity in space and time, which the transition from foraging to farming presents (*Pluciennik 1998*, 68-69*; Pavlů 2005,* 295).

Turning now to the nature of the transition to farming, it is worth pointing out that some authors also consider contacts that took place within the farmer/forager transition on the social level (*Zvelebil – Dolukhanov 1991; Zvelebil 1995b*). Some models even stress the significance of deeper symbolic meanings in the process of Neolithisation. Previously mentioned factors leading to the Neolithisation such as climate, environment, and population pressure have been relegated to the background. Instead, an emphasis is put on the study of social and ideological components of the 'Neolithic package'. According to J. Cauvin, the Neolithisation process lead to the shift in human thinking, culminating in the increasing sophistication of human symbolic and ritual behaviour (*Cauvin 2003*). Similarly, I. Hodder (*1990*) draws the attention to the transition to farming as a process, in which the wild and natural was transformed into the domesticated. This means the transition from the society living in the wild (*agrios*) to the domestic economy (*domus*), which he calls the domestication of society (Fig. 5).

2.2. The Neolithisation process: various approaches

Besides the models and hypotheses, also further aspects of the transition to farming and the origin of the LBK such as genetics, stable isotope analysis, lithic studies, and demography are considered and presented. In addition to trying to answer questions such as how was farming introduced to Europe, they enable to explore more about the nature of the agricultural transition.

2.2.1. Genetic aspects of the transition to farming

The nature of agricultural transition is a matter of continuing debates not only in archaeology, but also in population genetics. The genetic history of past populations has mostly been drawn from modern-day Eurasian populations. But recently, ancient DNA studies, which allow for the direct comparison of archaeological and modern populations, also enable to answer question whether early European farmers were immigrants or descendants of resident hunter-gatherers who had adopted farming (*Richards 2003; Haak et al. 2005*). On the other hand, these methods are still being verified and tested and they are, as yet, not extensive enough to provide conclusive results regarding the genetic contribution of SW Asian farmers to the European gene pool. Thus, they cannot solve this question themselves (*Bellwood 2001*).

Nevertheless, genetic studies showed that the modern European gene pool in Europe is mostly a consequence of three major demographic events (Fig. 6):

1) The initial colonisation by anatomically modern humans, who entered Europe between 40000 and 25000 years ago.
2) The late glacial population expansion and colonisation of areas freed by deglaciation in northern Europe between 15000 and 10000 years ago.
3) The postglacial penetration of Europe by the first farmers from the Near East (*Zvelebil 2002,* 385*; Soares et al. 2010*).

2.2.1.1. Modern human DNA

The wave of advance

The subject of the genetic history of Europe was created mainly by Luca Cavalli-Sforza and his colleagues in the 1970s. His pioneering work, carried out in collaboration with an archaeologist Albert Ammerman, was the first sustained attempt to apply genetic data to a question of archaeological interest. Their work *The Neolithic Transition and the Genetics of Population in Europe*, published in 1984, offered a scientific model explaining the origins and spread of farming in western Eurasia, accepting the central role of sedentism, population growth, and resource pressure in the early farming communities. Cavalli-Sforza and Ammerman measured the rate of spread of farming into Europe, drawing on radiocarbon dates provided by Clark (*1965*), and concluded that the entire process of the spread of the Neolithic, from Greece to the British Isles, took place in about 2500 years, by a uniform rate of about one kilometre per year. They compiled synthetic gene maps that demonstrate geographic clines by principal component analysis. The genetic map produced by the first principal component, accounts for 27 % of the total variation in classical markers frequencies across Europe and the Near East, showed a gradient from the south-east to the north-west (Fig. 7). Thus, they introduced the expression '*demic diffusion*' to illustrate the immigration of farmers themselves, in contrast to '*cultural diffusion*', the spread of farming as an idea through the indigenous hunter-gatherers (*Ammerman – Cavalli-Sforza 1973; 1984; Cavalli-Sforza et al. 1994*).

Moreover, they suggested a different model called '*wave of advance*', instead of traditional model of migration and colonization. The wave of advance model assumes the population growth resulting from agricultural surpluses, and either displacing or absorbing the less numerous Mesolithic hunter-gatherer population. This process leads to a radial expanding population wave, in which the culture spreads with the expansion of people. Not only the wave of advance model seemed to be compatible with the available radiocarbon dates from Neolithic sites, but also the introduction of genetic data including allele frequencies for blood groups, the tissue antigen HLA system, and some enzymes, into the question of agricultural transition supported this notion (*Ammerman – Cavalli-Sforza 1973; 1984; Richards 2003*). It is worth pointing out that although Ammerman and Cavalli-Sforza (*1984*) predict that the major component of the modern European gene pool is derived from Near-Eastern farmers, they acknowledge a role for indigenous people in the spread of the Neolithic. Some recent publications (*Barbujani – Dupanloup 2002; Chikhi 2002*), however, seem to do not credit any role to local foragers and argue that the Neolithic must have spread into the continent exclusively by population movement (*Thomas 2006,* 52).

Nevertheless, the wave of advance model introduced by Ammerman and Cavalli-Sforza (*1984*) has been substantially criticised (*Zvelebil 1986a; 1989; 1998; 2002; Thomas 1996; Pluciennik 1998; Price 2000*). Firstly, there was no evidence for identifying the first principal component with a Neolithic expansion. Instead, the gradients might have be the result of many other dispersals. Another problem derives from the fact that the items of Neolithic package, used by Ammerman and Cavalli-Sforza to identify a settlement as Neolithic, might often be exchanged into Mesolithic communities. Finally, there is broad agreement among archaeologists that there is no evidence for large scale continent-wide migration.

Molecular-genetic approaches

In the 1980s, apart from principal component analysis of the classical markers such as blood groups, HLA antigens, and enzymes, it became possible to analyse the DNA sequences of the genes themselves. In particular, attention has been drawn on two non-recombining loci in humans: the mitochondrial DNA (mtDNA), which is inherited only down the maternal line, and the Y chromosome, which is present only in males and inherited from father to son. The mitochondrial genome and the Y chromosome are ideal for reconstructing evolutionary trees or networks, which can be put into a time frame, and the age of the molecules at their nodes can be estimated (*Richards 2003,* 144-145).

Mitochondrial DNA analysis shows a similar trend as principal component analysis of the classical markers but accounts for only 10-20 % of mitochondrial sequences over all of Europe (*Richards et al. 1996; 1998*). The first results from European mtDNA concluded that ancestors of the great majority of modern lineages entered Europe during the Upper Palaeolithic, whereas the incoming lineages were in the minority (*Richards et al. 1996; 1998*). These results have been further supported by many studies (*Torroni et al. 1998; Richards et al. 2000; Richards 2003*) also indicating that on the maternal line of descent, only a minority of European ancestors were Near Eastern farmers. The main, however, were indigenous European hunter-gatherers, who adopted farming later on. Then, it is also worth mentioning that these results provide information about female heritage, therefore, men could be of foreign origin (*Ammerman et al. 2006*). Nevertheless, the mtDNA work has been criticised by a number of authors in the field of a traditional population genetics, using a different methodological protocol (*Cavalli-Sforza – Minch 1997; Barbujani et al. 1998; Chikhi et al. 2002; Barbujani – Bertorelle 2001*).

Y-chromosomal DNA analysis suggests that the frequency of haplotypes originating in the Near East averages about 20-25 %, similar to the estimates from mtDNA (Fig. 8) (*Semino et al. 1996; 2000; Underhill et al. 2000;* but see *Chikhi et al. 2002*). The contribution of Palaeolithic hunter-gatherers as opposed to Neolithic agriculturalists to the colonisation of Europe has also been recently studied in the Czech population (*Kračmarová et al. 2006*). The results indicate that the haplogroups (I, R1a, R1b) linked to the post-glacial recolonisation of Europe reached frequencies of 80.6 %. By contrast, haplogroups (E3b, G, J2) likely brought to Europe by agriculturalists from the Near East occurred in 15 % of the test sample. (*Kračmarová et al. 2006;* see *Zvelebil – Pettit 2006* for further discussion).

In spite of the fact that above mentioned genetic studies have led to conflicting results, it is possible to see congruence in the results of all three systems (autosomal, mtDNA, Y-chromosome) in relation to the demic expansion of the Neolithic Near Eastern farmers into Europe (*Lell – Wallace 2000*). All suggest a contribution of Southwest Asian populations of the European gene pool and report similar southeast-northwest clines across Europe. At a continental scale, above mentioned genetic evidence can be summarized as follows:

Source	**Contribution of Near Eastern farmers to the European gene pool**
Ammermann – Cavalli-Sforza 1984	75-90%
Chikhi et al. 2002	50-65%
King – Underhill 2002	2-40%
Richards et al. 1996; 2000	20-25%
Semino et al. 2000	20-25%

To sum up, the authors of recent studies of modern human DNA tend to support the integrationist view that the first farmers of central Europe made only a small contribution to the genetic heritage of present-day Europeans (*Richards et al. 1996; 1998; 2000; Semino et al. 1996; 2000; Torroni et al. 1998; Simoni et al. 2000; Underhill et al. 2000; 2001; Richards 2003; Kračmarová et al. 2006*).

Furthermore, the difference between greater male (Y-chromosomal DNA) and lesser female (mtDNA) genetic contribution to the Neolithisation process can indicate male exogamy and long-distance travel on one hand, and female matrilocality and regional endogamy on the other (*Zvelebil 2002*).

According to Marek Zvelebil (*2002*), four major processes are involved with the arrival of the Neolithic and contributed to the generation of southeast-northwest genetic gradient patterns:

1) The pattern of small-scale population movements progressing from southeast Europe to the northwest over millennia.
2) At the onset of the Neolithic, 'targeted', 'leapfrog' or 'pioneer' settlement of selected and targeted optimal areas by small numbers of incoming farmers from the Near east/Anatolia to southeast, central and Mediterranean Europe, resulting in the foundation of agricultural 'enclaves' within landscapes occupied by hunter-gatherers.
3) The adoption of farming by indigenous foragers through contact, intermarriage, and socially regulated mobility between hunter-gatherers and farmers within frontier zones.
4) A following regional demic expansion, infilling of locally available niches by a genetically mixed population involving local hunter-gatherers and some immigrant farmers (*Zvelebil 2002,* 385-386).

2.2.1.2. Ancient human DNA

Genetic studies carried out on the modern European populations have led to conflicting results (see above). Ancient DNA studies, however, seem to support gene admixture at a regional scale (*Haak et al. 2005; Ammerman et al. 2005; Bramanti 2008; Bramanti et al. 2009*). Haak et al. (*2005*) analysed mtDNA of the Neolithic skeletons from central Europe and concluded that those first farmers did not have a strong genetic influence on modern European female lineages. The likely explanation for these results offered by authors suggests that the female early Neolithic farmers could have been genetically diluted by resident native hunter-gatherers, since a particular mtDNA haplotype (N1a) found in early Neolithic skeletons is comparatively rare among modern Europeans (see *Ammerman et al. 2006; Burger et al. 2006* for further discussion). This conclusion is supported by above mentioned studies of modern human DNA, archaeologically (e.g. *Gronenborn 1999; 2007*), and also by stable isotope studies (*Bentley et al. 2002*).

On the other hand, some more recent ancient mtDNA studies (*Bramanti et al. 2009; Haak et al. 2010*) have suggested that the LBK populations shared an affinity with the modern-day Near East and Anatolia, supporting a major genetic input from this area during the advent of farming in Europe. These data are compatible with a model of central Europe in the early Neolithic of indigenous populations plus major genetic inputs from expanding populations in the Near East. Thus, on a regional scale, these results support 'leapfrog' colonization model, where early farmers initially target the economically favourable Loess plains in central Europe. Nevertheless, the LBK populations also showed unique genetic characteristics including a clearly distinct distribution of mitochondrial haplogroup frequencies, implying that further significant genetic changes took place in Europe after the early Neolithic (*Haak et al. 2010*). Moreover, despite the fact that discontinuity seems to be an important feature of the prehistoric mitochondrial record of central Europe, one should bear in mind that there are major problems with sample size, population substructure, and, of course, danger of sample contamination (*Soares et al. 2010*). In the Czech Republic, Bramanti (*2008*) has carried out ancient mtDNA analysis of an early LBK population from Vedrovice (see below).

2.2.2. Stable isotope analysis

Stable isotope analysis is useful technique contributing recently also to bioarchaeology. It helps directly answer often discussed questions concerning past diet, demography, residence patterns, and diseases. Stable isotopes get into organisms through diet, and then they are gradually integrated into the tissue of bones and teeth. Bioarchaeology uses mostly the following isotopes and their ratios: $^{13}C/^{12}C$, $^{14}N/^{15}N$, $^{87}Sr/^{86}Sr$, $^{18}O/^{16}O$, and $^{34}S/^{32}S$. Their natural sources are atmosphere, water, and geological base, from where they enter the plant and animal bodies and participate in their tissue building. To analyse for stable isotopes, the collagen or hydroxyapatite is extracted from the bone and the resulting material gives us the relative abundance of the different isotopes present (*Mays 1998,* 182*; Kovačiková – Brůžek 2008).* In order to investigate the nature of the agricultural transition, an emphasis is placed on analysis concerning mobility and dietary patterns carried out by examining human skeletons from Mesolithic and early Neolithic central Europe.

2.2.2.1. Mobility patterns

Measuring of strontium and sulphur isotopes in human skeletons can directly, in contrast to DNA analysis, examine human mobility on a regional and local scale. It is possible to identify migrant individuals who moved between geologic regions by comparing the isotope signature in adult teeth, composed during first years of life, with that in the bones, which preserve the isotopic profile corresponding to the last years of life. Therefore, if the teeth and bones of an adult have different signatures, then that individual spent his or her final years in different geological areas. These ratios are further compared with the values from the local geology and indicate whether an individual moved into region during later life (*Bentley et al. 2002; Bentley 2007; Bickle – Hofmann 2007; Katzenberg 2008; Richards et al. 2008*).

The strontium isotope analysis of skeletal remains from LBK sites in south-west Germany has indicated a high incidence of migration in these Neolithic communities (Fig. 9) (*Price et al. 2001; Bentley et al. 2002; 2003a; 2003b; Bentley 2006; Bickle – Hofmann 2007*). A high incidence of non-locals was revealed, for example, at LBK cemeteries of Flomborn (64%) and Schweitzingen (25%) in the Rhine Valley, Dillingen (65%) along the Danube Valley, and Vaihingen (30%) in the Neckar Valley. The authors have dealt with the pattern of migration of farmers into central Europe at the beginning of the Neolithic and have offered derivation from or interaction with hunter-gatherers as a likely explanation. In addition, the results from Schweitzigen have demonstrated that migration was dominated by females having grown in the uplands on either side of the Rhine Valley and joining the agricultural community through marriage (*Price et al. 2001; Bentley et al. 2002; Bentley 2007; Zvelebil – Pettitt 2008*). This is a common pattern observed and discussed in ethnographic and anthropological literature (*Zvelebil 1986a; Zvelebil – Pettitt 2008*).

2.2.2.2. Dietary patterns

Stable carbon, nitrogen, and sulphur isotope analysis has been successfully applied to address questions of subsistence and diet during the transition to farming (e.g. *Richards – Hedges 1999; Bocherens et al. 2007; Fischer et al. 2007; Nehlich et al. 2010*). It is based on the assumption that differences in the isotope ratios of elements reflect the fact that each organism is a component of global geochemical cycles and the concentration of isotopes deposited in human and animal bones and teeth during life inform us about climate and food web position by means of the isotope ratios which increase at each trophic level. Then, the ratio of $^{13}C/^{12}C$ ($\delta^{13}C$) can be used to distinguish between marine and terrestrial ecosystems or C_3 (lot of temperate plant species) and C_4 (e.g. maize, sorghum, millet, sugar cane) plants, which fix carbon by a different photosynthetic pathways. In combination with the stable nitrogen isotope ratio ($\delta^{15}N$), it is possible to identify categories of plants and separate herbivores from carnivores. The ratio of $^{34}S/^{32}S$ ($\delta^{34}S$) gives us an evidence of the proportion of terrestrial, freshwater, and marine sources in a diet, and it is complementary to that of carbon and nitrogen ratios (*Mays 1998*, 183*; Sealy 2001*, 270-271*; Katzenberg 2008,* 423-424*; Kovačiková – Brůžek 2008*).

As mentioned above, recent research has focused on stable isotope analysis, which provides strong evidence of sharp shift in subsistence practice during the transition to farming from various corners of the continent such as Denmark (*Tauber 1981; Fischer et al. 2007),* Portugal (*Lubell et al. 1994*), Great Britain (*Richards – Hedges 1999; Schulting – Richards 2002; Richards et al. 2003*), and the Danube Gorges (*Nehlich et al. 2010*). All of the citied studies reached the same conclusion, stating that there was a large input of marine and riverine food in human diets of the Mesolithic period, while with the onset of the Neolithic humans started consuming mainly terrestrial food (Fig. 10) (see *Milner et al. 2004; Richards – Schulting 2006* for further discussion). The scholars mainly explain this pattern either by agricultural colonisation by new people, whose diet was based on domesticates, or by rapid adoption of Neolithic culture and domesticates by indigenous people.

On the other hand, it is worth mentioning that stable isotope analysis cannot distinguish between wild and domesticated resources, so the shift from marine and freshwater resources may not mean that they were replaced by domesticates, but it is possible that this pattern is connected with subsistence diversity as well. Cereals could not be in the Neolithic used as staples, but in a range of different ways such as special-purpose food or alongside wild foods (*Thomas 2003; 2007*). Julian Thomas (*2003*, 69-70) further argues that Neolithic people had access to a rich source of food in the form of fishing and the shift in dietary preferences can be can be explained by a cultural prohibition on marine food, new relationship between humans and the sea, some kind of cultural identification, or marker of taking on a new identity - 'being Neolithic'.

2.2.3. Lithic studies

The potential of the lithic studies for the question of the Mesolithic studies of the Mesolithic-Neolithic transition in central Europe has been emphasised by a whole range of authors (recently *Gronenborn 1999; Mateiciucová 2003; 2004; 2008b*), since analysis of chipped stone artefacts is one of the few sources to be used by both the Mesolithic hunter-gatherers, as well as the early farmers. Inna Mateiciucová (*2003; 2004; 2008b*), whose studies build on the work of S. Vencl (*1960*) and D. Gronenborn (*1997*), has concentrated her study on the following features of the chipped stone industry: the technology of blade production, the distribution of raw stone sources, and the occurrence of so called 'culturally specific' toll types (trapezes, borers, and retouched blades) in order to answer questions concerning LBK origin and dispersals into a vast area of central Europe with an emphasis on the local Mesolithic background.

On the basis of the identification of different techniques of regular blade production at Mesolithic and Neolithic sites, Mateiciucová suggests that the process of Neolithisation in central Europe was not unified. Furthermore, indigenous Mesolithic populations played an important part in some regions, and were gradually acculturated. Moreover, the Balkan cultural complex (including the Starčevo and Körös culture) most likely participated in the Neolithisation of central Europe through mediation, the transfer of information via contacts in the exchange of raw materials, products, and partners. Then, the participation of the indigenous Mesolithic population in the formation of the Körös and possibly also the Starčevo culture is indicated by the Danubian tradition of blade production which originated in the late Mesolithic period as a local response to technological changes in the Mediterranean, which Mateiciucová calls 'a variation on the Mediterranean tradition' (*Mateiciucová 2004,* 91-96*; 2008b,* 57-110; 165-166).

The second focus of her study has been placed on the issue of the distribution of stone raw materials with special attention to the raw materials that may have played an important role in the Neolithisation process in central Europe (Fig. 11) (Szentgál radiolarite, Carpathian obsidian, Krakow Jurassic silicites). Mateiciucová suggests that the earliest LBK may have spread through pre-existing networks in central Europe, since the distribution of raw materials indicates that a network of contacts already existed in some areas of central Europe at the end of the Early Mesolithic. These networks, connecting areas of central Europe with areas in the Balkans, enabled flow of information and formed the ideal basis for the later rise of the Neolithic. In addition, some features of distribution typical for the Mesolithic period, also continue to appear in the Early Neolithic period. Attention should be especially drawn to the network of Transdanubian radiolarites, which dispersion corresponds with the west and northwest spread of the earliest phase of the LBK culture (*Mateiciucová 2004*, 96-98*; 2008b*, 111-155; 165-167).

On the basis of the information noted above, Mateiciucová concludes that the LBK culture developed autochthonously from the local Mesolithic substrate in the region of Transdanubia and immediately adjacent areas, but under the influence of contacts and partial mixing with the Starčevo culture communities (*Mateiciucová 2004,* 99-101*; 2008b;* 165-167). Her hypotheses also emphasises the psychological implications of the Neolithisation process by suggesting that first, there was a Neolithisation of the hunter-gatherers soul or psyche, followed by the Neolithisation at the material level (*Mateiciucová 2004,* 99-100).

2.2.4. Demographic aspects of the Neolithic transition

Although many different disciplines have been involved in explaining the mechanism of Neolithic dispersal, surprisingly little attention has been paid to the demographic aspects of the agricultural transition (*Galeta – Brůžek 2009*). Given the fact that the crucial prerequisite of colonisation would have been a high rate of population growth, LBK farmers would have had to reproduce at the rate approaching the theoretical maximum form human population (*Brůžek 2003; Galeta – Brůžek 2009*).

A population growth rate from 2.0% to 3.5% per year has been established as the input value in models of Ammerman and Cavalli-Sforza (*1973*). Since that time, E. Neustupný (*1983*), using life tables from LBK skeletons from Germany, and J. Petrasch (*2001*), employing data acquiring from function of exponential growth and input variables derived from the distribution of LBK settlement and radiocarbon dates, estimated the growth rate at 1-2%. Recently, Galeta and Brůžek (*2009*, 141), on the contrary, argue that these estimates do not account for the uncertainty connected with adopting input parameters from archaeological sources. Instead, they have developed their demographic model of the Neolithic transition in central Europe.

In their study, Galeta and Brůžek (*2009*) estimated the level of fertility (around 6-13 children per woman) and growth rate (0.64-1.96% per year) of the LBK population via demographic modelling in order to assess whether such a level of fertility and population growth rate would be high enough to allow the LBK farmers to spread across central Europe within less than 200 years without any admixture with indigenous hunter-gatherers. On the basis of data from human demography, archaeology, and human ecology, they constructed a stochastic demographic model of changes in farming population size and concluded that the establishment of farming communities in central Europe without an admixture with foragers may be rejected in 92% of simulations. Their study thus provides a strong argument against the colonization hypothesis and supports the integrationist view of the Neolithic transition in central Europe.

2.3.The origin and spread of the LBK

The Neolithisation of central Europe is unquestionably associated with the origin and rapid dispersal of the Linear Pottery Culture. Although most researchers believe that the LBK developed in the northern part of the Carpathian basin, there are several opinions regarding the origin and spread of the LBK (*Mateiciucová 2008b*).

According to E. Neustupný (*1956; 2004*) and H. Quitta (*1964*), the LBK originate in Transdanubia, where it developed indigenously under the influence of the Balkan Neolithic cultures, and later expanded to central Europe through migration. Some scholars (e.g. *Whittle 1996*), in contrast, believe that the origin of the LBK and its spread across Europe were caused by acculturation of the local Mesolithic under influences from the south-eastern Neolithic. Then, the later encounter of the Starčevo-Körös complex might be an explanation for its strong impact on the LBK further development. Another model, developed on the basis of similarities in the chipped artefacts, stresses the significant contribution of the indigenous hunter-gatherers to the formation of the LBK (e.g. *Tillman 1993; Gronenborn 1999; 2007; Mateiciucová 2003; 2004; 2008b*). The two latter authors have presented a model based mainly on analysis of chipped stone artefacts, which proposes that the LBK developed autochtonously from the local Mesolithic substrate in Transdanubia, but under the influence of contact and partial mixing with the Starčevo culture communities. Mateiciucová explains this process via marriage patterns, with an influx of Neolithic women into the settlement of Mesolithic Transdanubia.

Marek Nowak (*2004*) has recently suggested, on the basis comparative analyses of early LBK pottery and new ^{14}C dates, that the origin and the early spread of the LBK can be best explained by 'leapfrog colonisation' occurring between 5600 – 5400 BC, when small groups of Starčevo-Körös farmers from the Transdanubian region moved into targeted small territorial enclaves of central Europe. One must note that Nowak also discusses the role of indigenous hunter-gatherers, which is also emphasised by a growing number of scholars (e.g. *Bánffy 2004; Lukes 2004; Pavlů 2004; Pavúk 2004;* see *Lukes – Zvelebil eds. 2004*), who suggest that local Mesolithic groups contributed to the constitution of the LBK.

As summarized by Zvelebil (*2004*, 193), observations and analyses mentioned above lead to the conclusion that there is clear evidence for multi-cultural origin and fragmentation of the early LBK cultural horizon in time and space. Zvelebil goes on to consider four steps leading to the constitution of the LBK:

1) The arrival of the intrusive farmers into the frontier zone of Transdanubia ('leapfrog colonisation') when optimal patches of light fertile soils were targeted for the settlement by the farming communities of Starčevo and Körös traditions.
2) The establishment of contact, exchange (cultural knowledge, information, partnership), and frontier mobility between late Starčevo-Körös communities and the local hunter-gatherer groups resident in Transdanubia
3) Innovation in the realm of practical technological knowledge and social and symbolic structures and selective integration of ancestral traditions (both indigenous Mesolithic and Starčevo/Körös Neolithic) into a new cultural tradition by the means of routine practice and social agency
4) Regional population expansion, consisting of the colonisation and settlement of locally available niches by a genetically mixed population including local hunter-gatherers and immigrant farmers (*Zvelebil 2004,* 198-199).

2.3.1. The Linear Pottery Culture

The LBK can be divided into western and eastern branches. The eastern branch, covering the eastern half of Hungary, eastern Slovakia, and Northern Transylvania in Romania, is named the Alföld Linear pottery. Of particular interest is then the western branch, which covers the western part of Hungary, south-western Slovakia, and Burgenland, and continues across Bohemia, Moravia to all of central Europe (Fig. 12) (*Mateiciucová 2008b,* 37).

As already noted, the LBK appeared in the first half of the 6th millennium BC in dry loess regions of Bohemia and Moravia (*Pavlů 2004*). The absolute dating is based on calibrated and dendrochronological data coming from central Europe; the earliest dendrochronological date for the Czech Republic is the year 5450, which was obtained from the wood of well at Mohelnice (*Pavlů 2005*). Within the framework of the Early LBK, which lasted 300 – 400 years, settlements of the earliest phase of the LBK in Moravia were founded, for instance, at Žopy, Mohelnice, Kladníky, Žádlovice-Újezd, Brno-Ivanovice, Želešice, Vedrovice, Těšetice-Kyjovice, Boskovštejn, or Bojanovice (*Mateiciucová 2008b,* 39). In Bohemia, mention must be made of the very earliest sites including Litice in the Plzeň region, Holohlavy and Jiřice in the East Bohemia, and Nové Dvory, Čáslav, and Kolín in the Kutná Hora region (*Pavlů 2005*). According to I. Pavlů (*2005*), the relationship between these sites of the earliest Linear Pottery culture with earlier Mesolithic settlement may be identified by a variety of indicates such as the occupation of the region with an intimate knowledge of suitable locations for long-term settlement, or the insufficient knowledge of pottery production at the initial phases of the earliest LBK.

As mentioned above, the Early LBK culture has traditionally been characterized by a cultural uniformity including longhouse construction, which show a similar layout through the LBK range; a standard cultural repertoire such as ceramics, which is similar over a huge area, or polished stone tools; and an identical set of economic practices based upon domesticated crops and animals (e.g. *Neustupný 2004;* see *Zvelebil 2004; Robb – Miracle 2007*). Therefore, the emergence of LBK in central Europe has traditionally been understood as the result of rapid colonisation by farming groups arriving from the south-east (e.g. *Quitta 1964; Vencl 1982; 1986*). As summarized by Alena Lukes, the LBK culture has thus been conventionally understood as a clean break from the indigenous hunter-gatherer population, which lacked the social complexity and the technological knowledge to become Neolithic (*Lukes 2004*, 17).

Recently, however, the notion of a rapid dispersal and the cultural uniformity of the earliest Neolithic in central Europe has been challenged. Apart from already discussed elements of continuity in stone tool production between the Mesolithic and the LBK, there is a growing body of evidence indicating contacts between Mesolithic foragers and LBK farmers such as the presence of LBK imports (grinding stones, axes, and adzes) in late Mesolithic context of central Europe, as well as the finds of domesticated animals and archaeobotanical remains of cultivated grain within late Mesolithic context, which is tempting to interpret as a product of exchange between LBK farmers and late Mesolithic groups. A number of LBK sites also show relatively high percentages of game, which might be interpreted as an interaction between Mesolithic foragers and LBK farmers (*Gronenborn 2007*). These patterns of exchange thus may confirm the role of indigenous population in the emergence of LBK culture (*Gronenborn 1999; Zvelebil 2004*).

2.4. Vedrovice: a case study in southern Moravia

Special attention is given to the research into the process of Neolithisation in the Czech Republic, therefore, a particular case study concerning Vedrovice is introduced. The site Vedrovice is located in southern Moravia in the Czech Republic, within the drainage basin if the rivers Jihlava and Svratka. Sections of the site were excavated in the between 1961 and 2001, and have yielded the settlement, three enclosures as well as two cemeteries: the early LBK cemetery "Široká u lesa" and that called "U Vinklerovy cihelny" (*Ondruš 2002*). The conditions on site provided excellent preservation. Therefore the site of Vedrovice encompasses a significant range of material culture including ceramic vessels, figurine fragments, housing structures, construction pits, ovens, ceramic weights, flaked and polished stone tools, grinding stones, faunal remains as well as bones and bone tools and last but not least human skeletal remains (*Podborský ed. 2002*).

Recently, there has been a comprehensive international collaborative research programme focused on the human skeletal remains recovered from the cemetery "Široká u lesa" (Fig. 13) with the emphasis on two key goals – first, to establish a comprehensive holistic bioarchaeological research, and secondly, to generate new knowledge about the emergence of the LBK culture and the transition to farming in central Europe in broader context of European Neolithisation. To do so, there have been applied multiple bioarchaeological approaches including AMS radiocarbon dating, palaeopathology studies, dental microwear studies, material culture studies, and also ancient DNA analysis as well as chemical traces analyses (*Lukes et al. 2008*).

2.4.1. The origins and ancestry of the Vedrovice community: isotopic and ancient DNA analyses

Although the Vedrovice samples are not among the genetically best preserved ones, Bramanti (*2008*) successfully sequenced ancient mitochondrial DNA polymorphism from three male and three female individuals. She observed a prevalence of T2 (2 individuals) and K (2 individuals) sequences, whose founders are proposed to have been introduced into Europe during the Lower Upper Palaeolithic. These have also been observed in other LBK sample from north-central Europe (*Haak et al. 2005*). The remaining two individuals belong to haplogroup H, also deriving from the European Upper Paleolithic, and haplogroup J1c, which might be associated with the spread of the Neolithic (*Richards et al. 2000; Zvelebil – Pettitt 2008*). It is also worth noting that Bramanti (*2008*) has thus supported results of a recent study by Kračmarová et al. (2006), who have claimed that modern Czech male ancestry shows about 80% predominance of Palaeolithic genetic markers as indicated by Y-chromosome polymorphisms.

To reconstruct human mobility, strontium and sulphur isotope analyses of skeletal remains have been also undertaken. The results show that most of the humans buried at Vedrovice spent their childhood, as indicated by sulphur isotope values, and adulthood, indicated by sulphur isotope value, at or near Vedrovice. On the other hand, there are eight individuals with different isotopic values, which means that they spent their childhood or adulthood elsewhere, so they are likely immigrants to the site. These results thus suggest that a small percentage of the Vedrovice community were allochtonous and derived from areas at all points of the compass (*Richards et al. 2008*). As observed by Zvelebil and Pettitt (*2008,* 199), these migrants may have derived from or interacted with hunter-gatherers from the upland areas. This is a pattern that has been observed elsewhere, for instance by Price et al. (*2001*).

It can be seen quite clearly that ancient DNA and isotopic analyses have contributed to our understanding of the transition to agriculture in central Europe. Additionally, result of bioarchaeological research at Vedrovice has provided information about the health condition, palaeodemography and nutrition of Vedrovice inhabitants, their social status, and the transmission of cultural traditions (*Zvelebil – Pettitt 2008*). On the basis of all these results, Zvelebil and Pettitt (*2008,* 213-214) have concluded that Vedrovice was likely a Neolithic “gateway community”, both receiving individuals from afar and maintaining long-distance contacts, and also serving as a founder community for other early LBK settlements. They propose that Vedrovice was founded by a small community of incomers, who probably originated in western Hungary, since links with western Hungary are evident in the material culture. Soon after Vedrovice was founded (some time before 5300 BC), it attracted people from hunting-gathering communities within the region of Bohemian-Moravian Uplands and northeast Bohemia. Zvelebil and Pettitt go on to suggest that Vedrovice also served as a focal point of a far-flung contact network that facilitated the exchange of goods and information. The evidence for these connections is apparent from the material culture, such as the Spondylus ornaments, flints from southern Poland, Hungarian radiolarite, or schist/amphibolite from northern Bohemia (Fig. 14). They even go on to reconstruct life biographies of selected individuals from Vedrovice community in order to reconstruct personal diversity and variability of Vedrovice community and to emphasise that we can, within the bioarchaeological approach, reconstruct life histories of people who died long ago (*Zvelebil – Pettitt 2008*).

2.5. Some concluding remarks

The current research into the Neolithisation process in central Europe can be summarized as follows:

1) Although much attention has been given to the agricultural transition, archaeological attitudes towards the transition to farming have been influenced by a variety of reasons such as political and academic climate (*Zvelebil 1995a; Pluciennik 1998*). Therefore, prehistorians put an extraordinary emphasis on the Neolithic, whereas the study of Mesolithic hunter-gatherers remains one of the neglected issues in European prehistory. This has been true especially in the case of Czech archaeology (*Beneš 2004*).
2) It is believed that the first farmers of central Europe originated in Transdanubia, and spread rapidly across the broad area extending from the western Ukraine to the Rhine River in the Germany (*Lukes – Zvelebil eds. 2004; Gronenborn 2007*). These first farmers appeared in central Europe about 5500 BC (*Pavlů 2005*). Recently, it has become clear that the spread of the agriculture involved a variety of mechanisms and cannot be explained only by a simple model of migration or acculturation (*Zvelebil 2004; Robb – Miracle 2007*). According to the integrationist model, local Mesolithic groups played an important role in this process and, today, the majority of researchers concerned with Early Neolithic archaeology prefer this intermediate scenario (*Gronenborn 2007*).
3) The integrationist model finds strong support in a number of disciplines. Genetic studies of classical markers, mtDNA, and Y-chromosome have indicated a major contribution of Mesolithic foragers to the gene pool of modern Europeans. A contribution of Near Eastern lineages to the European gene pool has been indicated of around a quarter or less (*Richards 2003*). Similarly, ancient DNA supports gene admixture at a regional scale (*Haak et al. 2005*).
4) Also, strontium isotope analyses of LBK skeletons from Germany have revealed a high incidence of non-locals, which may indicate that people from hunting-gathering groups had joined agriculturalist communities (*Price et al. 2001*).
5) The admixture view has been also supported by recent lithic studies, which suggest continuity in stone tool production and the distribution of stone raw

materials from the Mesolithic to the Early LBK (*Gronenborn 2007; Mateiciucová 2008b*).

6) The integrationist view of the Neolithic transition in central Europe is supported by demographic model, which has indicated that LBK fertility was not high enough to allow farmers to spread over central Europe without admixture with local Mesolithic population (*Galeta – Brůžek 2009*).
7) Imported LBK finds within late Mesolithic context of central Europe may demonstrate contacts between Mesolithic foragers and LBK farmers, which also supports the integrationist view of the agricultural transition (*Zvelebil 2004; Gronenborn 2007*).
8) With regard to LBK homogeneity, traditionally considered as evidence of rapid colonisation of central Europe by farming groups, currently, some scholars regard that this uniformity as an actively chosen phenomenon for social reasons (*Robb – Miracle 2007*). Since current research has reached the conclusion that the LBK culture has many origins (admixture of intrusive Near Eastern farmers and indigenous Mesolithic populations) (*Zvelebil 2004,* 199), the LBK culture had to be symbolically standard and uniform. In other words, people from various communities joined the LBK and accepted a new way of life and new identity. This strategy, then, enabled rapid and successful spread of the LBK to all of central Europe (*Zvelebil 2009*). At a continental scale, sharp shift in subsistence practice with the onset of the Neolithic might also have been bound up with the assumption of a new cultural identification ('being Neolithic') (*Thomas 2003*).

3. The Mesolithic background for the Neolithisation process in central Europe with an emphasis on the human-environment relationship

3.1. The Mesolithic in the Czech Republic and the question of the relationship with the Neolithic

The term "Mesolithic" was coined by M. H. Westropp to distinguish lithic artefacts belonging to the Palaeolithic and polished stone tools of the Neolithic (*1866*, 291). Although Mesolithic artefacts were collected by amateurs in the Czech Republic from the very beginning of the 20th century, the existence of the Mesolithic was disregarded by Czech archaeology (*Vencl 2007,* 124). A general scepticism was even shared by some leading authorities about the very existence of the Mesolithic in the region of central Europe (*Svoboda 2008, 224*). In the Czech Republic, the Mesolithic was almost unknown period for years (*Vencl 2007,* 124-125). Moreover, study of the Mesolithic period was neglected in the second half of the 20th century by Czech archaeologists, who instead paid attention to the study of the following Neolithic age. Therefore, the study of the Mesolithic-Neolithic transition in the Czech Republic is distorted by large systematic error (*Beneš 2004,* 147).

On the other hand, currently, there is clear evidence for Mesolithic settlement of the Czech Republic (see for instance *Prošek 1951; Vencl 1990; 1992; 2007; Svoboda et al. 1999; Svoboda ed. 2003; Vencl ed. 2006; Šída – Prostředník 2007; Pokorný et al. 2008; Svoboda 2008*). Mesolithic occupation, as documented in the present-day archaeological record, demonstrates a change of settlement strategies compared to the Neolithic, which is reflected in all three types of sites encountered in the region: open-air sites, karstic caves, and pdeudokarstic rockshelters (*Svoboda 2008*, 221-224). Mesolithic populations thus preferred rocky areas with lakes, wetlands, and forested areas. Farmers, on the other hand, dispersed into the lowlands regions, characterized by generally drier and warmer climatic conditions and more suitable soil types (*Beneš 2004,* 147-149).

Nevertheless, it is interesting to note that there are indications in the form of radiocarbon dates implying an overlap between the Mesolithic and the Neolithic (Fig. 15). According to recent research, the Mesolithic occupation in Northern Bohemia took place between 7000 and 5000 BC, which suggests its continuity after the appearance of the LBK (*Svoboda ed. 2003*). Namely, the Pod Zubem rockshelter provided radiocarbon dates 6790±70 BP, 6850±50 BP uncal (upper bed, charcoal) (*Svoboda ed. 2003,* 210). Similarly, radiocarbon date obtained from the sediment layer showing signs of Mesolithic occupation of lake Švarcenberk in southern Bohemia (6350±100 BP) (*Pokorný – Jankovská 2000*) indicates possible contemporaneous appearance of Mesolithic and Neolithic activity.

Although Mesolithic and Neolithic occupations preferred different landscape setting, broader contact between Mesolithic and Neolithic people should not be excluded, since the geographical overlapping of those two cultures existed, for instance in central, northern, and eastern Bohemia (*Beneš 2004*). The question of the relationship between the Mesolithic and the Neolithic is, however, difficult to clarify, since a solid chronological framework, with emphasis on data from the latest and the earliest Neolithic in the region is still lacking (*Svoboda 2008,* 225). Furthermore, there has been traditionally a lack of discussion between specialists on the Mesolithic and those dealing with the Neolithic in the Czech archaeology, partly because of using different methodology (*Svoboda 2008,* 236).

The question of the relationship between the Mesolithic and the Neolithic in the Czech Republic has been recently interestingly discussed by P. Šída (*in press*). Apart from already considered issues such as many common features shared by the Mesolithic and Neolithic chipped stone industry, the polished stone tools occurring within the Mesolithic layers, or the absence of hiatus between the Mesolithic and the Neolithic, he draws attention to the use of Jizera-type metabasite already in the Mesolithic and its extremely quick and extensive dispersion indicating possible contacts between the Mesolithic population and the first agriculturalists (*Šída – Prostředník 2007*). The contact may have also been reflected through the possible exchange of ceramics, which is known in a Mesolithic context in the Bohemian Paradise (e.g. Záborčí, abri pod Pradědem, Ludmilina jeskyně). Moreover, Šída goes on to consider a particularly interesting situation concerning the former Lake Švarcenberk in southern Bohemia. An extensive Mesolithic settlement was detected near the lake including settlement remains and the presence of a large amount of microscopic charcoal indicating the periodic burning down of woodland or lakeside vegetation in the surrounding area (*Pokorný et al. 2008*). According to Šída (*in press*), fire clearance employed in the area of lake Švarcenberk may have been perceived by residents of agricultural settlements

(Horusice) at a distance of 7 km. In other words, contacts between Mesolithic and Neolithic populations should not be excluded.

3.2. Human impact on the landscape and vegetation during the Mesolithic

In this chapter, the evidence of human activity during the Early and Middle Holocene is discussed. According to the traditional point of view, the impact of pre-Neolithic man on the landscape, respectively on the vegetation within it, was negligible (*Rybníček – Rybníčková 1992*). Fortunately, the traditional point of view of pre-Neolithic human impact on the landscape and vegetation has been more as decade before re-evaluated (*Zvelebil 1994; Regnell et al. 1995*), particularly since Marek Zvelebil in 1994 reviewed current evidence for plant use in Mesolithic Europe.

3.2.1. Plant use in the Mesolithic

Firstly, it is important to point out that despite the problems of plant preservation and the lack of effective research methods, evidence consisting mostly of macrofossils of nuts, fruit, and grasses is continually increasing across the whole of Mesolithic Europe (e.g. *Zvelebil 1994; Kubiak-Martens 1996; 1999; 2002; Mithen et al. 2001; Holst 2010*) including the Czech Republic (*Pokorný 1999; 2003; Opravil 2003; Pokorný et al. 2008; 2010*). This evidence includes remains such as hazelnut, water chestnut, pear, raspberries, elder, *Chenopodium*, waterlily, reed, bogbean etc. In the Czech Republic, one should note a find of charred seeds of black elderberry (*Sambucus nigra)*, white goosefoot (*Chenopodium album*), raspberry (cf. *Rubus idaeus*), and hazelnut (*Corylus avellana*) in a sandstone rockshelter (Jezevčí Převis) in Bohemian Switzerland (*Pokorný 2003*). These macrofossils tell us about environmental and vegetational manipulation within the context of gathering and perhaps even within the context of first cultivated crops (*Sádlo et al. 2008*, 49). Recently, Pokorný et al. (*2008*) have also suggested the deliberate introduction of some species by transporting harvested hazels and water-chestnuts, buried in lake sediments of the former Lake Švarcenberk in the Třeboň Basin, South Bohemia, at the very beginning of the Holocene (see below). In addition to archaeobotanical evidence, artefactual evidence also supports the existence of intensive plant use strategies in the Mesolithic by a widespread distribution of soil-working tools (hoes and antler mattocks) and by a presence of reaping and grinding equipment, especially in temperate Europe (*Zvelebil 1994*).

3.2.2. Woodland clearance

Another point deserving attention is the fact that pollen analyses bring broad evidence of forest disturbances dated to the late Mesolithic period (*Zvelebil 1994*). Although traditionally, Mesolithic communities were not expected to clear forests (see *Vera 2000*), these disturbance phases visible in pollen diagrams, for example in Britain (e.g. *Simmons 1996; Innes et al. 2003*), Germany (*Bos – Urz 2003*), and recently also the Czech Republic (*Nováková et al. 2008; Pokorný et al. 2008*), are associated with evidence of regular and recurrent burning and clearance activity delaying forest regeneration (*Jacobi et al. 1976; Mellars 1976*). Such burning of the vegetation is documented not only by the permanent presence of microcharcoal in pollen records, but also increased incidence of certain anthropogenic pollen indicators. These are plants that prefer open habitats such as *Thalictrum*, *Rumex*, *Melampyrum*, *Plantago lanceolata*, *Poaceae*, and that expand to fire-affected areas including *Pteridium aquilinum*, or *Calluna vulgaris* (*Simmons 1996; Pokorný 1999; Pokorný et al. 2008*).

Such evidence also supports the suggestion that Mesolithic people deliberately manipulated their environment as a part of organized land use strategy (*Zvelebil 1994*). However, these disturbances can be interpreted also in terms of natural processes such as lightning strike, storms, windthrows etc. that would leave an identical signal in the palaeoecological record as anthropogenic clearance (*Simmons 1996; Brown 1997*). In addition to mentioned above, it has been proposed that only the presence of cereal pollen can indicate without doubt the anthropogenic origins of disturbances (*Simmons – Innes 1987*), but this would consider only forest clearances associated with cereal cultivation (*Zvelebil 1994*). Despite all of this, Mesolithic sites are almost everywhere in the world accompanied by large amounts of microcharcoal, which is found in sedimentary records. This plays into the idea of burning forests as a usual way of dealing with nature (*Sádlo et al. 2008*) and continuous presence of microscopic charcoal in the sediments is now also considered as reliable indicator of human activity during the pre-agricultural Holocene (*Pokorný 1999*).

3.2.3. Mesolithic agriculture?

Moreover, recently there has been also discussion of accumulating palaeobotanical evidence that points out to agricultural activity in central and northern Europe well before the onset of the Neolithic (*Innes et al. 2003; Poska and Saarse 2006; Behre 2007; Tinner et al. 2007*). The palynological evidence is based on the consistent presence of the Cerealia pollen within the sediments that provide high temporal resolution and precision for the period of interest. The presence of pollen of Cerealia during the Mesolithic period also correlates with the pollen of semi-cultural plants or weeds, such as *Plantago lanceolata* that is considered to be one of the most reliable indicators of agriculture (*Tinner et al. 2007;* see *Behre 2007* for further discussion). Given that the evidence for cereal cultivation during the Mesolithic is provided from Switzerland, Austria, France, Estonia, British Isles (*Innes et al. 2003; Poska and Saarse 2006; Tinner et al. 2007*) etc., some scholars (e.g. *Tinner et al. 2007*) thus consider the occurrence of pollen indicative of agriculture activities during the late Mesolithic as a widespread phenomenon in Europe.

However, the topic is in the centre of controversial debates mainly because there are no well-dated macrofossils of crop plants of pre-Neolithic age (*Behre 2007*) that may be caused by the fact that no late Mesolithic sites in and around central Europe are known with good conditions for preservation of botanical remains (*Jacomet and Kreuz 1999*, cited in *Tinner et al. 2007,* 1417). The Mesolithic agriculture, as assumed, is based solely on the occurrence of single Cerealia or Cereal-type pollen in the respective levels of pollen diagrams (*Behre 2007; Tinner et al. 2007*). Firstly, single pollen grains of Cerealia-type which have been interpreted as indicators of earliest agriculture, however, may not really derive from cereals, because cereal pollen can be morphologically similar to that of wild grasses and is not always distinguishable (*Dumayne-Peaty 2001,* 381). Another problem is the spontaneous polyploidization of wild grasses, which leads to the development of large pollen grains, contributing to the difficulties of identification cereals (*Behre 2007; Pokorný et al. 2008*). In addition to misidentification, there are also problems of contamination or possible long-distance transport of the Cereal-type wild grass pollen grains from the Near East and the eastern Mediterranean that cannot be distinguished from cereals (*Behre 2007*). Another explanation of the appearance of pre-Neolithic cereal-type pollen would be the cultivation of indigenous wild grasses (*Zvelebil 1994*).

One of the most common arguments for ruling out Mesolithic agriculture is that crops cannot be produced without permanent settlement activity protecting the fields against herbivores (*Behre 2007*). However, protection can be provided by simple fence construction made from prickly shrubs (*Pokorný – Sádlo 2008*). Moreover, evidence suggests that possible cereal production during the Mesolithic was low-intensity and the purpose of this could have been planting cereals for prestige reasons that are comparable with Neolithic copper axes that were too soft to be used to as effective tools (*Tinner et al. 2007*).

3.2.4. The extinct Lake Švarcenberk: a case study in southern Bohemia

The recent discovery of extensive Mesolithic settlement around the extinct Lake Švarcenberk in the Třeboň Basin, south Bohemia, has offered an extraordinary opportunity to study the natural environment and its interaction with human settlement for the period of time between 15 000 years BP and 5000 years BC (Fig. 16). Such a great scientific potential is based on conditions suitable for both palaeoenvironmental as well as archaeological research. Interestingly, an intensive occupation of the area during the Mesolithic period was indirectly substantiated on the basis of the results of pollen and other microfossils analyses and this hypothesis was supported through the findings of later archaeological survey and excavations (*Pokorný et al. 2008; 2010)*. So far eight Mesolithic archaeological sites were found in the southeast shore of the former lake. Additionally, undisturbed dry archaeological site was detected in the peninsula. In wet shoreline areas, organic strata transformed by humans were discovered together with wooden artefacts, dated to the Preboreal period *(Pokorný et al. 2010)*.

The importance of palaeoenvironmental research lies in the fact that it brings invaluable information to our understanding of the central European Mesolithic, particularly with respect to human influence on the environment. The investigated lake sediments showed to be rich in pollen grains and plant macrofossils, including fresh wood (Fig. 18) and large pieces of charcoal bearing traces of working, dated between 9 130 BC and 8 630 BC by radiocarbon dating. The presence of a series of types of herbs evaluated as secondary anthropogenic indicators as shown by pollen analysis and some plant macrofossils (shells of hazelnuts and raspberry seeds) are surprising in lake sediments, because they belong to types growing in drier areas. Obviously, these finds represent remains of gathered foodstuff (*Pokorný et al. 2008; 2010*). Moreover, half of the hazelnut, found within a layer of lake sediments with artefacts, have been radiocarbon dated between 8 640 and 8320 BC. At the very beginning of the Holocene hazel only occurs sporadically in central Europe, therefore, the hazelnuts found within this context may be interpreted as indirect evidence of the diffusion of this wood species by humans (*Pokorný et al. 2008*).

The layer of reed peat above the bed of above described sediments developed after the silting up of the lakeside zone between 9 000 and 5000 BC. This layer is characterized by the black coloured upper part, which is the result of the presence of a large amount of microscopic charcoal, likely indicating the burning down of woodland or lakeside vegetation in the surrounding area. The increased occurrence of pollen grains and spores of some anthropogenic indicators correlates with the presence of microscopic charcoal. Namely, plants which prefer an open grassy environment (*Thalictrum, Rumex acetosella, Melampyrum, Plantago lanceolata, Poaceae*) and that which expand into fire affected areas (*Pteridium aquilinum, Calluna vulgaris*). The occurrence of some taxa (*Artemisia*, Chenopodiaceae, *Plantago major*-type) could be connected to the presence of ruderal stands at the settlements. Of particular interest is the occurrence of water chestnut (*Trapa natans*) (Fig. 19) preserved in the lake sediments in the form of both plenty macrofossils and pollen grains. Amylaceous chestnuts of this aquatic plat formed a considerable part of Mesolithic diets and its surprisingly early appearance at the very beginning of the Holocene in the sediments of Lake Švarcenberk can thus be regarded as possible evidence of its deliberate introduction. The early occurrence (between 9050 and 8400 BC) of cereal pollen grains (*Triticum*-typ) is also interesting. These findings are not unique in central Europe and can be interpreted as the cultivation or polyploidization of indigenous wild grasses (see above) (*Pokorný 1999; Pokorný et al. 2008; 2010*). For pollen diagram from the centre of the lake basin, see Fig. 17.

3.2.5. Human-environment relationship

A fairly obvious conclusion that can be drawn at this point is that by the late Mesolithic, the patterns of plant use support the notion of controlled, regular, and intensive use of plant resources on a scale which left an imprint on the landscape instead of the incidental and opportunistic use of plants for food (*Zvelebil 1994; Sádlo et al. 2008*). Nevertheless, Mesolithic archaeology has been little concerned with understanding how hunter-gatherers in the past came to terms with the world around them and therefore they have been always separated from farmers (*Warren 2003*). However, by focusing on the Mesolithic in terms of not only economic, but also societal dynamics, imbued with ritual and symbolism, some form of continuity in human-environment relationships and 'forest identity' between later Mesolithic and Early Neolithic populations can be identified.

3.2.5.1. Ecological relationships with hazelnuts?

According to the famous statement by Richard Bradley (*1984,* 11) "…successful farmers have social relations with one another, while hunter-gatherers have ecological relations with hazelnuts." Although much has been written since this remark had been made and our view of the Neolithic and also Europe's hunter-gatherers past has significantly changed, there is still the persistence of this idea in the literature. Additionally, the point of that statement is that the Mesolithic is treated only as an economic phenomenon (*Moore 2003*).

To support Bradley's statement, it is generally accepted that woodland clearances, irrespectively of their causation (see above), were utilized by Mesolithic populations for food procurement. However clearances were created, they had an economic use. Plant and animal productivity could be almost doubled by a strategy of controlled burning (*Mellars 1976*). Forest clearance would have led to particular advantages for the propagation of edible plants and clearings serve also in order to facilitate hunting (*Jacobi et al. 1976; Mellars 1976; Zvelebil 1994*).

3.2.5.2. Social aspects

On the other hand, the palaeocological record is neutral with respect to origin, meaning or intention and Mesolithic populations should be no longer regarded as doing nothing more than pursuing a kind of optimal foraging strategy. The dominating ecological approach may originate from comparison with rich material culture of preceding Late Upper Paleolithic and succeeding Neolithic periods, but it does not take into account the fact that we face the lack of discussion concerning Mesolithic socialities (*Davies et al. 2005*). However, ecological relationships may have been a key factor in the development of social relationships in the Mesolithic and it is important not to separate the economic from the cultural, particularly in terms of understanding human interaction with woodlands in the Mesolithic (*Moore 2003*). Nonetheless, environment and trees within it should be considered as more than a background to human activity.

Before focusing on how woodlands and individual trees may have been regarded by people in the Mesolithic, it is important to distinguish between two possible modes of human-environment relationships. The first one can be described as beneficent human-environment relationship, where human and non-humans influence one another in a mutually beneficial way. This contrasts, however, with another mode of human-environment relationship, concept of wilderness, where fear is a primary motivator determining behaviour and surroundings is more often seen as malevolent rather than benevolent (*Evans et al. 1999; Warren 2003; Davies et al. 2005*).

With respect to anthropological and ethnographic evidence, Davies et al. (*2005*) suggest that Mesolithic populations may have been driven more likely by anxiety and fear of their surroundings, rather than be familiar with it. Therefore, thinking of the woodlands as being marked by paths (*Warren 2003; Tilley 1994,* 202), one of the primary motivators in establishing paths may have been fear of actual harm of wildlife, spirits, or getting lost in surroundings where the horizon is seldom visible. Consequently, woodland clearings may result from such fears and could be explained as a purely social phenomenon.

Another point deserving attention is the fact that woodland and trees may have been also an important factor in ritualising the landscape. In many cultures, trees are regarded sacred or even feared (*Frazer 1922; Rival 1998*). According to the Frazer's famous "*The golden bough*", there is a broad collection of customs relating to trees.

Trees are animate, they can be related to ancestors, or they can even have spirits. However, there has been little interest into the spiritual significance of trees both, anthropologically (*Rival 1998*), as well as archaeologically (*Moore 2003*).

With regard to many ethnographic accounts concerning hunter-gatherers, the resources of woodland, including food as well as other raw materials and medicines, may have been an important part in symbolic understanding of the aspect of natural world. We should also consider that the variation in the ease of mobility in woodlands as well as the availability of resources may have formed important structuring point in an understanding of seasonality (*Warren 2003*). In many cultures, woodland and trees are also thought to be the dwellings of spirits or ancestors (*Rival 1998*). Consequently, regarding the symbolism of woodland and particularly trees, we should bear in mind that although the evidence will not survive in the archaeological record, it should not be disregarded (*Neustupný ed. 2002; Moore 2003*).

3.2.5.3. Is there any continuity? Examples drawn from the British Isles.

According to Tilley (*1994*) the significance of place in the Mesolithic is understood in terms of its setting in the landscape. Conversely, in the early Neolithic, the relationship between the landscape and populations became restructured and the monuments can be understood in terms of connection between people and the land (*Tilley 1994,* 202). Furthermore, taking into account a consideration of the landscape settings of monuments, trees may have been an integral part of the experience and use of early Neolithic monuments in their wider landscape settings (*Cummings – Whittle 2003*). Additionally, taking into consideration the fact that many Neolithic monuments, including Stonehenge, show evidence of Mesolithic activity below a later monument (*Moore 2003*), Moore (*2003,* 142) makes the point that "…some monuments were constructed in, or closely associated with, sacred groves of woodland, the trees of the ancestors and that that 'sacredness' had come about from the beliefs of Mesolithic people." Moreover, Evans et al. (*1999*) have suggested that there may have been focal points in forests created by tree-throws or clearings in the early Neolithic, related to later Mesolithic pit dwellings, and suggest that the evidence may attest to a degree of continuity between the Mesolithic and the earliest Neolithic in terms of a shared forest identification.

4. Conclusion

To summarize, the present work brings a literature review of the Neolithisation process in central Europe. Some particular aspects including genetics, stable isotope analysis, lithic studies, and demography have been dealt with in order obtain the clearest possible picture of the process. It has become clear that the spread of the agriculture involved a variety of mechanisms and cannot be explained only by a simple model of migration or acculturation. According to the integrationist model, accepted by the majority of scholars, local Mesolithic groups played an important role in this process. In conclusion we can say that there is evidence which points at contact and interaction between local hunter gatherers and the earliest farming communities. Recently, it has become increasingly apparent that such a scenario provides a plausible explanation for the situation in the Czech Republic, where the spread of farming had traditionally been accepted as an example of agricultural colonization by farmers of LBK.

The work also deals with the Mesolithic background for the Neolithisation process, especially with respect to the impact of Mesolithic humans on the environment. Although the study of the Mesolithic period was neglected by Czech archaeologists for a long period of time, currently, there is clear evidence for Mesolithic settlement of the Czech Republic. Moreover, there is considerable evidence indicating contacts between Mesolithic and Neolithic populations. This may be partly due to the cooperation between archaeologists and archaeobotanists, as has been shown in the example of the recent discovery of extensive Mesolithic settlement around the extinct Lake Švarcenberk. Furthermore, interdisciplinary activities between specialist in the natural and human sciences enable us not only to detect the human impact on the natural environment but also to reflect more than just stone tools – instead, it helps to understand to people who made them by considering their social life.

5. Abbreviations

AV ČR – Akademie věd České republiky (The Academy of Sciences of the Czech Republic)

ČAS – Česká archeologická společnost (Czech Archaeological Society)

ČSAV – Československá akademie věd (Czechoslovak Academy of Sciences)

JM – Jihomoravské muzeum ve Znojmě (South Moravian Museum in Znojmo)

MZM – Moravské zemské muzeum (The Moravian Museum)

NM – Národní muzeum (National Museum)

ÚAPP – Ústav archeologické památkové péče (Institute of Archaeological Research and Preservation of Historical Monuments)

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7. List of figures

Fig. 1: Key sites mentioned in the work (Vedrovice, Švarcenberk), projected on a map of central Europe.

Age	Phytostratigraphy	Zoolitostratigraphy	Biocenosis development	Sedimentation Pedogenesis, Soil loss	Development stages	Chronology
1000 0	SUBATLANTIC	SUBRECENT 700 SUBATLANTIC	Current cultural landscape development Medieval colonisation - deforestation Modern species intrusion Beech-fir forest expansion	Soil erosion Soil degradation Temporary retreat of settlement Celtic oppida construction	MIDDLE AGES Slavs Migration Period ROME IRON AGE	YOUNGER HOLOCENE
-1 000	SUBBOREAL	-700 SUBBOREAL	Prehistoric colonisation, pasture, deforestation	Coarse debris formation	BRONZE AGE	
-2 000 -3 000		-1 400 EPIATLANTIC	Gradual spread of beech, beech-fir, and hornbeam forests Beech stage formation Formation of current vegetation stages Continuous afforestation of unpopulated areas	Calm development, soil and headwater limestone sedimentation interrupted by short-term fluctuation with the formation of debris	ENEOLITHIC	MIDDLE
-4 000					NEOLITHIC	
-5 000	ATLANTIC	-4 800 ATLANTIC	Two-track development Initial farmer settlement Rapid forest expansion overshadows the relicts of biocenosis of the open landscape	Sudden drying Intensive pedogenesis Calcareous tufa formation in caves	MESOLITHIC	
-6 000 -7 000	BOREAL	-6 500 BOREAL	The predominance of mixed oak forests, spruce in the mountains Park landscape –leaf formation of the chernozem steppe	Strong wetting Rapid rise in temperature Beginnings of $CaCO_3$ sedimentation		OLDER
-8 000	PREBOREAL	-8 500 PREBOREAL -9 500	Spread of pine, birch, first demanding woody plants, hazel	Weakly developed calcareous soils	LATE PALEOLITHIC	
-9 000	YOUNG DRYAS	YOUNG DRYAS -10 700	Sparse taiga, last occurrence of glacial features	Non-humic colluvial deposits		LATE GLACIAL PLEISTOCENE
	ALLERÖD	ALLERÖD -12 000	Spread of pine, birch at the expense of open formations	Weak humic soils		
-10 000	OLDER DRYAS	OLDER DRYAS -12 400	Cooling down		MAGDALENIAN	
	BÖLLING	BÖLLING -13 200	Spread of pine, birch	Beginnings of soil development		
-11 000	OLD DRYAS	OLD DRYAS -14 500	Transition from a loess steppe to more humid facies	Ceasing of loess formation		

Fig. 2: Chronological framework and periodization used in the text. The red outline shows the period of interest. After *Ložek 2007, 46*.

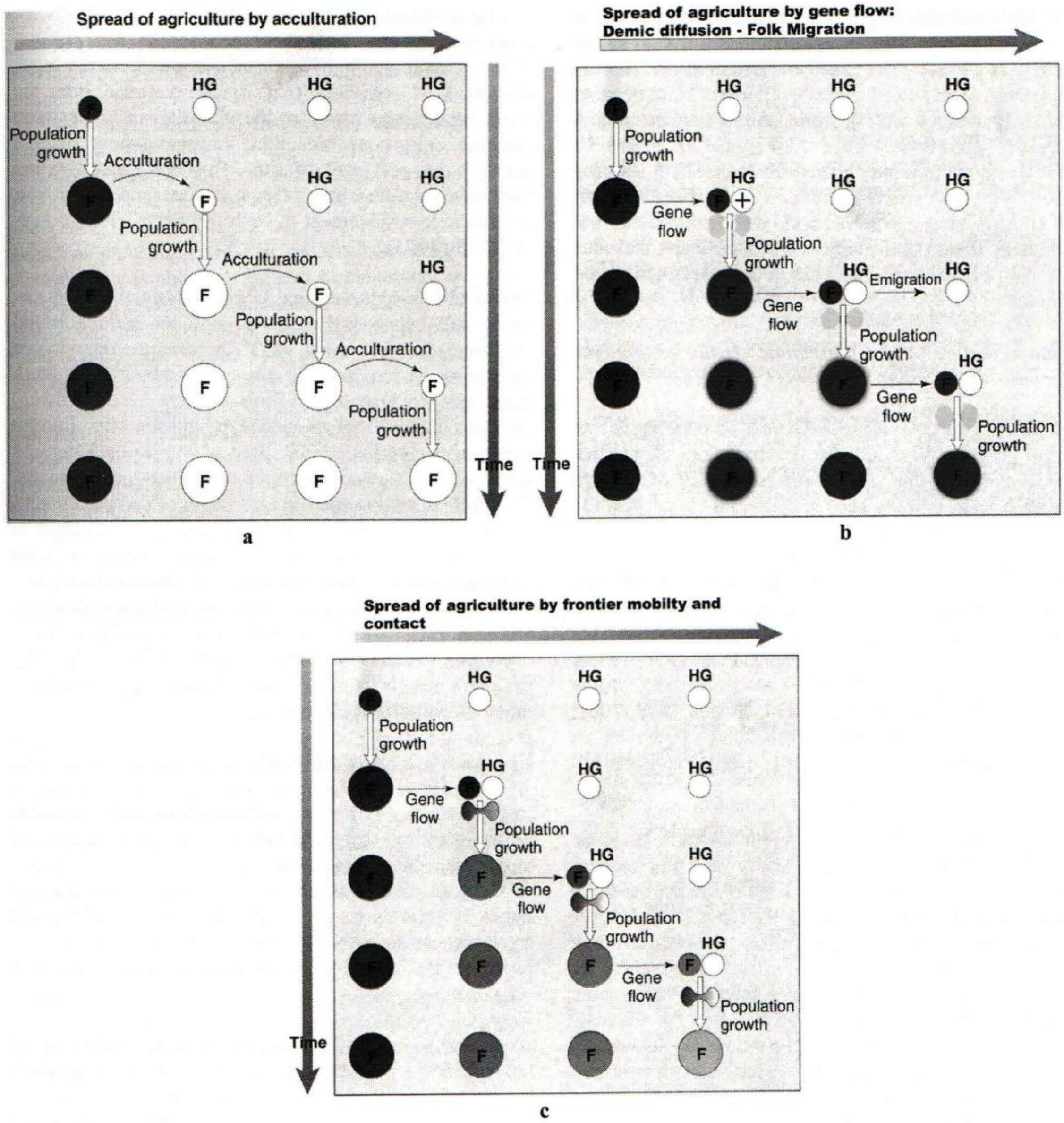

Fig. 3: Different models for the spread of farming diagrammatically expressed and incorporating gene flow and culture change. (A) Spread of agriculture by acculturation (B) Spread of agriculture by gene flow (C) Spread of agriculture involving gene flow, frontier mobility and contact. After *Zvelebil 2004*, 198.

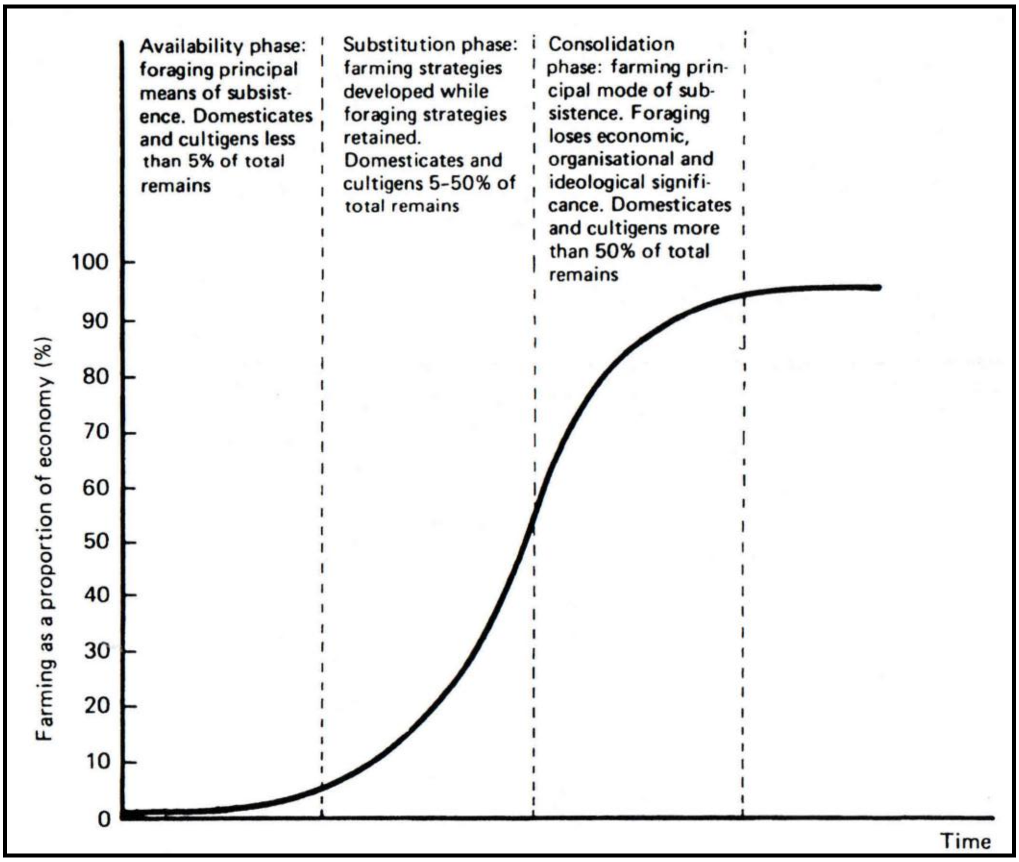

Fig. 4: The availability model of the transition from foraging to farming. After *Zvelebil 1986, 12*.

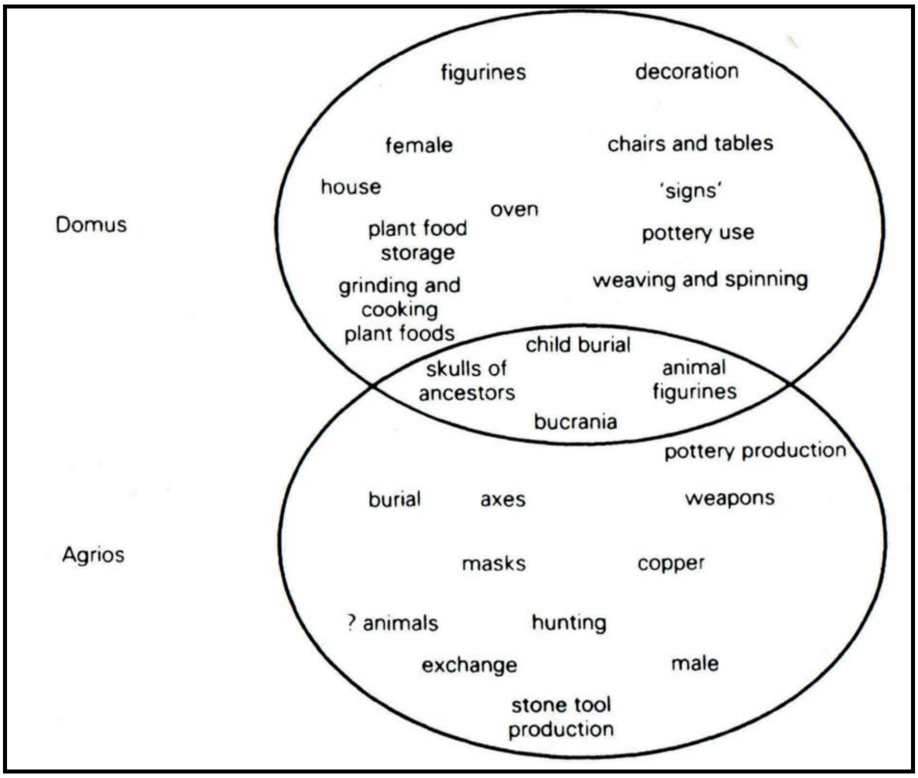

Fig. 5: Association of the domus and agrios in SE Europe. After *Hodder 1990, 69*.

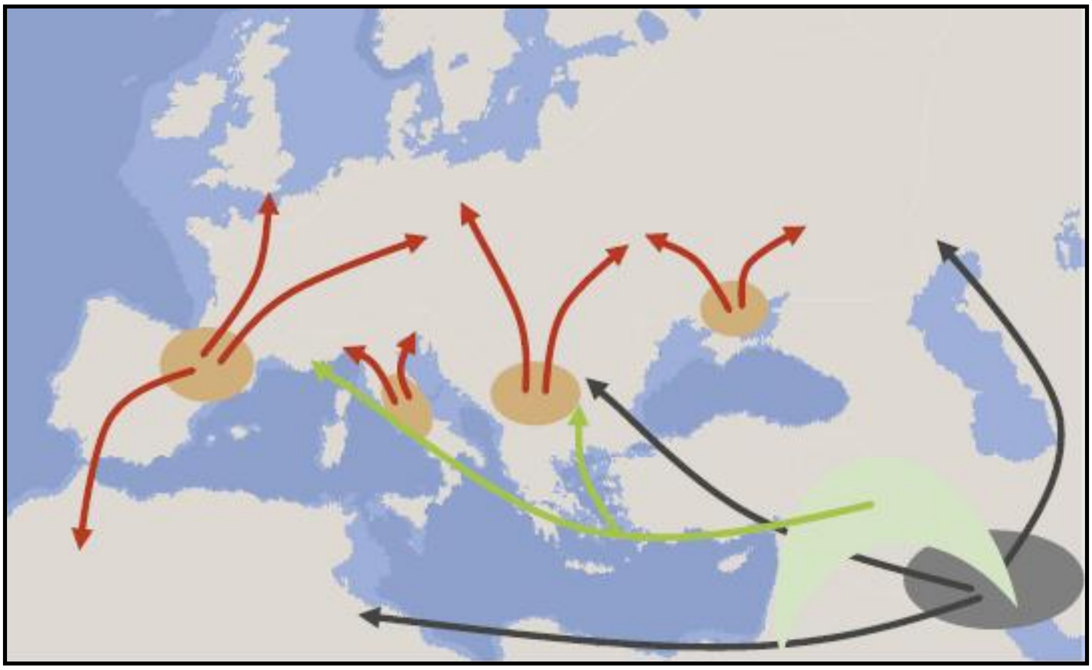

Fig. 6: European migrations. Black arrows indicate the first settlement by modern humans around 45 thousand years ago (kya). At the end of the last ice age, around 10–15 kya, Europe was re-populated from glacial refugia (red arrows). Around 8–10 kya, Neolithic farmers came to Europe from Anatolia and the Fertile Crescent (green arrows). After *Renfrew 2010, R164.*

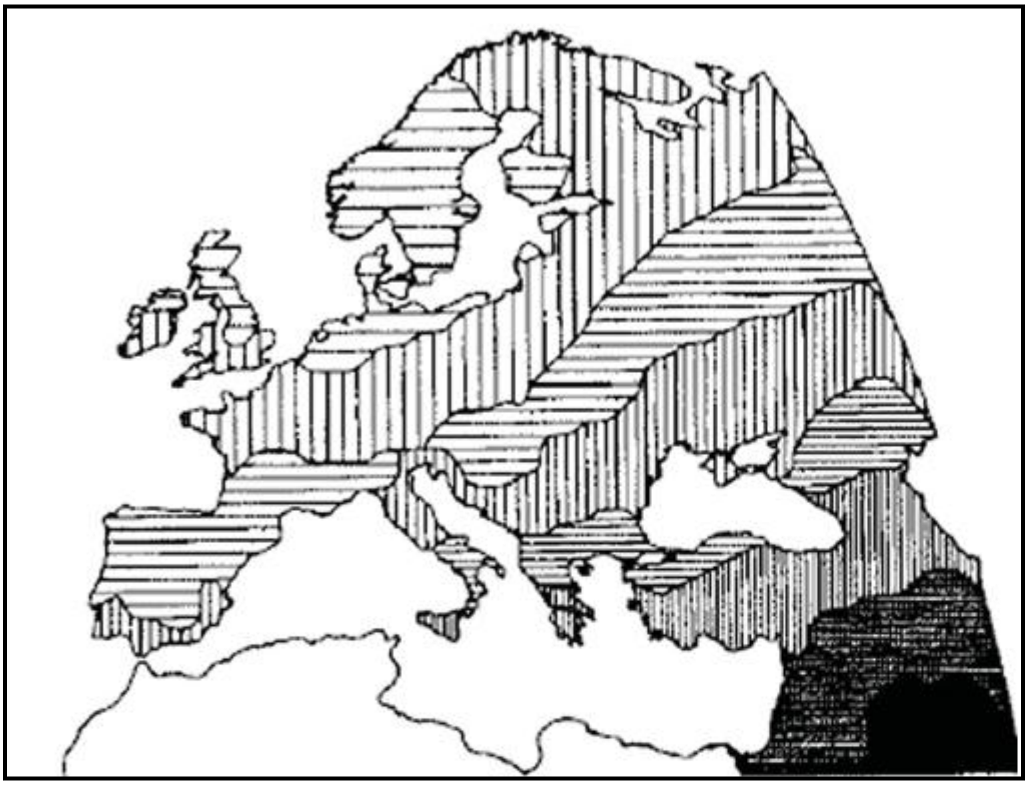

Fig. 7: Synthetic map of the first principal component, summarizing genetic variation in Europe. After *Cavalli-Sforza et al. 1994, 292*.

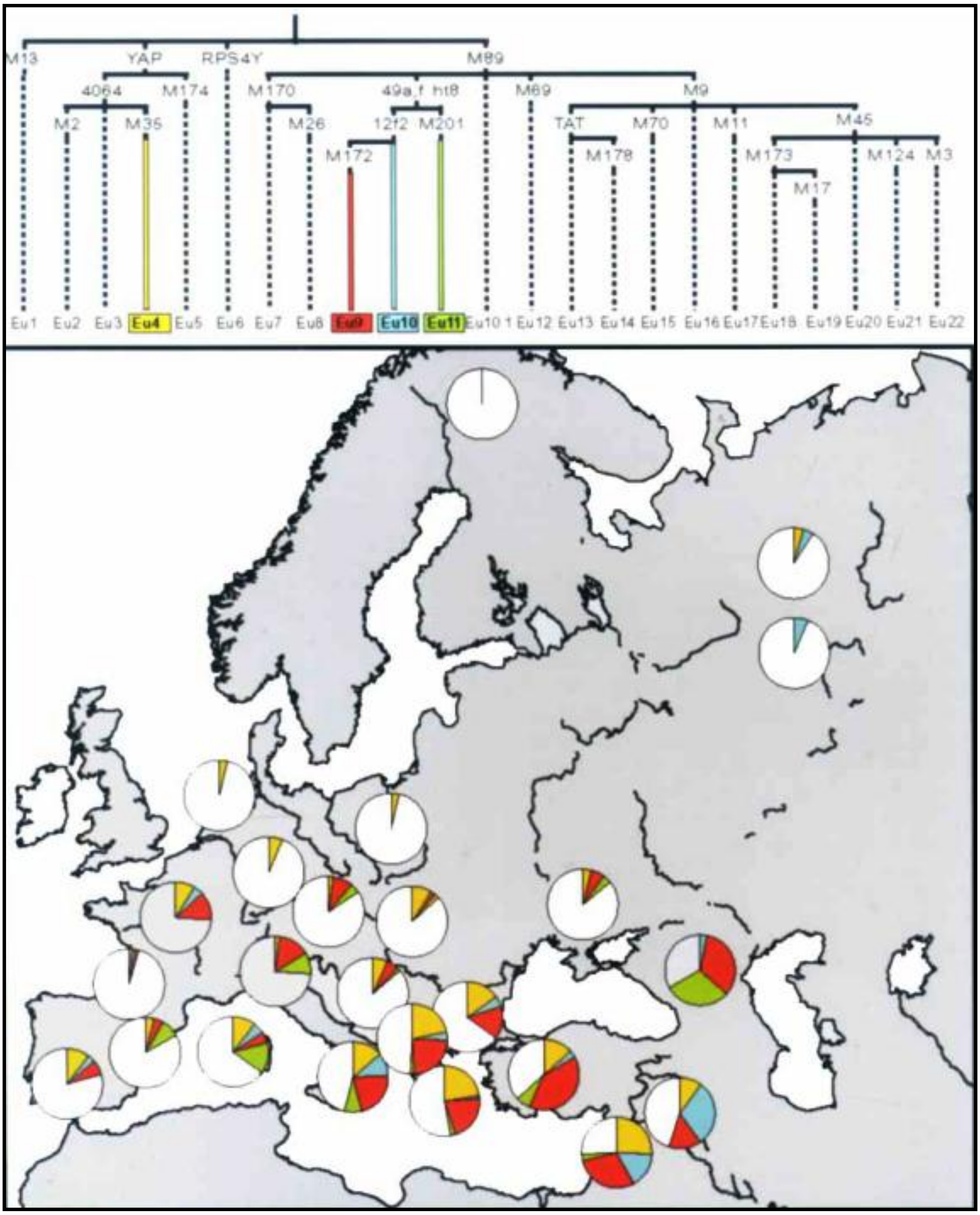

Fig. 8: Top: maximum parsimony phylogeny of Middle Eastern Y chromosome lineages possibly associated with the transition to agro-pastoralism. Bottom: Frequency distributions of relevant haplotypes reproduced from *Semino et al. 2000*. After *King – Underhill 2002, 710*.

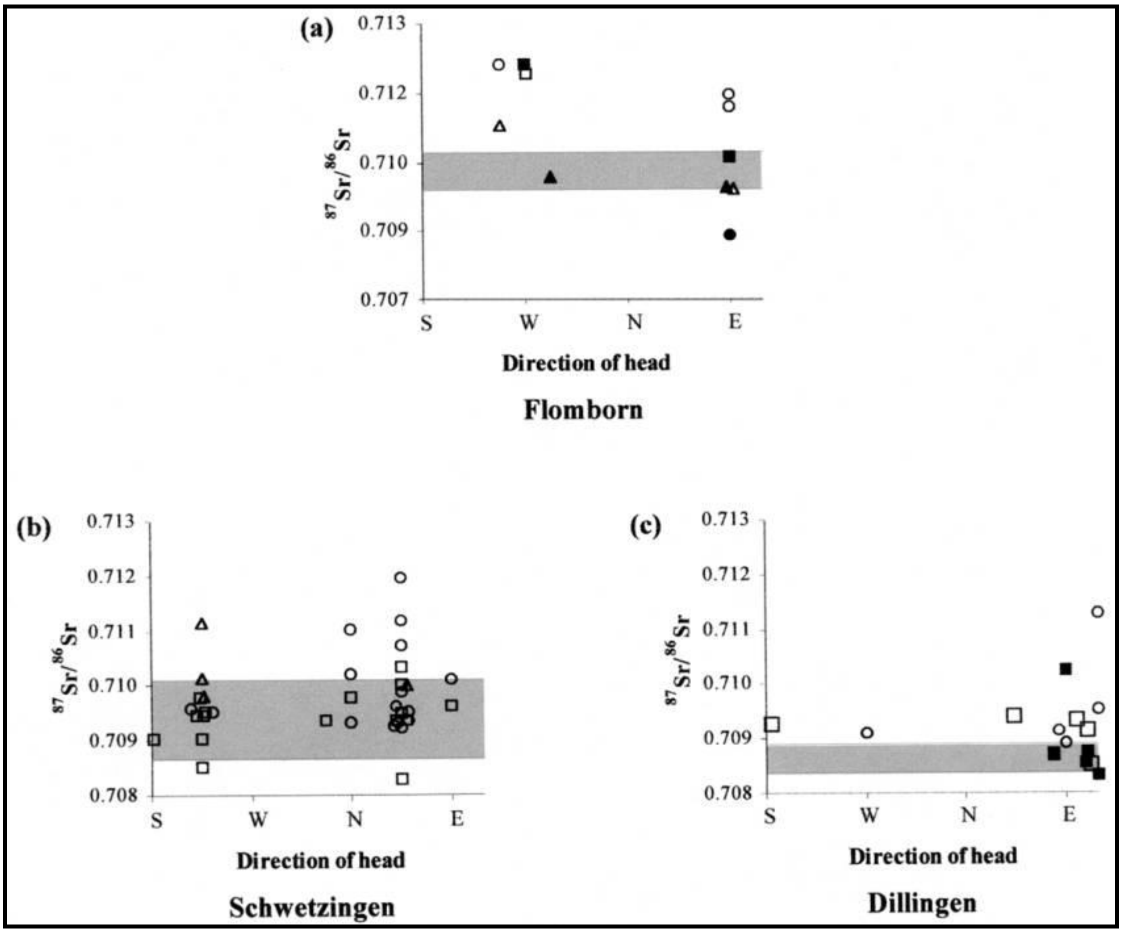

Fig. 9: Strontium isotopes in tooth enamel from three LBK cemeteries: a, Flomborn, b, Schwetzingen, and c, Dillingen. Each symbol represents a different individual: circles, female; squares, male; triangles, unknown sex (due to young age at death). The "local" 87Sr/86Sr range has been defined as two standard deviations from the average human bone value at each site (individual bone values not shown). The local range for each site is indicated by a grey bar. After *Bentley et al. 2002, 802.*

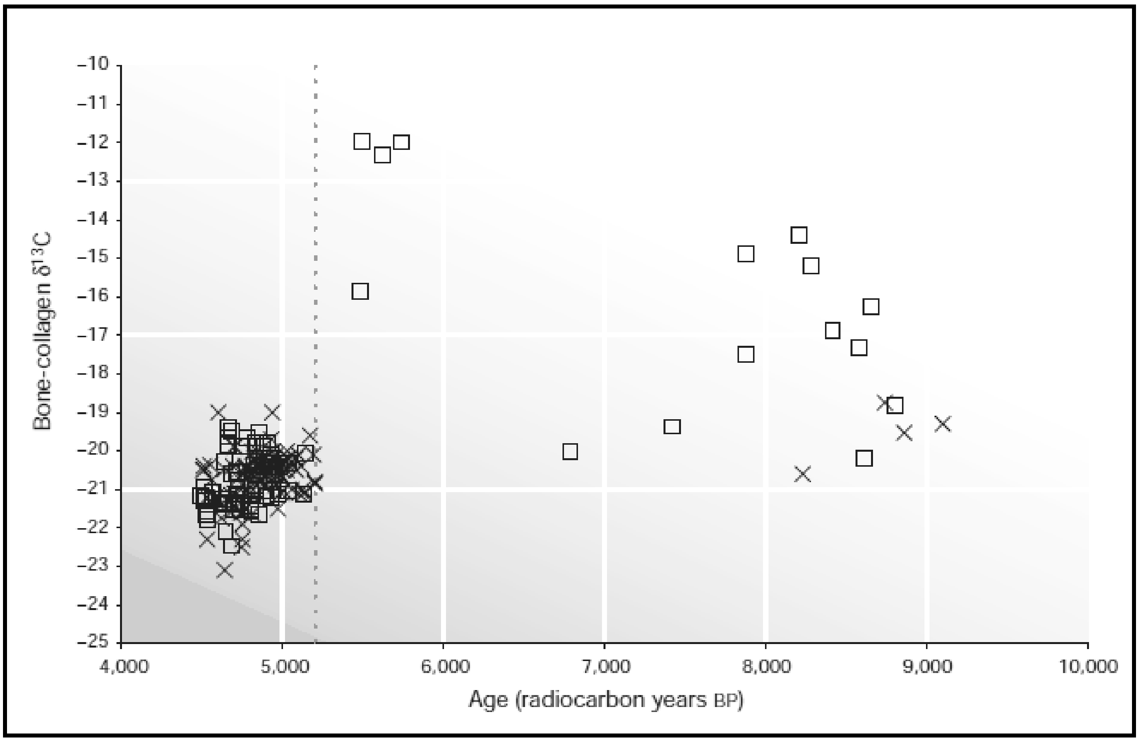

Fig. 10: Bone-collagen carbon-isotope ratios and radiocarbon ages of 183 Mesolithic and Neolithic humans from coastal (that is, living within 10 km of contemporary coastline; squares) and inland sites (crosses) in Britain. There is a sharp change in the carbon-isotope ratio at around 5,200 years BP (about 4,000 calendar years BC; dotted line) from a diet consisting of marine foods to one dominated by terrestrial protein. This period coincides with the onset of the Neolithic period in Britain. After *Richards et al. 2003, 366*.

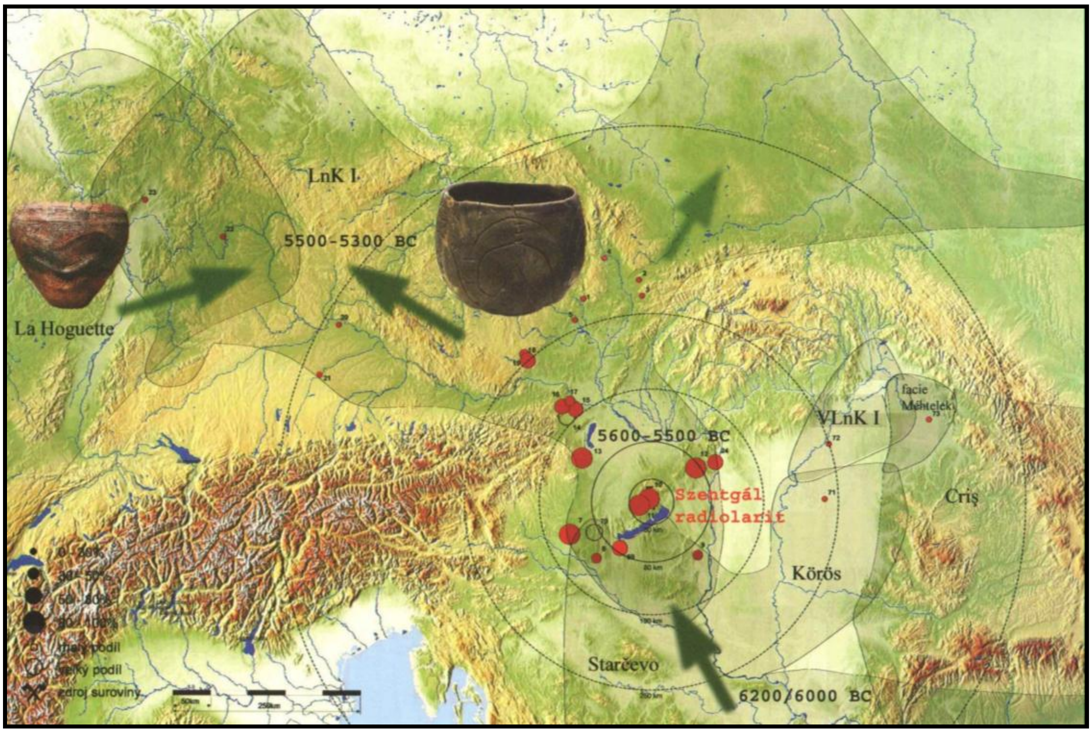

Fig. 11: Szentgál radiolarite distribution during the Early Neolithic. After *Mateiciucová 2008a, 35*.

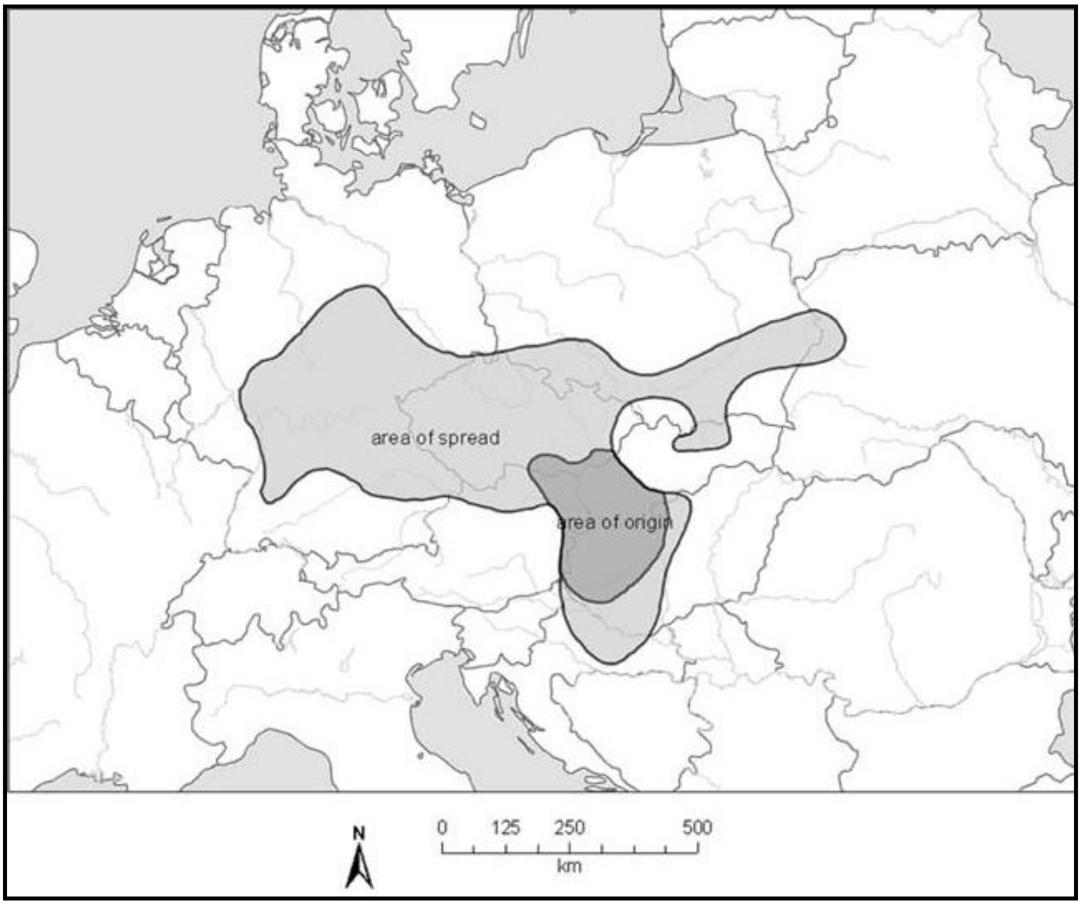

Fig. 12: Map of the LBK origin area in western Hungary and the area settled after the Earliest LBK expansion over central Europe. After *Galeta – Brůžek 2009, 140*.

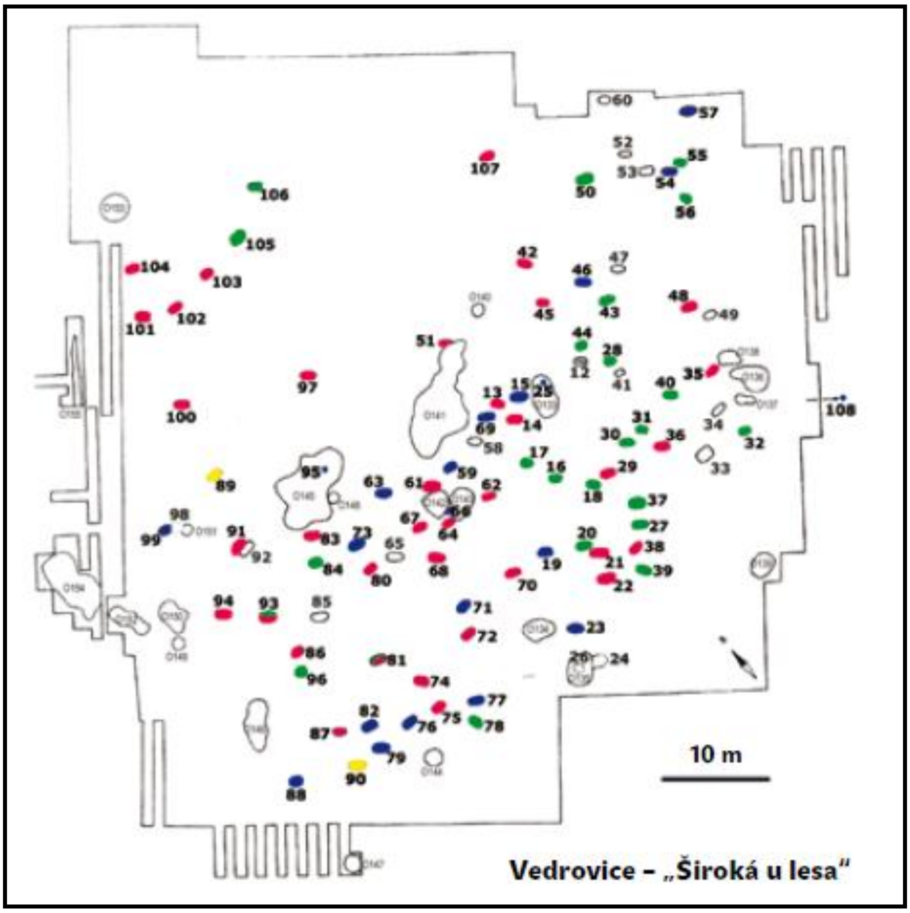

Fig. 13: Plan of the “Široká u lesa” cemetery at Vedrovice. Blue colour represents males; red colour represents females; green colour represents children; yellow colour represents unknown sex. After *Zvelebil et al. 2009, 90.*

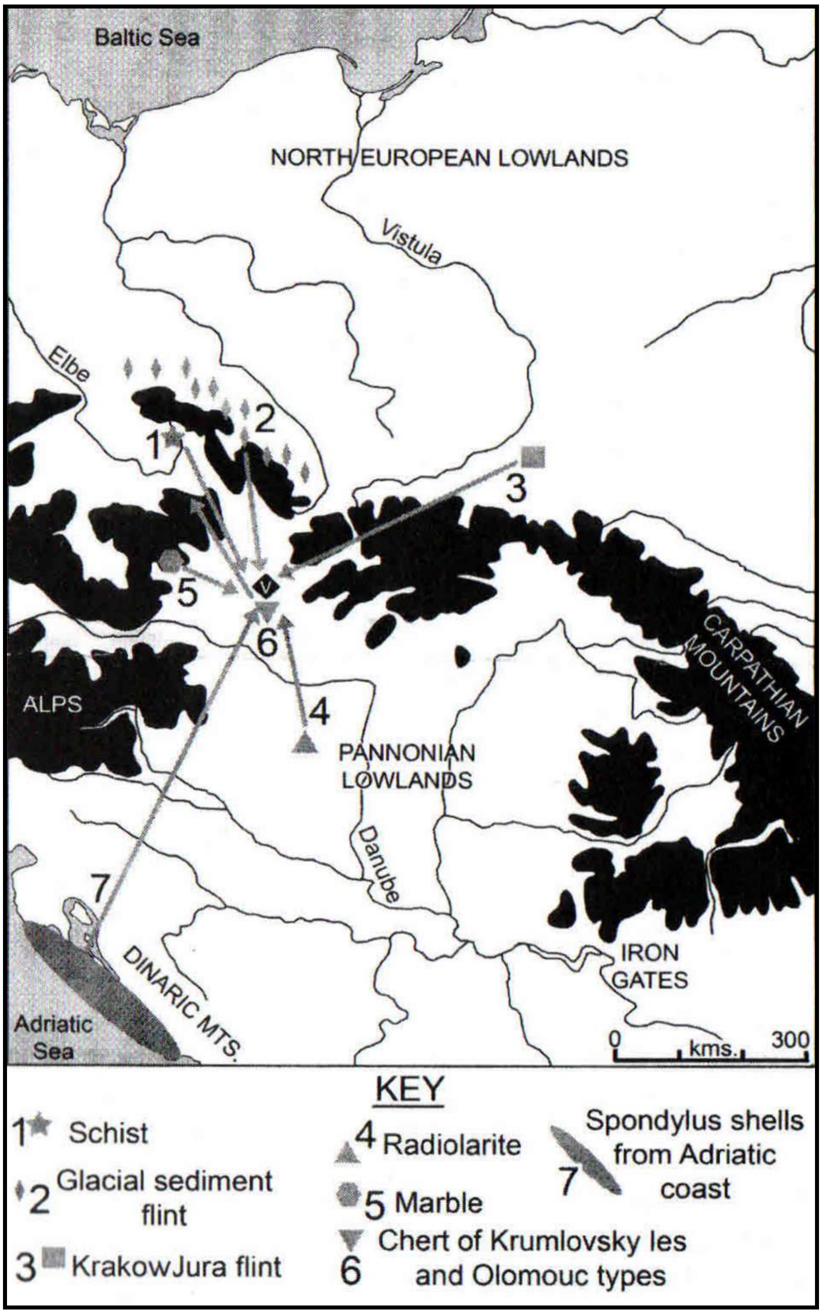

Fig. 14: Evidence of contacts between Vedrovice and other regions based on material culture. After *Zvelebil – Pettitt 2008, 201*.

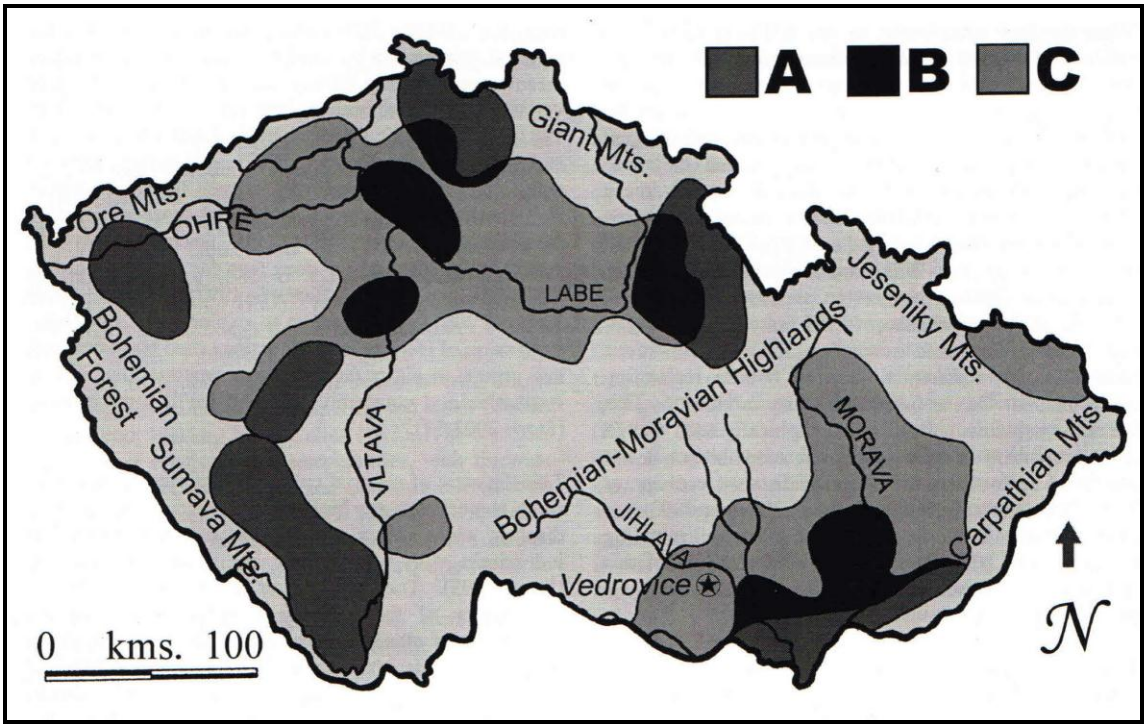

Fig. 15: Mesolithic and Neolithic settlement of the Czech Republic. A-Mesolithic settlement; B-Mesolithic overlapping with Neolithic; C-Early Neolithic settlement. After *Lukes 2004*, 20.

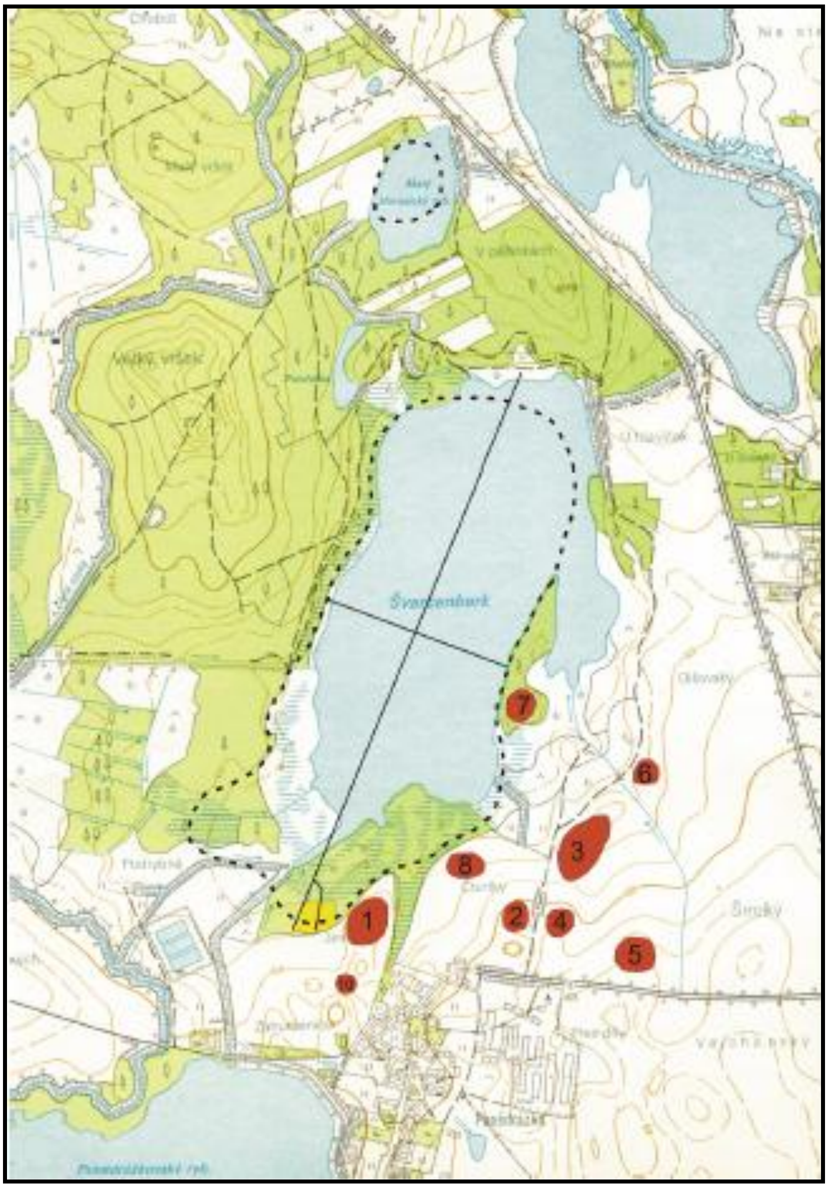

Fig. 16: Size of Lake Švarcenberk a Malý Horusický Pond and the identified archaeological sites. Legend: red – Mesolithic sites discovered through fieldwalking and archaeological research, yellow – preserved shore parts with documented archaeological situations, dashed lines – lines of lake shores, continuous lines – main profiles. After *Šída et al. 2010*, 37.

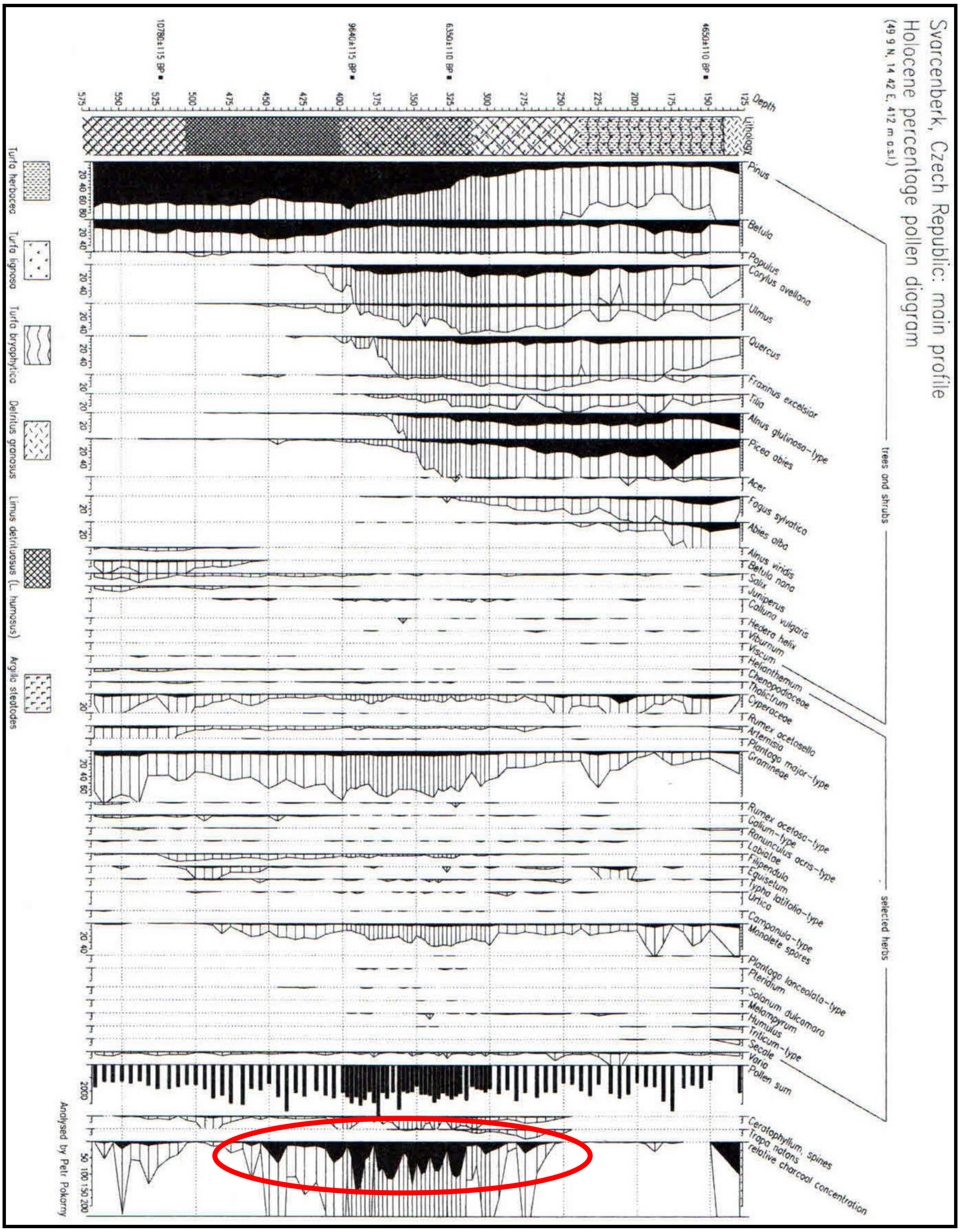

Fig. 17: Pollen diagram from the centre of the lake basin (core 1), upper part. The diagram represents the Holocene period. The red outline shows the presence of a large amount of microscopic charcoal indicating clearance of woodland in the Mesolithic. After *Pokorný et al. 2008*, 156.

Fig. 18: Detail of the fragment of the arrow shaft found in Lake Švarcenberk sediments, dated between 9 130 BC and 8 630 BC. After *Suda 2009*, 17.

Fig. 19: Detail of water chestnut (*Trapa natans*) found in Lake Švarcenberk sediments. After *Suda 2009*, 16.